Title
Nuclear Power Projects in Southeast Asia and sub-Saharan Africa – Balancing Stakeholder Perspectives and the Laws

Author
Saxena, Aishwarya

Publication Date
2023

Peer reviewed|Thesis/dissertation

Nuclear Power Projects in Southeast Asia and sub-Saharan Africa – Balancing Stakeholder Perspectives and the Laws

By

Aishwarya Saxena

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of the Science of Law – Juris Scientiae Doctor (J.S.D)

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Eric Biber, Chair

Professor Daniel A. Farber

Professor Raluca Scarlat

Summer 2023

Abstract

Nuclear Power Projects in Southeast Asia and sub-Saharan Africa – Balancing Stakeholder Perspectives and the Laws

by

Aishwarya Saxena

Doctor of the Science of Law – Juris Scientiae Doctor

University of California, Berkeley

Professor Eric Biber, Chair

In 2019, unprecedented extreme weather conditions occurred in several parts of the world as the temperature of the earth's surface hit a record high. This deterioration of environmental conditions can largely be attributed to rise in emissions resulting from high energy demand. The concentration of carbon emissions in 2018 was at its highest level in over 800,000 years, at 413 parts per million driven by higher energy demand. The energy sector contributed to about two-thirds of this growth in emissions. Coal use in power alone surpassed 10 Gt CO_2, mostly in Asia. Renewable energy sources and nuclear power met the majority of this growth in demand. Still, generation from coal and gas-fired power plants has increased considerably, continuing to ramp up emissions.

While an effort globally is needed, developing nations are a critical part of reducing emissions. In the US and most of Europe, discussions on a cleaner grid revolve around higher reliability, more efficiency, and affordability. However, in many developing countries in Southeast Asia and sub-Saharan Africa, the bigger question is to ensure electricity supply, as the nations in those regions go through rapid industrialization and population growth. As such, these countries remain dependent on fossil fuels. In Africa for example, states grapple with power infrastructural deficit requiring over $90 billion in investment. Together, 48 countries that form sub-Saharan Africa have only 170 gigawatts (GW) in installed capacity generation. This renders approximately 625 million people in Africa without electricity.

When incorporated in the grid with renewable energy sources, nuclear energy offers a

workable option. Therefore, while expanding generation from renewable sources, countries in Southern Asia like India, and Southeast Asia like Thailand, Malaysia, Vietnam and the Philippines are expanding and exploring their nuclear power programs to cope with the growing energy demand while also reducing emissions. Yet, there are major barriers for these countries to pursue commercial nuclear power generation. This dissertation seeks to analyze and propose plausible options to these issues by studying the relevant international instruments and domestic policies pertaining to nuclear energy and investigate the legal and policy aspects of nuclear safety, regulation, nuclear non-proliferation, and liability management that act as barriers to nuclear energy investment in these regions.

To my beloved late paternal grandfather Shri Krishan Behari Lall Saxena whom I never had the honor of meeting but whose journey as a scholar of the law I had the privilege of drawing inspiration from. Also, to my dear late maternal grandmother Shrimati Shanti Devi Saxena who was the epitome of grace, knowledge, and curiosity. I wish you were both here and I hope to make you proud.

Lastly, to all the women in my family including those who are yet to be born – do not hesitate to spread your wings and fly as high as you desire, there are no barriers you cannot surmount.

Table of Contents

Acknowledgments

Over the past four years, this research has been made possible by the invaluable support of my advisor, committee, UC Berkeley, and my amazing family, friends, and colleagues.

First and foremost, I would like to express my sincerest gratitude to my advisor Prof. Eric Biber and Committee Members – Prof. Daniel Farber, Prof. Raluca Scarlat, and former committee member Prof. Rachel Slaybaugh, whose guidance, mentorship, and unwavering support have been vital in shaping my research.

I am also extremely thankful to Berkeley Law for providing me with the opportunity to conduct research in the crucial yet relatively underexplored area of clean energy transitions in emerging economies across Southeast Asia and sub-Saharan Africa, in particular the application of nuclear energy in these regions.

This research would not be possible without the essential fellowships awarded by the Robbins Collection and the Gester Fund for Global Solutions, which have greatly contributed to the successful completion of this dissertation. I am honored to be recognized by you and will forever remain grateful for your support.

Finally, I cannot emphasize enough the importance of my family's encouragement and support throughout this journey. Without them, none of this work would have been possible. Before me, no other woman in my family had ventured out of the country for further education but my parents have never made me feel that my dream of earning a doctorate from one of world's best Universities was out of reach. Also, my brother has been a constant source of support and inspires me to always strive for excellence. Thank you for believing in me, for all your guidance, and for giving me all the opportunities to fulfill my goals. Words cannot express my gratitude towards you all. Despite being more than 8000 miles away from home, I have never felt alone in my journey as I am fortunate to have a wonderful group of friends and colleagues who feel like an extension of my family. I express my sincerest appreciation to my dear friends Ron, Gail, Hjalmar, and Sarah for all your encouragement and support at every step of my journey at UC Berkeley.

1 CHAPTER I - PREVAILING AND EVOLVING GLOBAL POWER SCENARIO – ENERGY POVERTY IN DEVELOPING NATIONS, GRID DIVERSIFICATION AND THE ROLE OF NUCLEAR ENERGY

Developing nations in Southeast Asia (Thailand, Philippines, Malaysia, Indonesia, and Vietnam) and sub-Saharan Africa (Ghana, South Africa, Nigeria, and Kenya) have shown inclination to embark on their nuclear power programs to support growing energy demand and reduce emissions. However, while these nations have continued to show strong interest in nuclear energy, there are several barriers as well as risks associated with incorporation of nuclear energy into their grids. Amongst these barriers are legal issues that affect implementation of nuclear power projects. The issues that this thesis will look into, pertain to regulation of nuclear facilities, management of liability emerging from nuclear accidents (including spent fuel management), and nuclear non-proliferation. The purpose of this dissertation is to propose plausible solutions to address the obstacles and risks in implementing nuclear power projects by finding areas where all project holders can work collaboratively to implement nuclear power projects safely in a way that benefits all stakeholders and ultimately supports global sustainable development. Specifically, this thesis will explore the following questions:

i. Why and how the international nuclear regulatory and liability regime needs to adapt to commercial use of nuclear energy in developing nations and developments in nuclear reactor technology?
ii. How can these countries devise national policies on nuclear energy to ensure that the interest of foreign vendors of nuclear equipment, as well as local communities are safeguarded for smooth implementation of nuclear power projects? What knowledge on these aspects can be borrowed from countries with advanced nuclear power programs like the United States (US), and France?
iii. How can the different project stakeholders including host states, project vendors, regulatory authorities, international organizations, and local communities work together to implement nuclear power projects effectively?

To provide context for discussion on the above questions, this chapter explains why emerging economies in sub-Saharan Africa and Southeast Asia are looking to integrate nuclear energy in their grid. For this purpose, the discussion below seeks to review literature on the level of electricity access, the extent to which electricity generation in these regions is responsible for rise in emissions, and the significance of clean baseload sources like nuclear energy.

1.1 A rapidly warming planet and deteriorating environmental conditions: Something worth Protecting

The environmental conditions on earth are deteriorating, affecting ecosystems and even endangering the quality of life on earth. The threat of climate change is not merely a distant worry anymore but has started affecting the functioning of ecosystems, agricultural productivity and inhabitability of several regions.[1] There have also been several other serious consequences of climate

[1] United Nations Environment Program (UNEP), Climate Change and Human Rights, December, 2015. at Pp. 2-10

change which have manifested themselves in the form of extreme weather conditions, unexpected natural disasters like devastating wildfires[2], and irreversible damage to biodiversity in the form of species extinction etc..[3] Projections also indicate that extreme weather and temperature occurrences may well become the norm and render several areas irrevocably uninhabitable. This has amplified risks[4] to inhabitants of low-lying and coastal areas, millions[5] of whom already face displacement[6] as Pacific Island ecosystems can no longer sustain the communities dependent on them.[7] Fragile mountainous ecosystems of developing countries are amongst the most vulnerable to these overall adverse effects of climate change.[8] Apart from that, even businesses report risks[9] to them posed by climate change at almost US$1 trillion with the possibility of many of them occurring within the next 5 years.[10]

1.2 Electricity generation as a significant contributor to rise in emissions and the need to decarbonize

This deterioration of environmental conditions can largely be attributed to rise in emissions driven by high energy demand. The concentration of carbon emissions in 2018 was at its highest level in over 800,000 years, at 413 parts per million driven by higher energy demand.[11] Energy, including electricity generation, transport, and industry accounts for 76% of global greenhouse gas emissions.[12]

Renewables and nuclear power met the majority of the growth in demand. Still, generation from coal, and gas-fired power plants has increased considerably, continuing to ramp up

---

[2] Thomas Fuller and Kendra Pierre-Louis, A Forecast for a Warming World: Learn to Live With Fire, New York Times, October 30, 2019, and Dana Nuccitelli, The many ways climate change worsens California wildfires, Yale Climate Connections November 13, 2018.

[3] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019 Global Assessment Report on Biodiversity and Ecosystem Services Pp. 66-68

[4] Field, C.B et. al., Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), Climate Change 2014 Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects, (2014) pp.368-370

[5] Human Mobility in the Context of climate change - Paris COP - 21: Recommendations from the Advisory Group on Climate Change and Human mobility (November 2015), UNHCR at p.9

[6] Supra. note 1

[7] John Campbell and Olivia Warrick, 'Climate Change and Migration Issues in the Pacific' (Report, United Nations Economic and Social Commission for Asia and the Pacific, 2014)

[8] World Health Organization (WHO) Discussion Paper (2012), Our Planet, Our Health, Our Future Human health and the Rio Conventions: biological diversity, climate change and desertification https://www.who.int/globalchange/publications/reports/health_rioconventions.pdf

[9] J.E. Aldy, Future-Proof Your Climate Strategy, Harvard Business Review May-June 2019 Issue, pp.86–97

[10] Carbon Disclosure Project - Global Climate Change Analysis 2018 https://www.cdp.net/en/research/global-reports/global-climate-change-report-2018

[11] Daily CO2. CO2.Earth. Available at: https://www.co2.earth/daily-co2 [Accessed November 5, 2019]; Lüthi, D. et al., 2008. High-Resolution Carbon Dioxide Concentration Record 650,000–800,000 Years before Present. Nature Publishing Group, 453(7193), pp.379–82. https://doi.org/10.1038/nature06949

[12] Intergovernmental Panel on Climate Change, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

emissions.[13] China, India, and the United States accounted for 85% of the net increase in emissions. In Asia, on average coal thermal power plants are only 12 years old, with almost two more decades of operation still remaining in their lifecycles.[14]

1.3 Why is electricity in developing countries a key part of the problem when talking about emissions from the energy sector?

As discussed above, in 2018 global energy-related CO2 emissions to a historic high, and the energy sector contributed to about two-thirds of this growth in emissions. However, for a more informed analysis, it is important to look at other sectors that contribute to emissions as well.

