

## **The Technological and Economic Future of Nuclear Power**

Reinhard Haas, Lutz Mez, Amela Ajanovic (Springer, 2019), 382

This book is edited by Reinhard Haas, Lutz Mez, and Amela Ajanovic, with contributions from various researchers and analysts in the areas of the economics of nuclear power, the legal and political aspects of sustainable energy, climate policies, and technical challenges. The book provides a comprehensive discussion and analysis of the technical and economic factors hindering the renaissance of nuclear power. It is divided into seven themes, covering a range of aspects that include nuclear power history, economics, legislation, technical issues, nuclear waste and proliferation, major accidents, and alternatives.

In the chapter titled *From Military to Early Civilian Applications*, Rosaria Di Nucci examines the transfer of nuclear technology from military institutions to civilian atomic agencies following the advocacy of “Atoms for Peace” program. She discusses the gradual development of nuclear frameworks that facilitate the legitimization of nuclear power and industry. Di Nucci highlights that Light Water Reactors (LWR) originated as by-products of research conducted for military submarines, particularly in the United States (US), the United Kingdom (UK), and France. Furthermore, she elaborates on the proliferation of LWR technologies through licensing agreements, such as the collaboration between Framatome and Westinghouse in 1958. Additionally, Di Nucci addresses the promotion of nuclear energy, which is strengthened by several factors such as the availability of enriched uranium, turn-key packages for plant construction, and government subsidies.

In the chapter *The Current Status of the World Nuclear Industry*, M. Scheinder and A. Froggatt correlate nuclear power with heat (temperature rise) and water in the context of climate impact. They highlight the ongoing struggles of the global nuclear industry, geographic trends, challenges being

faced by new reactor builds, economic viability, and future sustainability of nuclear power. They highlight that the global nuclear energy industry is experiencing stagnation with 32 units in Long Term Outage (LTO) as of July 2018, in the ‘big five’ nuclear generating countries, such as the US, the UK, France, and South Korea, except China. The authors mention that renewables and cheaper alternatives, efficient energy sources, e.g., natural gas combined cycle projects working in Egypt with 60% efficiency, rising costs, and political opposition, are changing the landscape of nuclear energy. Long construction timelines due to significant delays, budget overruns, or abandonment and aging reactor fleets turn nuclear power into an ‘endangered species’.

Aviel Verbruggen and Yuliya Yurchenko, in the chapter *The Collision of Atomic and Flow Renewable Power in Decarbonization of Electricity Supply*, critically analyzed the shift from nuclear to renewable energy in global climate policy, criticizing the Paris Agreement for allowing wealthy states to continue emissions under a ‘rights to emit’ framework. They argue that nuclear and renewable energy are incompatible in fully decarbonized systems due to their differing technical, economic, and systemic needs. They call for a transition to sustainable renewables supported by a stronger, binding, and equitable international governance framework beyond the current limitations of the Paris Agreement.

R. Haas et al., in the chapter *The Historical Development of the Costs of Nuclear Power*, describe the historical trajectory of nuclear power costs, focusing on investment and construction expenses and considering the actual investment cost rather than overnight costs (ONC). Once viewed as a low-cost option, nuclear power now faces rising expenses due to underestimated budgets, government subsidies, extended construction timelines (e.g., extreme cost overruns of projects Hinkley Point C, Olkiluoto-3, and Flamanville-3), increasing interest rates, rising raw material and labor costs, safety requirements, and pre-construction forecasts. They conclude that nuclear power is no longer an inexpensive

energy source and is not economically viable compared to renewable technologies like wind and solar.

In the chapter *Renewable Energies versus Nuclear Power Comparison of Financial Support Exemplified at the Case of Hinkley Point C*, Gustav Resch and Demet Suna evaluate the cost-effectiveness and financial support schemes for renewable and nuclear energy through both static and dynamic analyses. They underscore Hinkley Point C's cost escalation from €19 billion in 2013 to €43 billion in 2014, criticizing its financial model and comparing it to the European Union's (EU) renewable energy support, which resulted in a 40% increase in the deployment of renewable energies. The authors in this chapter reveal that renewable energy offers greater environmental and economic advantages, concluding that the UK could save up to 8.4% by selecting renewable energy over nuclear energy.