Apart from electricity, transportation, and land-use cause significant emissions. Agricultural and other land use account for about 26%[15], and as of 2019, transportation is responsible for 24% of direct CO2 emissions from fuel combustion.[16]

What makes energy in particular an important part of the problem, is the rate of emissions growth from the sector. Between 1960 and 2014 emissions from electricity generation nearly doubled constituting about 49% of global emissions.[17] Between 2010 and 2018, as also mentioned above, increase in emissions was driven by higher energy consumption influenced by economic and weather conditions globally. In 2019 however, global energy-related emissions flattened at around 33 Gt resulting in large part from reduction in emissions from the power sector in advanced economies as usage of renewable energy sources expanded, and dependence of coal reduced by switching to natural gas, as well as higher nuclear power output particularly in Korea and Japan.[18] Advanced economies mentioned here constitute developed nations that the International Monetary Fund (IMF) in its World Economic Outlook (WEO) has classified as advanced on the basis of mainly their per capita income, export diversification, and overall integration into the global financial systems.[19]

Yet, projections show that the demand for electricity will rapidly increase in emerging economies as they become more industrialized. Of course, it still remains to be seen what the global electricity demand will look like in the future as economies have at the moment come to a standstill due to the COVID-19 pandemic and electricity demand has declined.[20] In response to this decline in electricity demand due to COVID-19, global CO2 emissions are expected to reduce by 8%, to levels of 10 years ago resembling a similar reduction from the 2009 financial crisis. However, the rebound in emissions may be larger than the decline, unless significant investment is made towards clean energy infrastructure as part of economic recovery efforts.[21]

---

[13] International Energy Agency, Global Energy & CO2 Status Report 2019
[14] International Energy Agency, Global Energy & CO2 Status Report The latest trends in energy and emissions in 2018
[15] Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science, 360(6392), 987-992
[16] International Energy Agency, Tracking Transport, IEA, (2019) https://www.iea.org/reports/tracking-transport-2019
[17] Hannah Ritchie and Max Roser, CO_2 and Greenhouse Gas Emissions May 2017
[18] International Energy Agency, Global CO2 emissions in 2019
[19] International Monetary Fund, World Economic Outlook Database 2019
[20] Faith Birol, The coronavirus crisis reminds us that electricity is more indispensable than ever, International Energy Agency 2020
[21] International Energy Agency (IEA), Global Energy Review 2020 at p.4

While the US, China and the Asia Pacific region as of 2017 were the biggest emitters, between 1998 and 2019 emissions from non-advanced economies grew about three-fold from 9.2 Gt to 22 Gt., while emissions from advanced economies, only had slight fluctuations and remained the same as they were in 1990 at 11.3 Gt.[22] Further, between 2018 and 2019 while emissions from the power sector declined in EU countries, Japan, and the United States owing to a 1.3% drop in demand, they increased to about 400 Mt CO2 in the rest of the world with almost 80% of the increase coming from Asia.[23] The concentration of emissions in these regions can be explained by their rapid economic development. Trends show that countries that have been successful in accelerating economic progress have also significantly increased their per-capita emissions in doing so.[24] These emerging economies, with rapidly developing industrial sectors and increased electrification, are expected to greatly contribute to higher energy demand at about 2% per year, and it is projected that between 2018 to 2050, purchased electricity will be the fastest growing fuel consumed in these countries primarily in the developing world.[25]

1.4 Growing Energy Demand, Sustainable Development, and Energy Investment

Mindful of the above, all member states of the United Nations in 2015, adopted the 2030 Agenda for Sustainable Development under auspices of the United Nations which includes 17 Sustainable Development Goals echoing the Agenda adopted at the 1992 Earth Summit held in Rio de Janeiro. The sustainable development goals represent issues, tackling which is essential to improving the quality of life globally such as poverty and healthcare access. One of the 17 Sustainable Goals adopted is affordable clean energy.[26] Since 1992, the global energy access has risen from 76% to 88.84% and the level of energy access in sub-Saharan Africa stands at 44% with just over two-fifths of the population in Sub-Saharan Africa with access to electricity.[27]

Addressing climate change while advancing global well-being is regarded as one of the key challenges of the twenty-first century, and clean energy production is vital for surmounting it.[28] Currently, about 840 million people remain without access to electricity.[29] In 2019, even with great advancements and innovation in clean energy technology, it is a grim statistic that about 10.5% of the global population still remains without electricity. Lack of energy access has far-reaching effects for both a nation's overall economic development, and for the environment since the population without electricity access ends up using polluting fuels like fuelwood, charcoal and kerosene to meet their needs, thus contributing to emissions.[30]

---

[22] IEA, Energy related CO2 emissions, 1990-2019, IEA, Paris https://www.iea.org/data-and-statistics/charts/energy-related-co2-emissions-1990-2019

[23] IEA, Change in energy related CO2 emissions by region, 2018-2019, IEA, Paris https://www.iea.org/data-and-statistics/charts/change-in-energy-related-co2-emissions-by-region-2018-2019

[24] J. Steckel, Enabling Low-Carbon Development in Poor Countries https://link.springer.com/chapter/10.1007/978-3-319-48514-0_3

[25] World Energy Outlook, 2019

[26] Transforming our world: the 2030 Agenda for Sustainable Development, United Nations General Assembly A/RES/70/1

[27] M.P. Blimpo, Electricity Access in Sub-Saharan Africa Uptake, Reliability, and Complementary Factors for Economic Impact, Africa Development Fund, World Bank 2019

[28] S. Bakker et. al., Transport, Development and Climate Change Mitigation: Towards an Integrated Approach Transport Reviews, 2014 Vol. 34, No. 3, 335–355 (2014)

[29] International Energy Agency World Energy Outlook, 2019

[30] *Supra.* at 11

Developing countries in Asia and Africa account for about two-thirds of the global electrification deficit and four-fifths of the global deficit in access to non-solid fuels, and account for nearly 80% of people across the world living without access to energy.[31] These nations are classified as high-impact countries[32] by the International Energy Agency, and represent countries with the highest gaps in access to electricity and clean cooking. While progress in all countries is important, achievement of the global sustainability goals depends heavily on the progress made in high-impact countries that have a particularly large effect in aggregate global performance.

Achieving the goal of providing sustainable energy access demands energy investments to increase significantly.[33] A UN Sustainable Energy for All Initiative study shows that annual investment of USD 52 billion is needed to meet universal electrification by 2030. Yet, finance commitments for electricity in these high-impact countries has not increased sufficiently. Another Sustainable Energy for all Initiative study from a year later to the one mentioned above reveals that out of the USD 36 billion in total finance for electricity access in 2017, only USD 12.6 billion was estimated to support new access for households. This study also underlines the importance of making non-coal fired or fossil fuel power generation as bigger parts of the energy mix with increased investment in clean baseload sources of energy.[34]

In Africa, states grapple with grave power infrastructural deficit requiring over $90 billion in investment. Together, 48 countries that form sub-Saharan Africa have only 170 GW in installed capacity generation.[35] This renders approximately 600 million people in Africa without electricity. On the other hand, while in Southeast Asia energy access is much better, most of the grid comprises of polluting fossil fuels. This is because many developing countries face the tough decision of having to burn polluting fossil fuels to meet their energy demands while it is projected that their combined energy demand will increase by 45% and their share of global demand from 64% to 70%.[36] Philippines, India and Bangladesh are the top three countries receiving financing commitments for coal with Kenya coming in fourth due to one large investment commitment up to $1 billion between 2015 and 2016. While fossil fuel energy-based projects contribute to increasing electricity supply into grids, they do not benefit those living away from the power lines, and these facilities lock in high-carbon assets for 30 years or more and have significant impact on

[31] Sustainable Energy for All (SEforALL) and the Climate Policy Initiative (CPI). 2018. Energizing Finance: Understanding the Landscape, 2018: Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries." SEforALL and CPI, Washington, DC p.10

[32] Afghanistan, Angola, Bangladesh, Burkina Faso, Congo (DR), Ethiopia, India, Kenya, Korea (DPR), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Philippines, Sudan, Tanzania, Uganda, and Yemen for electricity. Bangladesh, China, Congo (DR), Ethiopia, India, Indonesia, Kenya, Korea (DPR), Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Philippines, Sudan, Tanzania, Uganda, and Vietnam for access to clean cooking.

[33] J. Corfee-Morlot, P. Parks, J. Ogunleye and F. Ayeni, Achieving Clean Energy Access in Sub-Saharan Africa, Financing Climate Futures OECD (2019) at p. 21, Sustainable Energy for All, Energizing Finance: Understanding the Landscape, Energy Finance Report Series 2019, and The World Bank, Tracking SDG 7: The Energy Progress Report 2019 p.7, Tracking SDG 7: The Energy Progress Report The World Bank, the International Energy Agency, the International Renewable Energy Agency, the United Nations Statistics Division and the World Health Organization, 2019 at p. 32.

[34] *Ibid.*

[35] Accelerating SDG 7 Achievement Policy Brief 18: Achieving SDG 7 in Africa, United Nations Economic Commission for Africa (UNECA) 2018

[36] International Energy Agency, International Energy Outlook 2018, Southeast Asia Energy Outlook 2019, Africa Energy Outlook 2019

the planet.[37]

1.5 Decarbonization through Grid Diversification

While renewables significantly contribute to decarbonization, they are intermittent in nature and need to be combined with a clean baseload source for meeting energy demand.[38] The International Energy Agency in its 2018 World Energy Outlook predicted power output to soar by 140 percent by the middle of the century. Currently, as aforementioned countries rely heavily on fossil fuels to satisfy their energy needs, which though cheap in monetary terms, impose a heavy cost on the planet. For example, the average estimated levelized costs per unit of output (LCOE)[39] of coal in India is 55.7 $/MWh[40] in comparison with other baseload sources like 70 dollars per Megawatthour ($/MWh) for nuclear, and 95 $/MWh for natural gas.[41] Given its low price, coal has continued to be India's largest domestic source of electricity generation.[42]However, as of 2017 regardless of being cheap, coal caused 14.57 billion tons in global carbon emissions accounting for around 40% in total of all fuel-based emissions.[43] Thus, like many other developing nations in Asia, India is rapidly moving to increase the share of renewable energy in its energy mix especially with solar which remains quite cheap in the nation at 45 $/MWh.[44] Yet, unless a clean baseload source of energy is made part of the energy mix, it would not be possible to effectively decarbonize electricity generation.[45]

Literature on clean energy transition shows that nuclear energy as a zero-carbon baseload source of energy if made a greater part of the energy mix alongside renewables[46], can help achieve

---

[37] Supra.

[38] Planning for the Renewable Future: Long-term Modelling and Tools to Expand Variable Renewable Power in Emerging Countries, International Renewable Energy Agency 2017 at p. 33; Fathima, A.H.; Palanisamy, K. Energy Storage Systems for Energy Management of Renewables in Distributed Generation Systems. In Energy Management of Distributed Generation Systems; InTech: London, UK, 2016; Luo, X.; Wang, J.; Dooner, M., Clarke, J. Overview of current development in electrical energy storage technologies and the application potential in power system operation. Appl. Energy 2015.; H. Zsiboracs et. al., Intermittent Renewable Energy Sources: The Role of Energy Storage in the European Power System of 2040, Electronics. 8. 729. 10.3390/electronics8070729.

[39] Levelized cost of electricity (LCOE) estimates of the revenue required to build and operate a generator over a specified cost recovery period.

[40] IEA, Levelised cost of electricity LCOE for solar PV and coal-fired power plants in India in the New Policies Scenario, 2020-2040, IEA, Paris https://www.iea.org/data-and-statistics/charts/levelised-cost-of-electricity-lcoe-for-solar-pv-and-coal-fired-power-plants-in-india-in-the-new-policies-scenario-2020-2040

[41] IEA (2019), World Energy Model, IEA, Paris https://www.iea.org/reports/world-energy-model

[42] IEA (2020), India 2020, IEA, Paris https://www.iea.org/reports/india-2020

[43] Hannah Ritchie and Max Roser (2020) - "Energy". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/energy'

[44] *Supra.* 39

[45] Energy Transitions Commission (2018), Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century, http://www.energy-transitions.org/sites/default/files/ETC_MissionPossible_ReportSummary_English.pdf.

[46] Evelyne Bertel and Joop Van de Vate, Nuclear energy & the environmental debate: The context of choices. IAEA Bulletin April, 1995 Pp. 2-7; McMillan, C., Boardman, R., Mckellar, M., Sabharwall, P., Ruth, M., Bragg-sitton, S., 2016. Generation and Use of Thermal Energy in the U. S. Industrial Sector and Opportunities to Reduce its Carbon Emissions, Bataille, C. et al. (2018); A review of technology and policy deep decarbonization pathway options for making energy-intensive industry production consistent with the Paris Agreement", Journal of Cleaner Production,

decarbonization of energy, and also increase access to electricity. Over the past half a century, nuclear energy has helped avoid about 55Gt of energy related emissions and in absence of more new projects or life-style extensions for nuclear facilities, emissions could rise about 4 billion tons.[47] As has also been seen from the recent example of Germany, where most of the energy deficit from scrapping nuclear was supported by increased coal usage which in turn resulted in increase in emissions .[48] Further, the fastest any country has ever managed to decarbonize outside of an economic collapse was at the rate of 4.5 percent per year, which France achieved during its nuclear energy buildup.[49] Countries like India, Turkey, China, Romania and the United Arab Emirates are therefore making significant progress to expand their civil nuclear power programs. Similarly, nations in Southeast Asia and sub-Saharan Africa too are showing strong interest in embarking on their nuclear power program and are also taking concrete steps to further this goal as discussed below.[50]

1.6 Southeast Asia

Developing Asia is home to around 700 million without access to electricity. Further, about 2 billion people lacking clean cooking facilities. In total, around 2.6 billion people lack access to clean cooking facilities globally, relying instead on solid biomass, kerosene or coal as their primary fuel for heat and cooking.

Countries in Southeast Asia have different levels of economic development, varying consumption patterns and resources. However, they share a common challenge of meeting their energy demand while also trying to reduce greenhouse gas emissions. Owing to rapid industrial growth and urbanization, Southeast Asia's energy demand has grown by 60% since 2000, at 6% each year which is fastest in the world. This increase in demand has been met largely by fossil fuel

---

Vol. 187/20, pp. 960-973; M. Åhman, L.,J. Nilsson, F.N. Andersson Industrial development towards net zero emissions – policy conclusions and first steps. (Industrins utveckling mot netto-noll utsläpp- – policyslutsatser och första steg) IMES/DESS report nr 88 Environmental and energy System Studies Lund university (2013); S, Lechtenbohmer et. al., Decarbonising the energy intensive basic materials industry through electrification – Implications for future EU electricity demand, Energy Volume 115, Part 3, 15 November 2016, Pages 1623-1631.

[47] IEA (2019), Nuclear Power in a Clean Energy System, IEA, Paris https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system

[48] Jarvis, S., Deschenes, O., & Jha, A. (2019). The Private and External Costs of Germany's Nuclear Phase-Out (No. w26598). National Bureau of Economic Research.

[49] Guivarch, C., and S. Hallegatte. 2013. "2C or Not 2C?" Global Environmental Change 23 (1): 179–192.

[50] Reuters, October 24 2019Russia's Rosatom, Rwanda sign deal to build nuclear science center https://www.reuters.com/article/us-russia-rwanda-nuclear/russias-rosatom-rwanda-sign-deal-to-build-nuclear-science-center-idUSKBN1X32DV; P.Burkhardt, Russia's State-Owned Nuclear Giant Is Targeting Africa for its Growth, Bloomberg October 30 2019 https://www.bloomberg.com/news/articles/2019-10-30/russia-s-rosatom-focuses-on-africa-for-its-nuclear-expansion; I. Nechepurenko and A. Higgins, Coming to a Country Near You: A Russian Nuclear Power Plant, New York Times March 21 2020 https://www.nytimes.com/2020/03/21/world/europe/belarus-russia-nuclear.html; The Moscow Times, Russia Spreads Influence in Africa Using Nuclear Power – Reports, August 29 2019 https://www.themoscowtimes.com/2019/08/29/russia-spreads-influence-in-africa-using-nuclear-power-reports-a67077; S. Malo, Russia, China back nuclear as a clean-power fix for Africa, Reuters February 6 2019 https://www.reuters.com/article/us-africa-energy-nuclearpower/russia-china-back-nuclear-as-a-clean-power-fix-for-africa-idUSKCN1PW0KV

usage.[51]

Currently, despite the abundance of renewable energy potential, its share in Southeast Asia's energy mix remains low with Indonesia at 6.9%, Malaysia at 4.4%, Vietnam at 13.2%, and in the Philippines at 11.5%.[52] The energy mix in this region is dominated by oil contributing to 34% of energy production, gas at 22% and coal at 18%. Thus, about 80% of the aggregate energy mix of Southeast Asia consists of fossil fuels. While Southeast Asia is an important producer of oil, gas and coal, their domestic supply is declining, and it is projected that in 2040 this region will be spending about $300 billion annually in importing their energy supply.[53]

It is also pertinent to note that Southeast Asia given its geographical position is one of the most vulnerable regions to the effects of climate change, especially its coastal nations. As a result of climate change, these coastal nations will experience increase in the average temperature, extreme rainfall events, ocean acidification and sea-level rise which can in turn lead to displacement of population.[54] Given this scenario, its essential for Southeast Asia to explore non-polluting sources of baseload energy production. Hydropower is an important source of baseload energy for the region and while its output had quadrupled since 2000, Southeast Asia is still heavily dependent on energy related imports as demand for oil coal is projected to steadily increase.[55] For this reason, many nations in Southeast region are exploring their nuclear power programs.

The idea of nuclear energy is not entirely new to Southeast Asian countries, for example Vietnam has been seriously considering embarking on its nuclear power plan since 1995 but financial constraints primarily have kept it from having its own nuclear power plant. Also, the Philippines now is strongly considering more nuclear on the grid and has been in talks with Russia about the same.[56]

The groundwork for expansion of civilian uses of nuclear energy in Southeast Asia was laid in 2009 when the IAEA began conducting its International Nuclear Infrastructure Review (INIR) missions. These missions were aimed at evaluating and considering improvements to the national framework for introduction of nuclear power projects. This has now evolved into a promising trend of growing interest in nuclear energy in Southeast Asia and this was reflected in the signing of "Practical Arrangements" between the IAEA and the Association of Southeast Asian

---

[51] International Energy Agency, Southeast Asia Energy Outlook 2019

[52] International Energy Agency, Sustainable Development Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all 2019

[53] International Energy Agency, Southeast Asia Energy Outlook, 2017 p.11-14

[54] Oppenheimer, M. et. al, Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate In press. 2019 P. 321; John Campbell and Olivia Warrick, Climate Change and Migration Issues in the Pacific, United Nations Economic and Social Commission for Asia and the Pacific August, 2014; Locke, J.T. (2009). Climate change-induced migration in the Pacific region: sudden crisis and long-term developments. Geographical Journal, vol. 175, No. 3, pp. 171-180.; Kalin, W. (2013). Changing climates, moving people: distinguishing voluntary and forced movements of people. In Changing Climates, Moving People: Framing Migration, Displacement and Planned Relocation, K. Warner and others, eds. UNU-EHS Policy Brief, No. 8., Farbotko, C., and H. Lazrus (2011). The first climate refugees? Contesting global narratives of climate change in Tuvalu. Global Environmental Change, vol. 22, No. 2, pp. 382-390.; International Panel on Climate Change (IPCC) (2000), "Summary for Policymakers" Emissions Scenarios: A Special Report of IPCC Working group III, IPCC.

[55] *Ibid.*

[56] Asia's Nuclear Energy Growth, World Nuclear Association 2019 https://www.world-nuclear.org/information-library/country-profiles/others/asias-nuclear-energy-growth.aspx

Nations (ASEAN) during the IAEA's yearly General Conference.[57] The Practical Agreements lay out the framework for cooperation between these economies and the IAEA on technical, legal and regulatory aspects of nuclear power projects. This may help resolve some major financial, regulatory and infrastructural issues that thwart the growth in civilian uses of nuclear energy.

Currently, Indonesia, Malaysia, Philippines, and Thailand are the frontrunners with sufficient infrastructure and financial capacity to bring nuclear energy into their mix. Additionally, there are plans to have an operational plant by 2030 in Vietnam and Thailand by 2036.[58]

1.7 Sub-Saharan Africa

Sub-Saharan Africa's technical generation capacity potential is estimated to be 11,000 GW, largely from renewables.[59] Despite the resource potential and rising demand, the current total electricity installed capacity in Africa is only around 170 GW.[60] Beyond an abundance of solar and wind energy resources, three of the ten-largest uranium resource-holders in the world (Namibia, Niger and South Africa) are in sub-Saharan Africa.[61] However, a limiting factor in the region's electricity development is effective technical, financing, and policy mechanisms to enable the region to fully utilize these resources.[62]

The lack of energy access in sub-Saharan Africa is also unique given that it has countries whose level of electrification is below what their income level would predict.[63] The electricity supply mix is dominated by coal at about 35 per cent, with South Africa being the biggest contributor by producing 90% of its energy requirement from coal. Access to electricity in Kenya, stands at 75%, and in Ghana and South Africa at 84.3% and 94.9% respectively while Democratic Republic of Congo still stands at only 8.7%. Except for the Democratic Republic of Congo, these statistics don't particularly alarm. However, it appears far more concerning when we talk in terms of the number of people without access to electricity, which stands at about 600 million given that sub-Saharan Africa constitutes about 16% of the global population.

Beyond this, the access to clean cooking shows much worse statistics. In Ghana for example, only about 24% of the population has access to clean cooking, 15% in Kenya and only

---

[57] Alex Nitzsche, IAEA and ASEAN Strengthen Cooperation in Nuclear Science, Technology and Applications, and Nuclear Safety, Security and Safeguards, IAEA Office of Public Information and Communication (September 16, 2019) https://www.iaea.org/newscenter/news/iaea-and-asean-strengthen-cooperation-in-nuclear-science-technology-and-applications-and-nuclear-safety-security-and-safeguards

[58] ASEAN Center for Energy (ACE), Pre-Feasibility Study on the Establishment of Nuclear Power Plant in ASEAN (April 2018)

[59] N, Avila et. al. The energy challenge in sub-Saharan Africa: A guide for advocates and policy makers, Oxfam Research Backgrounder 2017, Part 1 p.20.

[60] International Energy Agency, Africa Energy Outlook (2019)

[61] International Energy Agency, Africa Energy Outlook (2014)

[62] M.P. Blimpo and M. Cosgrove-Davies, 2019. Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact. Africa Development Forum series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1361-0. License: Creative Commons Attribution CC BY 3.0 IGO Pp. 22-34; P.A Trotter, M.C McManus., R. Maconachie, Electricity planning and implementation in sub-Saharan Africa: A systematic review (2017) Renewable and Sustainable Energy Reviews, pp. 1189-1209.

[63] *Ibid.*

35 yearsa in Congo.[64] Thus, these economies remain heavily reliant on polluting sources of energy and despite the steady growth in clean energy investment, the share of renewables in their energy mixes remains quite low for e.g. the share of renewables in the energy consumption in Kenya stands at 3.5%, in Ghana at 13.7% (excluding hydro power), in Congo at 17.2%, South Africa at 3.3%.[65] The two major constraints to renewable energy production are the lack of infrastructural capacity and the issue of reliably meeting baseload energy demand.[66]

The above figures do not include hydropower because of the socio-economic and environmental effects of hydropower. While Africa offers immense scope for hydropower expansion, only about 11 per cent[67] of hydropower capacity available there has so far been utilized.[68] Hydropower combined with nuclear energy constitute the largest carbon-free sources of electricity generation[69] and application of both hydro[70] and nuclear in Africa is expected to accelerate in response to growing energy demand. Yet, there are factors that inhibit development of hydropower including risk of floods, damage to marine life, and displacement of local population which are especially amplified in certain regions already prone to flooding and landslides.[71] Beyond environmental concerns hydropower projects are susceptible to cost overruns and construction delays.[72] These concerns are partly similar to concerns surrounding large-scale nuclear power as well.

The daunting level of commitment required to embark upon a nuclear power program and the lack of funding as mentioned above have significantly discouraged sub-Saharan African economies from considering nuclear energy despite the fact that 57% of their population altogether is rendered without access to electricity. Interestingly, in 2018, the IAEA-INIR mission to Nigeria found that while Nigeria is infrastructurally ready to expand its nuclear power program, many sub-Saharan African grids are not yet ready for it. For example, in Kenya which depends heavily on diesel generators, the grid capacity currently stands at 2400 Megawatts (MW) while a country needs to have 10,000 MW already in place to use1000 MW from a nuclear reactor.