Wolfgang Irrek, in the chapter *Financing Nuclear Decommissioning*, analyzes the growing financial challenges of dismantling aging nuclear power plants. He discusses the complexities and risks involved, the polluter pays principle, and long-term liabilities. The chapter highlights the need for accurate cost estimates and strong regulatory frameworks. The author emphasizes that uncertainty can be minimized through transparent, well-governed financing models with segregated funds and regular contributions to ensure sufficient resources for decommissioning.

The chapter, *Nuclear Policy in the EU from a Legal and Institutional Point of View* by Dörte Fouquet, highlights the legal and institutional aspects of nuclear regulation in the EU. It focuses on the founding treaty establishing the European Atomic Energy Community i.e., treaty of EURATOM, its limited scope, challenges, and power struggles, its relationship with EU laws, and its conflicts with EU energy market goals. The author reveals the structural weaknesses in the EURATOM treaty and argues for its revision or replacement with a more effective regulatory framework to address current market conditions instead of relying on its outdated subterfuge.

In the chapter *Economic Management of Future Nuclear Accidents*, Tomas Karberger argues that the financial burden of seven nuclear accidents falls on victims and taxpayers due to hidden subsidies enabled by international liability frameworks. Using car accident analogies, he critiques the Price-Anderson Act (1957) and international conventions for shielding the nuclear industry from full liability. Citing approximately 10 major incidents over 17,000 reactor-years, the author highlights underestimated risks and costs and proposes a compulsory catastrophe bond system to ensure operator accountability and shift cost assessments from political to market-based mechanisms.

In the chapter *Corporate Policies of the Nuclear Vendors*, Stephen D. Thomas analyzes the global nuclear reactor supply industry as a risky niche market in some states. He discusses the financial struggles of major Western vendors such as Westinghouse, GE, Siemens, Framatome, Hitachi, and Toshiba, many of which have shifted to service roles or exited the market. He notes the rising dominance of Russian and Chinese firms but points to challenges such as limited Western regulatory reviews, China's restricted exports, and financial constraints. The author concludes that the future of the industry hinges more on political and economic support than on commercial viability.

David Reinberger et al., in the chapter *The Technological Evolution of Different Generations and Reactor* explores the technological evolution of nuclear reactors from Generation I to emerging Generation IV designs. They discuss improvements in safety and performance, construction delays, and rising costs in Gen III+, along with the potential of SMRs and Gen IV technologies. However, they highlight persistent challenges such as economic uncertainty, material limitations, and fissile control. The authors conclude that even with substantial public investment, nuclear research is unlikely to resolve issues related to nuclear power, climate change, and energy security.

Ben Wealer et al., in the chapter *Decommissioning of Nuclear Power Plants and Storage of Nuclear Waste: Experiences from Germany, France, and the UK*, explore the technical and financial challenges, national strategies, and funding sources involved in the decommissioning of large nuclear power plants and the storage of nuclear waste in Germany, France, and the UK. They note that France and the UK are postponing the decommissioning of the legacy fleets well into the next century, using internally segregated funds in France and taxpayer costs over the next 100 years in the UK. They argue that uncertainties in financial estimates for decommissioning, a lack of visible scale effects, public trust issues, and long-term waste disposal represent significant challenges.

In the chapter *Future Prospects on Coping with Nuclear Waste*, Gordon MacKerron investigates the global challenges of managing high-level nuclear waste, addressing technological, political, ethical, and economic dimensions. He also explores issues like Geological Disposal (DGD), the ‘polluter pays’ principle, public distrust, and centralized decision-making. The author contends that enhanced public trust and participatory approaches observed in Sweden and Finland are essential for advancing nuclear waste management while ensuring ethical responsibility and public acceptance.