Now however, there is renewed interest in seriously committing to a nuclear power project in Kenya, Ghana and South Africa with assistance from the China National Nuclear Corporation.[73] Additionally, there is also serious interest from Russia to invest in nuclear energy in sub-Saharan Africa. This however, has its own legal issues, for example recently an agreement between Russia and South Africa for adding 9600 MW capacity with 10 nuclear reactors was ruled unlawful for

[64] Accelerating SDG 7 Achievement Policy Briefs in Support of the First SDG 7 Review at the un high-level political forum 2018, united nations department of economic and social affairs
[65] International Energy Agency, Sustainable Development Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all 2019
[66] supra 38.
[67] International Hydropower Association, Hydropower Status Report, 2019 p.57
[68] IEA (2019), Tracking Power, IEA, Paris https://www.iea.org/reports/tracking-power-2019
[69] IEA (2019), Nuclear Power in a Clean Energy System, IEA, Paris https://www.iea.org/reports/nuclear-power-in-a-clean-energy-system
[70] International Hydropower Association, Hydropower Status Report, 2019 p.57
[71] Kumar, A., T. Schei et. al., Hydropower, IPCC Special Report on Renewable Energy Sources and Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, 2011 at p. 449.
[72] Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)
[73] Reuters, Kenya on course to develop nuclear energy, official says (October 5, 2018)

lack of transparency and unfair tax incentives to Russia.[74] The legal, financial, and security issues related with involvement of foreign entities in the nuclear power program of these emerging economies will be discussed in detail in a later chapter.

1.8 Barriers to Nuclear Energy for Electricity Generation

While there is considerable interest among Asian and African economies to utilize nuclear energy as a clean baseload source of electricity, and despite the fact the it has been utilized for electricity generation since the 1950s, commercial application of nuclear energy especially in developing economies presents some peculiar challenges. Major barriers include the high cost of building nuclear power plants, the time required to develop robust legal and regulatory frameworks, the long-term commitment required towards establishing a sustainable safety and non-proliferation culture, small grid sizes and lack of interconnections, and human resources capacity.[75]

1.8.1 ***Financial and Infrastructural Barriers***

Developing states face unique challenges and often lack the finances, institutional capacity, and physical infrastructure to support a large-scale, multibillion-dollar nuclear power plant project, even if the costs are spread out over several years. There is no precise way to measure whether a country can afford a nuclear power plant, especially since decisions may be driven by factors such as politics, national pride, energy security, industrialization strategy and proliferation risks. Although stretching a national budget to buy a nuclear power plant may in theory be possible, this always implies opportunity costs, since even development banks do not lend for nuclear energy projects, and private investors are likely to be wary. Despite this, the construction of nuclear power plants is set to continue at a steady rate in many countries in Asia, where India and China are considering adding over 30 more nuclear power plants to meet rising demand for energy. That said, large traditional nuclear facilities are generally extremely capital-intensive and expensive to build and maintain.[76] With advancements in nuclear reactor technology however, there may be lower-cost options for these economies.

Small Modular Reactors (SMRs) which will be discussed in greater detail in a later chapter, are one such way to counter a lot of the issues associated with construction and maintenance of large-scale nuclear facilities. [77] Cost estimations for SMRs tend to be much different in comparison with large nuclear power plants.[78] The estimated cost of construction of SMRs is around USD 3 billion in contrast with the average of USD 9-12 billion for large nuclear facilities.[79]

---

[74] W. Roelf, South African court declares nuclear plan with Russia unlawful (April 26, 2017)
[75] Newcomer countries face common challenges in nuclear infrastructure development, IAEA Bulletin April, 2016 Pp. 28-32
[76] International Atomic Energy Agency (IAEA), Financing Nuclear Power in Evolving Electricity Markets April, 2018 at p.6
[77] Organisation for Economic Cooperation and Development (OECD-NEA), Small Modular Reactors: Nuclear Energy Market Potential for Near-term Deployment, Nuclear Development 2019 NEA No. 7213 Pp. 19-27,
[78] International Status and Prospects for Nuclear Power 2012, IAEA Vienna (2012), https://www.iaea.org/sites/default/files/gc56inf-6_en.pdf
[79] S. Kirshenberg et. al., Purchasing Power Produced by Small Modular Reactors: Federal Agency Options, Department of Energy (DOE) Small Modular Reactor Report, MSA No. DOE0638-1022-11 (2017) ap P. 66,

SMRs are reactors that are much smaller in size producing less than 300 MW. [80] Given their smaller size and reduced cost, SMRs can be a plausible option for several countries who are currently unable to afford embarking on a nuclear power program. In fact, the key driving forces of SMR development are providing flexible power generation and economic affordability.[81] SMRs are different in design to large nuclear facilities and have far fewer components resulting in reduction of cost. Further, the modularity of SMRs makes their production process more competitive by replacing the need for on-site deployment with much more economical centralized fabrication of components, standardized design and mass production. Thus, SMRs can also provide power to smaller grids in contrast with the traditional large 1000 MW reactors which require minimum grid capacity of 10,000 MW that several emerging economies especially in sub-Saharan Africa do not yet have.[82]

With the current rate of development, it is expected that SMRs will reach commercial operation 2030 and it is estimated that they will reach the wider global market by 2035. There is a need for much more research and demonstrations to ensure that SMRs also reach the emerging economies of Southeast Asia and sub-Saharan Africa. However, about 50% of demonstrations in energy innovation (including in advanced nuclear) are in Europe while the rest are primarily in the US, Australia, Canada, China, and Japan. Only about 5% of such demonstrations can be tracked in emerging economies.[83]

In addition to technological development there is also a need to simultaneously create regulatory preparedness to create pathways for fast implementation of SMRs. In advanced nuclear economies, the existing licensing and regulatory frameworks rely on several decades of experience regulating conventional large light water reactors (LWRs). The limited experience that regulators (both in established and embarking nuclear economies) currently have with different SMR designs (including light water SMRs and Molten Salt Reactors and other types of advanced reactors) calls for enhancing the existing licensing and regulatory approach such that it is applicable to the licensing of SMRs and advanced reactor designs. To elucidate further, several SMRs have safety mechanisms built into them that reduces the number of failure scenarios that need to be considered in their licensing process. At the same time, the lack of experience with these new designs (with the introduction of coolants other than light water and modularization) also creates challenges for regulators to come up with the appropriate set of failure scenarios and safety aspects to consider with regards to SMRs. In order to make SMR deployment viable in emerging economies there is thus a need for international collaboration to comprehensively review licensing and regulatory frameworks at both the international and domestic levels.[84]

Matthew Wald, The Next Nuclear Reactor May Arrive Hauled by a Truck, The New York Times, 24 April 2013, http://www.nytimes.com/2013/04/25/business/energy-environment/thenext-nuclear-reactor-may-arrive-hauled-by-a-truck.html?_r=0.

[80] International Atomic Energy Agency, Deployment Indicators for Small Modular Reactors, IAEA TECDOC 2018

[81] International Atomic Energy Agency (IAEA), Advances in Small Modular Reactor Technology Developments, IAEA Advanced Reactors Information System (ARIS) 2018 Edition

[82] Laura Gil, Is Africa Ready for Nuclear Energy? – Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication September 3, 2018 https://www.iaea.org/newscenter/news/is-africa-ready-for-nuclear-energy

[83] IEA (2022), Clean Energy Technology Innovation, IEA, Paris https://www.iea.org/reports/clean-energy-technology-innovation, License: CC BY 4.0

[84] Small Modular Reactors: Challenges and Opportunities, OECD-NEA 2021 https://www.oecd-nea.org/upload/docs/application/pdf/2021-03/7560_smr_report.pdf

1.8.2 ***The policy argument to first explore renewable energy instead of nuclear energy***

Globally, despite the rise in renewable energy, projections indicate that natural gas will overtake oil as the world's biggest energy source by 2034. It is pertinent to emphasize here the underlying flaw in the argument of renewable or nuclear energy as replacements for one another. Renewables without any other clean baseload energy source remain insufficient for now to completely replace polluting fossil fuels while also keeping up with rapid population growth and the consequent demand. Additionally, because of their intermittent nature renewable energy sources require energy storage which is expensive given the currently available energy storage technology.[85] A new study has shown that the cost for energy storage technology would need to drop significantly for a 100% renewable reliant future.[86]

Speaking specifically in the context of developing countries, there is also an argument that they should first look toward renewable energy before exploring nuclear energy. However, in 2016 developing economies continued to increase deployment of renewables outspending developed countries[87] and in spite of that they remain heavily reliant on fossil fuels. Much of this is motivated by economic factors as the high price for energy storage preventing the ability to completely rely on renewable energy sources.[88] Developing countries with their high rates of economic and population growth are thus largely dependent on fossil fuels.

Furthermore, a trend of favoring investment in carbon-based technologies has been seen as a result of the fact that these technologies are already mature and enjoy a large market.[89] Coal-fired power plants that are currently under construction or planned would if realized consume one third (240 Gt of CO_2) of the carbon budget still available to achieve a 2 degrees Celsius goal. Six nations including China, India, Vietnam, South Africa, Turkey and Indonesia account for 85 per cent of ongoing and planned coal investments. In these economies, coal remains highly competitive given its low prices despite policies to subsidize low carbon alternatives.[90]

Nuclear energy can be an effective counter-balancing force against mature carbon-based energy production mechanisms given that it has been utilized for electricity generation since the 1950s and count as a mature technology ready for commercial application.[91]

---

[85] M. Ziegler et. al., Storage Requirements and Costs of Shaping Renewable Energy Toward Grid Decarbonization, Joule Vol. 3 Issue 9 2019, A. Blakers, M. Stocks, B. Lu, et. al. (2019) Pathway to 100% Renewable Electricity. IEEE Journal of Photovoltaics, 99:1-6

[86] *Id.*

[87] Ren 21, Renewables 2019 Global Status Report (2019)

[88] *Supra.* note 82

[89] Acemoglu, D., P. Aghion, L. Bursztyn, and D. Hemous. 2012, The Environment and Directed Technical Change. American Economic Review 102: 131–66, International Energy Agency, Coal 2019

[90] Edenhofer, Ottmar, Jan Christoph Steckel, Michael Jakob, and Christoph Bertram. 2016. How cheap coal threatens the Paris agreement. MCC Working Paper.

[91] Organisation for Economic Cooperation and Development - Nuclear Energy Agency and International Energy Agency, Technology Roadmap: Nuclear Energy (2010)

1.8.3 Perception of risks associated with nuclear energy and devising regulations to address them

1.8.3.1 *Perception of risks associated with nuclear energy*

Lastly, there is still the issue of perception of nuclear energy and its impact on existing and upcoming nuclear power projects. A strong argument against nuclear energy is the possibility of a nuclear accident and its devastating impact that can potentially transcend national territories and affect several generations.

To put this in perspective, it's important to compare the perception of nuclear energy with that of climate change. As discussed at the beginning of this chapter, electricity generation is responsible for a considerable amount of greenhouse gas emissions causing temperature of earth's surface to rise, which in-turn severely impacts life. Nuclear energy along with hydro power constitutes one of the largest sources of carbon-free electricity generation. There's significant amount of literature outlining the human health, safety, and carbon footprint reduction benefits of transitioning away from fossil fuels by replacing them with nuclear as well as renewable sources.[92] Yet, there is a common perception that it is too dangerous for application which plays a large role in how legislation and policies are shaped.[93] This negative perception of nuclear energy has affected its phase out in many advanced economies like US and Germany.

As discussed earlier, the threat of climate change is no longer just a distant worry but something we have already begun to experience.[94] Yet, unless one regularly follows the climatic changes, it can be difficult to fully discern their gravity.[95] Studies have shown that climate change still tends to be perceived as a lesser imminent threat and thus is often allotted lower importance[96] among other issues[97] for those who do not read about it on a daily basis.[98] On the other hand, nuclear energy is commonly associated with the atomic bomb, Chernobyl, and Fukushima disasters. Naturally, risks associated with nuclear energy have been in the public know-how far

---

[92] Burgherr, P., & Hirschberg, S. (2014). Comparative risk assessment of severe accidents in the energy sector. Energy Policy, 74, S45-S56; McCombie, C., & Jefferson, M. (2016). Renewable and nuclear electricity: Comparison of environmental impacts. Energy Policy, 96, 758-769; Hirschberg, S., Bauer, C., Burgherr, P., Cazzoli, E., Heck, T., Spada, M., & Treyer, K. (2016); Health effects of technologies for power generation: Contributions from normal operation, severe accidents and terrorist threat. Reliability Engineering & System Safety, 145, 373-387; Luderer, G., Pehl, M., Arvesen, A., Gibon, T., Bodirsky, B. L., de Boer, H. S., … & Mima, S. (2019). Environmental co-benefits and adverse side-effects of alternative power sector decarbonization strategies. Nature Communications, 10(1), 1-13, and Hertwich, E. G., Gibon, T., Bouman, E. A., Arvesen, A., Suh, S., Heath, G. A. and Shi, L. (2015). Integrated life-cycle assessment of electricity-supply scenarios confirms global environmental benefit of low-carbon technologies. Proceedings of the National Academy of Sciences, 112(20), 6277-6282.

[93] Paul Slovic, The risk game Journal of Hazardous Materials 86 (2001) 17–24

[94] Intergovernmental Panel on Climate Change (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press

[95] Geoghegan, H., & Brace, C. (2011). On climate change and cultural geography: Farming on the Lizard Peninsula, Cornwall, UK. Climatic Change, 113(1), 55–66. doi:10.1007/s10584-012-0417- 5.

[96] Ibid.

[97] Ibid.

[98] Amos Tversky & Daniel Kahneman, Judgment Under Uncertainty: Heuristics and Biases, 185 SCI. 1124, 1127 (1974).

more than its actual benefits[99] and may therefore be perceived as much closer or bigger a risk than say a natural hazard.[100] Thus, the possibility of a nuclear accident may seem like a fathomable and more credible threat in comparison to the imminent possibility that climate change might render major cities uninhabitable due to heat, sea level rise, or more frequent natural hazards.[101] Still it is important to note that this misperception of climate change is gradually changing, in the wake of recently experienced warning signs in the form of far worse wildfires in California as well as Australia, and more frequent Atlantic storms[102] for example.

While it is true that seriousness of the risk of even one nuclear accident occurring is concerning, phasing out or refusing to utilize nuclear energy for grid diversification is a flawed approach.[103] Realistically, over a span of five years the probability of having one year with one major nuclear accident is 14.3 per cent,[104] while there is a near certain chance that human life, biodiversity, ecological and hydro systems on earth will suffer serious irreversible damage by 2050 due to anthropogenic climate change, if the earth's temperature keeps rising at the current rate.[105]

1.8.3.2 Devising regulations to address risks associated with nuclear energy

Harnessing trust and confidence in public's mind towards nuclear energy can help offset some of the abovementioned concerns about nuclear energy without the need for excessive steps in the form of complete nuclear phase-out, and also make it easier to implement new nuclear power projects.[106] This is where choices about how a regulatory framework is devised become crucial in maintaining a balance between public concerns and the role nuclear energy can play in decarbonization.

There are two defined objectives of nuclear safety regulation. First, to defend against and monitor the risk of radiological hazards. Second, to ensure safe operation of nuclear facilities by adherence to stringent safety standards.[107] However, regulating nuclear facilities is not restricted to a combination of legal and technical standards, but requires an interdisciplinary approach. Regardless of how many safety barriers are incorporated into the technology itself, risks associated with a complex system like nuclear is not entirely limited to those emerging from the technology itself.[108] Similarly, regardless of how stringent regulations may be, they are vulnerable to several other factors that impede their effectiveness such as bureaucracy and institutional misjudgment.

---

[99] Paul Slovic and Ellen Peters, Risk Perception and Affect, Current Directions in Psychological Science, Vol. 15, No. 6 (Dec., 2006), pp. 322-325

[100] R.I. Palm, Natural Hazards: An Integrative Framework for Research and Planning, Johns Hopkins, Baltimore, 1995.

[101] How Climate Is Changing, NASA, https://climate.nasa.gov/effects/ (last updated Oct. 3, 2018).

[102] John Schwartz, How Has Climate Change Affected Hurricane Dorian?, New York Times September 3, 2019

[103] Slocum, R. (2004). Polar bears and energy-proficient light bulbs: Strategies to bring climate change home. Environment and Planning D Society and Space, 22, 413–438.

[104] Minh Ha-Duong, V. Journ´e. Calculating nuclear accident probabilities from empirical frequencies. Environment Systems and Decisions, 2014, 34 (2), pp.249-258.

[105] Alan Buis, A Degree of Concern: Why Global Temperatures Matter, NASA's Global Climate Change Website, June 9, 2019

[106] S. Breyer, Breaking the Vicious Circle: Toward Effective Risk Regulation, Harvard University Press, Cambridge, MA.

[107] Carlton Stoiber et. al., Handbook on Nuclear Law, International Atomic Energy Agency, 2003 at p. 64.

[108] Bea, R., I. Mitroff, D. Farber, H. Foster and K.H. Robert, "A New Approach to Risk: The Implications of E3," Journal of Risk Management, February 2009, Vol. 11, pp. 30-43, doi: 10.1057/rm.2008.12.

Regulating industries with high-magnitude risks of this sort has several aspects including psychological, social, organizational and political processes.[109] Data shows that in high-magnitude risk industries like aviation industry, medical industry, commercial nuclear power industry, 80% of all accidents are a result of human error[110] which can be hard to predict, and must be factored in while devising a regulatory framework to ensure safe operation of nuclear facilities. Also, operation of a nuclear facility usually involves numerous stakeholders, such as research and development organizations, processors of nuclear material, manufacturers of nuclear devices, medical practitioners, architect–engineering firms, construction companies, operators of nuclear installations, financial institutions, members of public in the vicinity of the facility, and regulatory bodies.[111] For effective regulation, having just a designated regulatory authority based solely on inflexible technical and legal standards would be insufficient. Instead, a framework capable of quickly adapting to changing circumstances is far more functional,[112] and national commitment to regulating with better informed, more adaptive and accountable policies is essential in achieving that.[113] Given how complex nuclear technology is and the number of stakeholders involved, a holistic approach is needed to address all the interdisciplinary aspects of regulating it as mentioned above. [114]Participation and coming together of all stakeholders, culture within nuclear corporations to engage in internal criticism to garner public trust, uniform regulations help rationalize the highly technical aspects of nuclear energy to be enforced by an independent regulatory body equipped with a credible system for hearing and addressing public grievances form key considerations for any nation's nuclear safety regime.

Given that nuclear is a mature industry, much can be learned from history of how it has been regulated in economies like the US, and France who have very advanced nuclear power programs. There is of course not a specific form of regulatory regime that is suitable for all countries and how it is shaped depends largely on the needs of each jurisdiction. The countries within the scope of this research are mainly states that are in the initial stages of their nuclear power programs and are referred to as embarking states. In most embarking states, the government is significantly involved in the nuclear power program and there may be doubts regarding the independence of the regulator since there may be strong interplay between different departments. So, an optimal regulator in these nations needs to be configured keeping in mind all those factors and this will be dealt with in greater detail in the next chapter.

1.9 Conclusion

As we have already begun to feel the brunt of a warming planet, decarbonization of the electricity sector holds one of the keys to mitigating and minimizing the impact of climate change. As discussed above, electricity generation has been seen to significantly contribute to the rise in emissions driven by increasing energy demand. This demand for energy is only projected to grow especially in emerging economies which have become more dependent on fossil fuels as they go

[109] Ibid.
[110] DOE Standard Human Performance Improvement Handbook, Vol. 1 DOE-HDBK-1028-2009 June 2009 at 1-10
[111] Carlton Stoiber et. al., Handbook on Nuclear Law, International Atomic Energy Agency, 2003.
[112] Jody Freeman & Daniel A. Farber, Modular Environmental Regulation, 54 Duke L.J. 795, 876 (2005).
[113] Daniel Farber, Robert Bea, Karlene Roberts and Kofi Inkabi, Reinventing Flood Control, 81 Tul. L. Rev. 1085 (2006)
[114] Stephen Breyer, Breaking the Vicious Circle: Toward Effective Risk Regulation, Harvard University Press, Cambridge, MA.

through rapid industrialization and population growth. Reducing emissions from electricity generation becomes vital in this context to prevent irreversible damage to the planet which would occur if earth's temperature continues to rise. Decarbonizing the electricity sector can be achieved though grid diversification, such that we are able to sustain a continued process of decoupling from polluting fossil fuels as we become dependent on clean zero-carbon emission sources of electricity generation. Renewable energy sources combined with nuclear energy provide us an option to pursue that path.

We are much beyond the era when nuclear energy was deemed to be a luxurious option for producing energy and also considered a matter of national pride for many countries. Today, it is an option that many countries are taking as a matter of necessity to meet their basic energy needs for their burgeoning populations. Electricity constitutes one of the most basic necessities one needs in modern society to maintain a reasonable quality of life and therefore it is crucial to explore safe and zero carbon emission sources of baseload generation in these regions. As discussed above, when incorporated in the grid with renewable energy sources, nuclear energy offers a plausible solution.

Nuclear energy has an especially important role to play in emerging economies in Southeast Asia and sub-Saharan Africa where a fast-growing population and even faster growing energy demand need a zero-carbon baseload source of energy. In this background, nuclear energy investment in these regions remains a very pertinent issue given the need for improving energy access there while ensuring compliance with internationally recognized safety principles for nuclear power project implementation. Several countries within the scope of this dissertation do not have specific legal framework in place for regulating nuclear energy production or have a system for settlement of liability claims in case of an accident. This is a strongly discouraging factor for many foreign vendors of nuclear technology to engage in nuclear power projects in these regions, given the legal uncertainty and the lack of well-defined liability and regulatory legal provisions. Beyond that, absence of appropriate legislation on nuclear energy can be problematic to safeguarding the interests of local communities leaving them vulnerable to safety concerns and arduous claims settlement litigation in case of a nuclear accident. This is why this dissertation will take up an objective evaluation of the interests of various stakeholders while taking into account the concerns of developing countries and evolve solutions that may be acceptable to all sides.

This dissertation will delve into the legal, safety and security related issues pertaining to nuclear energy investment in Southeast Asia and sub-Saharan Africa. For this purpose, the forthcoming chapter will analyze the existing relevant international regulatory and liability instruments pertaining to nuclear energy, and how they translate into domestic policies.

After understanding the relation between international and domestic nuclear legal regimes, the third chapter of this dissertation will provide a full picture of the factors that affect nuclear investment and cover the timeline between a state's decision to embark on a nuclear power program to procurement of its first nuclear reactor. It underlines the considerations that go into deciding to embark on a nuclear power program, both from the state and investor/suppliers' perspectives. In particular, the third chapter will study the specific challenges that emerge in the context of foreign investment and involvement of multiple foreign entities in nuclear power projects in Southeast Asia and sub-Saharan Africa.

With the above background on the law and nuclear vendor perspective, Chapter four addresses the challenges that an emerging economy faces while negotiating a nuclear power

project with international entities. The analysis in this chapter will address the disadvantaged negotiating position of the countries within the scope of this research. Nuclear power projects today have shifted from the traditional state-owned model and become more complex with the involvement of foreign entities. Countries in Southeast Asia and sub-Saharan Africa lack the technical know-how, financial resources and the massive capital required to invest in a large-scale nuclear facility. Thus, these countries are heavily dependent on foreign suppliers for their nuclear power programs and often take a less powerful position in negotiating agreements for these projects. As a result, the interests of local communities are often ignored, for example, majority nuclear reactors both proposed and under-construction in sub-Saharan Africa are going to be supplied by Chinese Corporation (China National Nuclear Corporation) and Russian Corporation (Rosatom), and these projects will be structured on a build-own-operate model. Under this build-own-operate model, the China National Nuclear Corporation (CNNC) and Rosatom will finance the construction and operation of these nuclear facilities, as well as own them for sale of electricity to local power companies at an agreed price. Arrangements like these are capable of putting these nations in a position where they have little to no control over the course of these transactions and how they will impact their own citizens. It therefore becomes pertinent to implement practices that allow fair negotiations and safeguard the interests of local communities in implementing nuclear power projects. For this purpose, this chapter will include case-studies from India, Turkey, and the United Arab Emirates who have already implemented nuclear power projects in cooperation with foreign vendors in the past. Further, this chapter will also include case-studies of what partnership between developed and developing nations on large-scale projects has looked like in other comparable industries to look for lessons that can be learned therefrom.