M. V. Ramana, in the chapter, *The Changing Picture in China and the Global Future of Nuclear Power*, evaluates China’s ambitious targets in nuclear power, the evolving landscape of nuclear energy within the country, and its implications for global nuclear expansion. The chapter highlights China’s nuclear policy and goals, its nuclear growth, the economic and technical challenges limiting that expansion, and export restrictions. The author argues that China’s nuclear program—once perceived as a potential savior for global nuclear expansion—is unlikely to reverse the overall decline of nuclear power.

In the chapter *The Reality after Fukushima in Japan Actual Damage to Local People*, Tadahiro Katsuta describes the human impact of the Fukushima Daiichi nuclear disaster, highlighting the suffering of nearly

99,000 evacuees and the inadequate government response. The author discusses TEPCO's bankruptcy, massive compensation costs, and the political use of science to downplay risks. The chapter also notes a rise in thyroid cancer, especially among children, and criticizes Japan's renewed focus on nuclear energy policy, arguing it comes at the expense of victim welfare and public health.

In the chapter titled *Three Decades after Chernobyl: Technical or Human Causes?* Nikolaus Muellner provides a thorough reassessment of the Chernobyl disaster, referencing INSAG reports (A report by the International Nuclear Safety Advisory Group) and expert evaluations. The author emphasizes the underlying deficiencies in the RBMK (Reaktor Bolshoy Moshchnosty Kanalny) reactor design, including flawed control rods, prevailing safety misconceptions, and breaches of operational protocols. He contends that the disaster resulted from a combination of design vulnerabilities and procedural shortcomings, suggesting that any crew in a similar situation might have made comparable errors. Furthermore, Muellner cautions that Western reactors could also be at significant risk if existing design flaws are overlooked or if safety warnings are disregarded.

Eri Kanamori and Tomas Kåberger assess costs to manage the consequences of the Fukushima-Daiichi nuclear disaster in the chapter 'Distributing the Costs of Nuclear Core Melts: Japan's Experience after 7 Years.' They describe the financial burden of managing the Fukushima-Daiichi disaster, the escalation of an initial estimate of €25 billion in 2012 to €215 billion by 2017, and continuously changing TEPCO's (Tokyo Electric Power Company) business plans. They also discuss the complex financial mechanisms devised by TEPCO, such as government contribution, special bonds, transmission charges, and contributions from all nuclear operators, and distributing liabilities across consumers and taxpayers. Authors evaluate that Japan's nuclear cost management approach is unsustainable in a competitive market and suggest that nuclear operating countries prepare financial strategies for future nuclear accidents.

The last chapter of the book, *On New Thinking and Designs of Electricity Markets Heading towards Democratic and Sustainable Electricity Systems*, Reinhard Haas and Hans Auer examine how the increasing shares of variable renewables are reshaping electricity markets. They trace the market's historical evolution, review the reliance on capacity payments for underutilized plants, and propose a decentralized, bidirectional system featuring innovative technologies and active consumer participation. The authors advocate shifting away from rigid, centralized models toward a more flexible, competitive, and sustainable market design that integrates high levels of renewables without depending on government subsidies.

This book presents a thorough and critical examination of the ongoing debate surrounding nuclear energy. Through comprehensive case studies and comparative analyses, it elucidates the economic, political, and technical challenges that currently confront the nuclear power sector. The authors highlight these issues by juxtaposing them with the swift advancements in renewable energy sources and their economic viability. Furthermore, the contributors compellingly question established perceptions regarding the potential of nuclear energy. This volume serves as essential reading for stakeholders engaged in formulating future energy policies and addressing the risks associated with climate change.

***Reviewed by Khalil ur Rahman, PhD, Principal Engineer at National Institute of Safety and Security, Pakistan Nuclear Regulatory Authority (PNRA), Islamabad.***