Lastly Chapter five, will address the lack of coordination between the international nuclear legal framework and different domestic regimes that leaves many stakeholder concerns either unanswered or inadequately addressed. It will further analyze how domestic legislation, investor/business stakeholder perspectives and international instruments can be bridged together to ensure that nuclear power projects are implemented in a way that protects the interests of the host countries, their populations, as well as the interests of foreign developers/vendors of nuclear technology. This chapter will also include recommendations for changes to the existing international nuclear legal framework to create more uniformity and encourage international collaboration on nuclear power projects.

1.10 Methodology

1.10.1 Comparative Legal Analysis

The regions within the scope of this research are Southeast Asia (Thailand, Philippines, Malaysia, Indonesia, and Vietnam) and sub-Saharan Africa (Ghana, South Africa, Nigeria, and Kenya). The methodology that I will adopt is a combination of legal analysis, comparative legal analysis, impact analysis, and case studies. First, this thesis will study the law on nuclear regulation, liability, and non-proliferation by analyzing the evolution of the current law on nuclear energy through relevant international instruments, and explain how they influence domestic laws on the subject in each country within the scope of this research.

1.10.2 Impact Analysis and Case Studies

After providing an overview of nuclear legal framework at both the international, and domestic level, I will conduct an impact analysis to understand how this legal framework influences the implementation of nuclear power projects from the perspective of foreign vendors, national governments, and local communities affected by these projects. Further, this thesis will make domestic policy recommendations and propose changes to the existing international legal framework on nuclear energy for successful implementation of nuclear power projects in these regions as well as to provide for commercial use of Small Modular Reactors in the future. The analysis here will be supported by interview as well as case-study methods to gather information about the practicalities of implementing nuclear power projects in developing nations. The legal systems represented within this research are Common Law (South Africa, Ghana, Kenya, Nigeria, and Malaysia), Civil Law (Thailand, Vietnam, and Indonesia), as well as a combination of both common and civil law (Philippines). To be mindful of this legal plurality, this thesis will analyze the nuclear energy law scenario as well as make policy recommendations for each of these countries separately and include case-studies of nuclear power projects in India (Common Law), Turkey, and the United Arab Emirates (Civil and Islamic Law). Beyond this, the thesis will include case-studies of negotiations and court cases related to construction of nuclear power plants in developing nations in Asia to help illuminate the exact impact of nuclear power projects and the law pertaining to them on affected local communities.

2 CHAPTER II – INTERNATIONAL LEGAL FRAMEWORK PERTAINING TO NUCLEAR ENERGY AND ITS TRANSLATION IN DOMESTIC POLICY

To understand the different facets of nuclear energy investment in Asia and Africa, it is first important to look at the international and domestic legal instruments that form the existing nuclear energy regime. The discussion here will study the development of the nuclear regulatory, and liability regime over the past half a century and how international legal instruments impact domestic nuclear energy policies, trade, and investment. For this purpose, this chapter will be divided into two sections. The first section will discuss laws pertaining to regulation of nuclear installations and the second section pertains to management of liability in the aftermath of a nuclear accident.

Commercial use of nuclear technology has interdisciplinary aspects and can involve the application of various laws such as environmental protection, industrial safety, land use planning, administrative procedure, mining, transport, and electricity rate regulation. However, the complex nature of nuclear technology requires special legal arrangements in order to ensure its application.[115] Nuclear law is a set of norms and rules that govern any use of nuclear energy or fissionable materials and consists of international instruments under the auspices of international organizations like the International Atomic Energy Agency (IAEA), and the Organization for Economic Cooperation and Development (OECD). Regulation, liability, security, and disarmament are among the big themes in the current transnational nuclear law framework.

2.1 Regulation of Nuclear Installations – The role of international law in shaping domestic legislation and policies

Chernobyl[116] and Fukushima both had severe impacts on the growth of nuclear energyand raised several concerns about nuclear safety and liability. Both of these accidents while evident of the catastrophic nature of the potentiality of a nuclear accident also exposed the inadequacy the existing legal system to address that. Many victims of Chernobyl were left with the burden[117] of establishing their claim through complicated and cumbersome procedures[118], litigation with regard to claims settlement for Fukushima[119] is still[120] ongoing.[121]

The 1986 accident at the Chernobyl nuclear power plant gave a clear picture of the catastrophic effects of a nuclear accident. Twenty-eight highly exposed reactor staff and

[115] Carlton Stoiber et. al., Handbook on Nuclear Law, International Atomic Energy Agency, 2003 at p. 4
[116] S. Alexievich, Voices from Chernobyl: The Oral History of a Nuclear Disaster, Picador (2006)
[117] A. Petryna, Nuclear Payouts: Knowledge and Compensation in the Chernobyl Aftermath, Anthropology Now, November 19, 2009
[118] A. Gee, Chernobyl Victims Struggle with Consequences of Radiation Exposure U.S. News April 24, 2008
[119] Case 3:12-cv-03032, Cooper et al. v. Tokyo Electric Power Co. Inc. In June 2017, the Ninth Circuit, backed by an amicus curiae brief by the US government, upheld the lower court´s decision declaring US courts competent to rule).
[120] Fukushima plaintiffs exhausted after settlements urged but rejected by Tepco, The Japan Times March 7, 2020 https://www.japantimes.co.jp/news/2020/03/07/national/3-11-plaintiffs-exhausted-lawsuits-court-deals-urged-rejected-tepco/
[121] Case 3:2017v01671 Bartel et al. v Tokyo Electric Power Company Inc. et al., 18 August 2017. Complaint with Jury Demand against Does 5 through 200, General Electric and Tokyo Electric Power Company, Inc.

emergency workers died from radiation and thermal burns within four months of the accident. Officials believe the accident also was responsible for nearly 7,000 cases of thyroid cancer among individuals who were under 18 years of age at the time of the accident. As of 2005, 15 people who were under the age of 14 in 1986 had died of thyroid cancer.[122] Apart from its physical effects, Chernobyl exposed several inadequacies in the international legal framework concerning nuclear energy and there was a global realization of the dire need for efforts to have a well-established system in place, to prevent and in case they occur, mitigate the effects of a nuclear accident. Then 25 years later, occurrence of the Fukushima Daiichi accident triggered worldwide concern over the safety of nuclear power plants. Nuclear law as we see it today, has evolved under the shadow of the Chernobyl accident and several changes to it have been made in response to Fukushima.

2.1.1 Institutional Nuclear Infrastructure –Implementation Issues and Support from the International Community

2.1.1.1 Overview of International Framework for Nuclear Safety and Regulation

As mentioned earlier, international nuclear regulatory framework has evolved primarily after the Chernobyl nuclear incident and can be analyzed separately based on their nature i.e. Obligatory and Recommendatory. Obligatory instruments include treaties ratified by states and have binding legal effect upon members. On the other hand, recommendatory instruments include safety guides and manuals that lay down the basic standards of nuclear safety and best practices which although not binding, are followed by states via common consensus as they are recognized as generally agreed upon principles and thus have global relevance.

Three conventions mainly form the international framework for nuclear safety and regulation: Convention on Nuclear Safety, 1994 (CNS)[123], Convention on Physical Protection of Nuclear Materials, 1980 (CPPNM)[124], Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, 1997 (JC).[125] Of course, every state has to decide whether becoming contracting party to defined international instruments will serve its interests. On the other hand, nuclear energy is a politically sensitive matter and staying away from conventions like the Nuclear Non-Proliferation Treaty (NPT) or the Nuclear Safety Convention would create major political drawbacks for the respective state including difficulties in supply.[126]

CPPNM includes measures related to the prevention, detection and punishment of offenses relating to nuclear material and JC deals with safety of management and storage of radioactive waste and spent fuel in countries with and without nuclear programs. Convention on Nuclear

[122] Sources and Effects of Ionizing Radiation, UNSCEAR 2008 Report to the General Assembly with Scientific Annexes, Vol. II Scientific Annexes C, D and E
[123] Convention on Nuclear Safety, 1994, International Atomic Energy Agency (IAEA) INFCIRC/449

[124] Convention on Physical Protection of Nuclear Materials (CPPNM), 1980, INFCIRC/274
[125] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, 1997 (JC) INFCIRC/546
[126] V. Lamm, Reflections on the development of international nuclear law, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1

Safety was a response to the Chernobyl nuclear incident.[127] It lays down the basic requirements that every state must fulfill to ensure nuclear safety and to that end, makes it obligatory on member states to establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.[128] CNS calls for "sufficient separation between the regulator and other entities involved in the promotion or utilization of nuclear materials."[129] In most embarking states, the government is significantly involved in the nuclear power program and there may be doubts regarding the independence of the regulator since there may be strong interplay between different departments.

Then once again in response to the Fukushima incident, different countries came together in reevaluating their domestic nuclear safety policy as well as the international nuclear safety regime. Their response emphasized the importance of regulatory independence and a regulatory safety culture for effective regulatory oversight of the safety of nuclear installations. [130] The ability of regulatory bodies to make independent safety decisions and to ensure their implementation depends on them having sufficient independence in terms of human resources and financing. However, it is pertinent to note that regulatory frameworks have to be configured to suit each country's needs and the key is to make sure that the regulator is unbiased and independent[131] enough to discharge its mandate.[132] This would be further elaborated in section iii.

2.1.1.2 The need for uniformity in nuclear regulation

In addition to the abovementioned instruments, the IAEA safety standards establish fundamental safety principles, requirements and measures for the safety of radioactive material to mitigate the consequences of a nuclear accident. The standards apply to all facets of nuclear industry including facilities, transport and waste that may harbor risks arising from ionizing radiation. However, they are not binding upon states and are issued in the form of guidelines. Given their recommendatory nature, states can choose to incorporate into their domestic framework to facilitate trade. An incentive to doing so is that uniformity in norms and rules eliminates any chances of conflict and uncertainty which is highly encouraging for the industry, especially foreign investors. This again allows for better regulation even regionally as it creates more confidence between neighboring states that may be concerned about the possibility of transnational damage from a nuclear incident in either of their territories. The Convention on Nuclear Safety, 1994 was a big stride in creating more uniformity in the way nuclear safety and regulatory regimes work globally. The intention behind creating uniformity in regulation stems from the fact that a nuclear accident can potentially cause transboundary damage and also result

[127] O. Jankowitsch and F. Flakus International convention on nuclear safety: A legal milestone, IAEA Bulletin, 3/1994
[128] Article 7, Convention on Nuclear Safety, 1994
[129] Article 8 (ii), CNS 1994
[130] Impacts of the Fukushima Daiichi Accident on Nuclear Development Policies Impacts of the Fukushima Daiichi Accident on Nuclear Development Policies, Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD-NEA) 2017
[131] The concept of regulatory independence will be explained in greater detailed later in this chapter in section II.
[132] IAEA Report on Strengthening Nuclear Regulatory Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant (2013)

in other global consequences by say affecting public confidence in nuclear power. Therefore, states have found it mutually beneficial to bind themselves to a number of safety rules, and maintain transparency with one another about their implementation.[133]

Synchronizing regulatory authorizations with the industry's operational needs is also an important part of effective regulation.[134] As each country implementing a nuclear program will have its own specific industrial, economic, legal and regulatory structure, international suppliers of nuclear technology and fuel need to adjust to these national measures. At the same time though, recipient country would also need to adjust their systems to comply with recognized international requirements which were put in place with involvement of all stakeholders including industry and national governments.

Additionally, regional cooperation on nuclear safety is an essential part of ensuring uniform application of safety standards and complement the multilateral partnerships with IAEA. In Southeast Asia, there is a growing nuclear energy community under Association of Southeast Asian Nations (ASEAN) in the form of ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM).[135] In Africa as well, African Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology (AFRA) has been established under the auspices of IAEA to promote collaboration on nuclear safety issues.[136]

2.1.1.3 Post-Fukushima Regulatory Changes in the International Nuclear Regulatory Regime

Following the Fukushima Daiichi accident, the international community addressed, among other things, the issue of the national regulatory frameworks and the national regulatory authorities. In the "Declaration by the IAEA Ministerial Conference on Nuclear Safety in Vienna on 20 June 2011"[137], IAEA Member States unanimously adopted the Action Plan on Nuclear Safety, which was built on this declaration. The benefits of strengthened and high quality independent international safety expert assessments through periodic reviews and evaluation missions assessing national regulatory frameworks were underlined and commitment was expressed "to further strengthening the authority, competence and resources of national regulatory authorities, including through appropriate technical and scientific support and to continuously ensure their effective independence." [138]

Under this Action Plan, the IAEA Secretariat was asked to organize International Experts

[133] O. Jankowitsch and F. Flakus International convention on nuclear safety: A legal milestone, IAEA Bulletin, 3/1994
[133] Article 7, Convention on Nuclear Safety, 1994
[134] Effective Nuclear Regulatory Systems: Facing Safety and Security Challenges, Proceedings Series - International Atomic Energy Agency (2006)
[135] Wan, Wilfred. "Southeast Asia." In *Regional Pathways to Nuclear Nonproliferation*, 78-94. Athens: University of Georgia Press, 2018. Accessed April 26, 2020.
[136] African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) 1990, International Atomic Energy Agency (IAEA), April 3 2020 INFCIRC/935
[137] Declaration by the IAEA Ministerial Conference on Nuclear Safety in Vienna on 20 June 2011, International Atomic Energy Agency (IAEA), INFCIRC/821
[138] *Ibid.* para. 12

Meetings to analyze all relevant technical aspects and learn the lessons from the accident. The Action Plan includes twelve main actions.[139] The actions adopted within this plan lay down some general provisions for cooperation on safety assessment of nuclear installations post-Fukushima, emergency preparedness and response during a nuclear accident and other safety concerns regarding nuclear installations, and revision of IAEA as well as domestic safety standards. One of the actions is focused on communication and information dissemination, and includes six sub-actions calling for a stronger emergency notification system for accurate reporting in the event of a nuclear accident between IAEA member states as well as the general public. They also emphasize the significance of sharing information regarding the transparent assessment of lessons learned from the Fukushima Daiichi nuclear incident.[140]

2.2 Establishment of a Nuclear Regulatory Framework in Embarking States

The discussion above explained the evolution of nuclear safety standards and law at the international level. This section talks about how an embarking state can in accordance with applicable international instruments establish its own nuclear regulatory framework. The IAEA has developed an approach to introducing nuclear power in a country, which is set out in the document "Milestones in the Development of a National Infrastructure for Nuclear Power" published in 2007. This has become the foundational document guiding countries in the development of a nuclear infrastructure and the basis of the agency's assistance program in this area. In developing the infrastructure for building a nuclear power program, there is a range of activities that must be completed. The IAEA's Milestones document as demonstrated in the chart below, divides these into three progressive phases of development. Each of these milestones are accompanied by a phase which involves completion of a set of activities. These phases include a) making a commitment to embark on a nuclear power program; b) readiness to invite bids/negotiate a contract for the first nuclear power plant; and c) readiness to commission first nuclear installation.[141]

[139] Safety Assessments post-Fukushima; Strengthen peer review for regulatory effectiveness, operational safety, design safety, and emergency preparedness and response; Emergency preparedness and response; Strengthen National Regulatory Bodies and Operating Organizations; Review IAEA Safety Standards, Improve International Legal Framework, Facilitate development of necessary infrastructure in embarking states; Capacity Building; Protection of people and environment from ionizing radiation; Communication and information dissemination, Research and Development.

[140] IAEA Action Plan on Nuclear Safety at p.6. September 22, 2011

[141] Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev.1), 2015

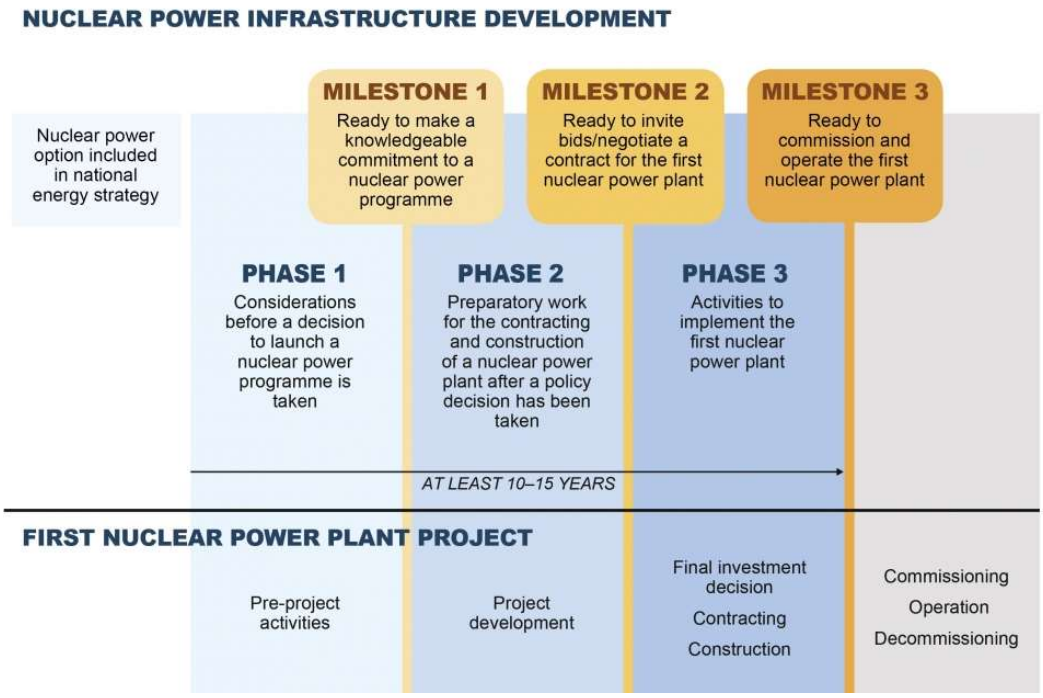


Image Source: IAEA Milestones Approach
https://www.iaea.org/topics/infrastructuredevelopment/milestones-approach

The completion of a specific set of goals in each phase is marked by accomplishing a specific "milestone" at which the progress of the infrastructure development can be evaluated, and a decision made as to whether or not to move on to the next phase. Achieving these 19 infrastructural goals[142] more or less completes the first of the three phases of the International Atomic Energy Agency (IAEA) required milestone approaches for every newcomer country to achieve before the development of a national infrastructure for nuclear power.[143] Establishment and maintenance of a governmental body to exercise regulatory control over the users of ionizing radiation is a basic pre-requisite for harnessing nuclear energy in any state[144] and is also recognized as a Phase II milestone under the IAEA framework for development of a nuclear program.[145] Embarkation on a nuclear power program entails obligation to use nuclear power for peaceful purposes and demonstrate compliance with international legal instruments, established nuclear safety standards, and safeguards. It also demands putting in place the essential governmental, legal, regulatory, managerial, technological, and industrial support system for the nuclear program. Thus,

[142] 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 ste management; industrial investment; and procurement.
[143]Ghana completes first phase of nuclear power programme
http://www.ghana.gov.gh/index.php/media-center/news/3356-ghana-completes-first-phase-of-nuclear-power-programme
[144] Article 4, Convention on Nuclear Safety, 1994
[145]IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1) Milestones in the Development of a National Infrastructure for Nuclear Power (2015)

any embarking state must first put in place a reliable regulatory regime.

It is also pertinent to note that establishing an effective nuclear legislative framework for nuclear regulation regulatory framework can be a very complex process and can take decades. Despite establishing clear goals, there are several other factors including industry considerations that may impact the establishment of effective regulation in an embarking country. In the early years of nuclear technology development in the US, the Atomic Energy Act of 1946 established the Atomic Energy Commission (AEC) which was also responsible for regulating nuclear energy. The Atomic Energy Commission continued to be tasked with regulatory functions after nuclear energy was commercialized with the Atomic Energy Act of 1954. However, there were several concerns raised about the regulatory approach of the AEC which was driven by the impetus for encouraging the growth of civilian nuclear industry. The Act itself directed the AEC to encourage widespread participation in the development and utilization of atomic energy for peaceful purposes. By the 1970s, there was a lack of confidence in AEC's ability to be a regulator when it is tasked with dual responsibilities of both developing as well as regulating the nuclear industry. Finally in 1974 the Nuclear Regulatory Commission was established under the Energy Reorganization Act, the Nuclear Regulatory Commission was established such that in comparison to AEC, its regulatory staff's decisions will be less susceptible to being influenced by industry development priorities.

The Aviation industry has had a similar journey. After the Air Mail Act, 1925 which drove the commercial airline industry, the Air Commerce Act, 1926 tasked the Secretary of Commerce with fostering as well as maintaining oversight over the airline industry, and the Aeronautics Branch of the Department of Commerce took up the primary responsibility of aviation oversight. This Branch was later renamed as the Bureau of Air Commerce. After a series of aviation safety failures, the Civil Aeronautics Act, 1938 created the Civil Aeronautics Authority (CAA). The CAA was later split into the Civil Aeronautics Administration tasked with air traffic control and safety enforcement, and a Civil Aeronautics Board responsible for safety rulemaking, accident investigation, and regulating airlines. Then after a major midair collision in 1956, a need was felt to take additional steps to mitigate midair collisions. In 1958, the Federal Aviation Act came into force creating an independent agency for aviation oversight called the Federal Aviation Agency. Ultimately, in 1967, the Department of Transportation began its operations and the Federal Aviation Agency became the Federal Aviation Administration and a National Transportation Safety Board was created which took over the responsibilities of the Civil Aviation Board.

An embarking country may likely face similar challenges in balancing the considerations of growing its domestic nuclear industry, inviting foreign investment in its nuclear power program while also grappling with growing energy demand. All of these factors can make it difficult to establish an independent regulatory framework.

2.2.1.1 Guiding principles for establishment of regulatory authority

There are three main aspects that the national regulatory framework on nuclear energy of a state must cover: nuclear safety, nuclear security, safeguards and civil liability for nuclear damage). This is known as the 3S concept i.e. safety, security and safeguards. The 3S concept applies to the structuring of the regulatory body. The term reflects the three technical areas that need to be addressed in establishing an adequate legislative and regulatory framework to ensure

the peaceful uses and prevent the non-peaceful uses of nuclear energy and ionizing radiation[146]. Safety is concerned with prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards. Security entails taking steps to prevent and respond effectively to illegal transfer or other malicious acts involving nuclear material, other radioactive substances or their associated facilities, while safeguards are focused at nuclear non-proliferation.[147] An effective regulatory authority would be tasked with ensuring all three aspects – safety, security, and safeguards and independence of the regulatory authority is critical to accomplishing this goal.

Regulatory independence has been treated as. a core element of the nuclear framework and has been further emphasized after Fukushima. The IAEA in its comprehensive report on effective regulation emphasized that, regulatory bodies should continue their efforts to ensure that the national regulations are in line with the IAEA safety standards. The report also pointed out that the ability of regulatory bodies to make independent safety decisions and to ensure their implementation requires the following:

(a) competent and sufficient human resources
(b) adequate legal authority (including the right to suspend operation and/or to impose safety improvements on licensees)
(c) adequate financial resources
(d) international cooperation, including exchange of regulatory knowledge and experience among regulators and peer reviews with transparent and open dialogue.[148]

In addition to the above, it is also important that national regulatory bodies should determine safety objectives to be achieved by the licensees and ensure implementation of the necessary safety measures. The required safety measures need to be implemented by licensees within stipulated deadlines and subject to regulatory verification. Inadequate regulatory verification may have a negative impact on safety if the licensee does not take the appropriate actions. Regulatory review and assessment should be expanded to include a systematic reassessment of safety margins (robustness of the nuclear power plant design) for both existing and future nuclear power plants[149].

2.2.1.2 Structure of the Regulatory Body for an Embarking State

Institutional separation of the regulatory body from bodies responsible for the promotion or development of nuclear energy and nuclear applications is often seen as particularly important for achieving effective independence. This means that a regulatory body should possess an adequate measure of independence or functional separation from entities having interests or responsibilities that could unduly influence regulatory decision making. Such entities include not

[146] Z. Ilyas, Nuclear Regulatory Policy Concept on Safety, Security, Safeguards and Emergency Preparedness (3S+EP), IAEA-CN-166/19
[147] D. Hanks, Managing Safety, Security, and Safeguards (3S) Relationship: A National Regulatory Authority Perspective United States Nuclear Regulatory Commission, Institute of Nuclear Materials Management 54th Annual Meeting (2013)
[148] T. Taniguchi, Establishment and Application of Safety Standards and Security Guidance, Effective Nuclear Regulatory Systems: Proceedings of an International Conference, IAEA 2006 at p. 97
[149] IAEA Report on Strengthening Nuclear Regulatory Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant (2013)

only the regulated industry and medical users of radioactive material and technology, but also other governmental bodies charged with the development or promotion of the technology, as well as political bodies and non-governmental bodies. The reason for using the phrase adequate measure here instead of simply saying independence is that there is no single method of ensuring regulatory independence. This is because, states with different governmental structure and legal systems will take different approaches to maintaining a regulatory body.[150] IAEA as well the OECD-NEA recommend that one way of structuring an independent nuclear regulator is by defining its role and responsibility by law and to ensure that it is insulated from executive intervention as well as the state's influence. The OECD-NEA recommends that a nuclear regulatory authority should be answerable to the parliament and its decisions subject to judicial review.[151] This is also vital for ensuring the regulator's reliability and to encourage public confidence.[152]

Ultimately, whichever approach a state ends up taking in structuring its regulatory authority for nuclear energy, what matters is that the adopted model establishes a rigorous, evidence-based oversight process covering all activities in a State that may pose significant risks of radiological harm.[153]

2.2.1.3 Regulation and nuclear power project models

In different countries, institutional arrangements vary. Historical factors and legislative practicalities are the usual bases for determining the overall structure of a state's nuclear law. Usually governments have a great degree of involvement in nuclear planning, and especially in the case of developing countries they also play a pivotal role in financing and operation. Conventionally, the state used to own the entities operating nuclear power plants. However, as has also been seen recently in Turkey[154], the United Arab Emirates (UAE)[155], and India[156], that is changing. The recent nuclear power projects in each of these countries have had significant involvement of private entities.

As the industry becomes more international, private entities are becoming significantly involved in nuclear power program of several nations. Embarking states may initially lack the technical know-how, and therefore new arrangements are emerging in the form of public-private partnerships to incentivize technology development through collaboration between new technology developers to share risk with the government to accelerate deployment[157]. These

[150] C. Stoiber, A. Cherf, W. Tonhauser, M. De Lourdes, Handbook on Nuclear Law, IAEA 2010 at p. 25
[151] The Characteristics of an Effective Nuclear Regulator, Nuclear Regulation NEA/CNRA/R(2014)3, OECD-NEA (2014)
[152] *Ibid.*

[154] IAEA Country Nuclear Profiles: Turkey 2019
https://cnpp.iaea.org/countryprofiles/Turkey/Turkey.htm
[155] IAEA Country Nuclear Profiles: UAE 2019
https://cnpp.iaea.org/countryprofiles/UnitedArabEmirates/UnitedArabEmirates.htm
[156] S. Miglani, Russia signs pact for six nuclear reactors on new site in India, Reuters October 5, 2018
https://www.reuters.com/article/us-india-russia-nuclear/russia-signs-pact-for-six-nuclear-reactors-on-new-site-in-india-idUSKCN1MF217
[157] Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)

partnerships may take several forms including turnkey, build own operate (BOO), and build own operate transfer (BOT) schemes.

Under the turnkey structure, the reactor vendor assumes all technical and commercial risks in delivering a functioning plant on time for various types of cost reimbursement models, where the contractors are reimbursed based on the actual costs of the project with a fee being paid for their services. [158] Turkey's Akkuyu nuclear power project was initially proposed as a turnkey project with Russia's Rosatom, but was later changed to a build operate transfer model. Owing to the large scale at which nuclear power projects are undertaken, the vendor may create a consortium to build, own and operate the plant. In this arrangement, the investor builds a plant, operates the plant and sells the output under a pre-agreed contract before transferring it to local ownership (either a state-owned body or a private investor). However, when the investor builds, owns and operates a plant to recover its investment by selling the power output at an agreed price to local utilities, it is referred to as a build own operate model (BOO). [159]

Involvement of private entities in the nuclear power program of a country raise other issues with regards to licensing and liability management. This makes it important to examine whether existing institutional frameworks at both the domestic and international level are equipped to cater to these developments.

2.3 Nuclear Licensing in Embarking States

As mentioned above, embarking states may initially lack the technical know-how and personnel to maintain its nuclear facilities. So international vendors of nuclear technology may be significantly involved in building and maintaining nuclear power plants in these states. This raises the question of how these nuclear installations will be licensed and by whom? Regulation and licensing are the sovereign functions of every installation state. The IAEA only provides recommendations, as regulation and licensing fall beyond its mandate, given that regulation is a sovereign function and beyond that, regulation has many regional factors attached to it (for eg. factors applicable in one country may greatly differ in other countries based on geological conditions peculiar to a specific region). Therefore, compliance with the IAEA standards is based on incentives (as listed above with uniformity discussion) leaving regulation strictly a national issue.

While the nuclear industry is unique in its own sense, analogies can be drawn from industries having relatively similar risk portfolio like aviation and spaceflight industry wherein bilateral agreements are seen between the relevant design certifying authorities to maintain reciprocity. Under this framework, nations recognize each other's certification mechanism to eliminate the need for reevaluation of designs. A similar arrangement with convergence of state functions with international best practices as the OECD-NEA provides a Multi-national Design Review Secretariat which provides nuclear reactor design certifications. However, all MDEP certifications are of recommendatory nature and cannot serve as a license. Design certification of the GE BWR by NRC was seen quite early in the nuclear industry in the 1970s and also the Areva EPR has been certified. However, there may still be hurdles as the national regulator will still need to investigate and examine whether a particular reactor fulfills all their safety requirements in spite of it being internationally certified, since reports or certifications issued by international

[158] The Financing of Nuclear Power Plants, NEA No. 6360, OECD 2009 at p.44
[159] *Ibid.* p.52

organizations are usually recommendatory and thus have value as evidence but they can't be used as a license.[160] Further, there may be additional requirements that may differ from country to country for e.g. seismic risks for a site. The aforementioned is an issue in the US as the nuclear industry has large involvement of private entities.

2.4 International Cooperation and Oversight in Licensing

In terms of international cooperation, the principal flow of information related to best practices and safety in the nuclear power industry is among the staff of the 440 power reactors operating in 31 countries. This is at a number of levels. Internationally, the World Association of Nuclear Operators (WANO) is the lead player, but among governments the UN's International Atomic Energy Agency (IAEA) is also vital.[161] The OECD Nuclear Energy Agency's (NEA) Multinational Design Evaluation Program (MDEP) is also a multinational initiative to leverage the resources and knowledge of national regulatory authorities that are, or will shortly be, undertaking the review of new reactor power plant designs. MDEP incorporates a broad range of activities including enhancing multilateral co-operation within existing regulatory frameworks, and increasing multinational convergence of codes, standards, guides, and safety goals.

MDEP has developed a process for identifying and documenting common positions on specific issues among the member regulators, which may be based on existing standards, national regulatory guidance, best practices, and group member inputs. Design-specific common positions document common conclusions that each of the working group members have reached during design reviews. Discussions among the members and sharing of information in these areas help to strengthen the individual conclusions reached. Although MDEP is not currently considering the designs of advanced reactors and only certified Westinghouse's AP 1000 design, it has interacted with the Generation IV International Forum[162] to keep informed of multinational co-operative activities in the area of advanced reactors. MDEP also receives updates, through NEA, of the work of the NEA Group on the Safety of Advanced Reactors, and maintains an awareness of the efforts of the IAEA Small Modular Reactor Forum.

As a parallel effort on the vendor/utility side, in 2007 the World Nuclear Association[163] created the Working Group on Cooperation in Reactor Design Evaluation and Licensing (CORDEL), an industry sponsored group that "promotes the achievement of a worldwide regulatory and industry environment where internationally accepted standardized reactor designs can be widely deployed without major design changes except those dictated by site-specific and minor local necessities. The underlying motivation for CORDEL is that increased uniformity leading to standard designs operating in many countries will enhance nuclear safety.[164] While the OECD-NEA is a regional

[160] Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group Annual Report 2011-2012
[161] Cooperation in Nuclear Power, World Nuclear Association, August 2017
[162] Gen IV International Forum is an independent international aimed at exploring areas of mutual interest and make recommendations regarding both research and development discussions on international collaboration in the development of Generation IV nuclear energy systems.
[163] World Nuclear Association (WNA) is an international organization that represents the global nuclear industry. The WNA also publishes non-technical source of information on global nuclear industry.
[164] World Nuclear Association Annual Report; Working Group on Cooperation in Reactor Design Evaluation and
Licensing (CORDEL); 2001-2012

organization, the establishment of alike mechanisms in the Asian and African context can significantly facilitate the licensing process, as well as help enhance safety standards.

2.5 Civil Nuclear Liability Management – Mitigating Risks through International Cooperation

While more international cooperation to create uniformity in regulation will help ensure safety and prevent accidents, it is pertinent to have a framework in place to mitigate the effects of one in case it occurs. Therefore, the discussion below explores why it is so important to have a clear domestic law, supported by a wider international instrument which binds nations to expedite claims settlement in the aftermath of a nuclear incident. This can be achieved by more cooperation in managing civil nuclear liability.

The law on civil nuclear liability is extremely complicated. The overall legal regime for nuclear liability consists of international conventions and domestic laws. Before doing a deep dive into the laws, it is important to first understand why specific laws need to be enacted to deal with nuclear liability and why there needs to be synchronization between laws of different countries.

The discussion here will deal with the peculiarity of the nuclear industry and liability management, as well as nuclear liability in cases of transboundary damage. Chernobyl clearly showed how far-reaching the effects of a nuclear accident can be and the level of specialized knowledge required to investigate claims of radiation damage. There was widespread damage suffered even in neighboring countries. In the aftermath of Chernobyl, victims from neighboring countries were left distraught as they found themselves faced with the challenge of seeking remedy through the Soviet courts, because there was no reciprocity established between their countries and the USSR to create binding obligation to compensate such victims in case of transboundary nuclear damage.[165] The principle of reciprocity[166] in international law implies that any benefits, favors or penalties granted by one state to the citizens of another should be returned by that state. It was finally agreed that it was not rational to make one state responsible to compensate victims from another state which would have no obligation for the same under similar circumstances.[167]

Despite the experience from Chernobyl today, and even after the Fukushima Daiichi nuclear incident, the law relating to international nuclear liability is extremely complex owing to the existence of different regimes subscribed to in different parts of the world and the lack of participation from several major nuclear power states.[168] This is highly problematic given that a nuclear accident has been seen to result in transboundary damage and lack of uniformity in liability rules may complicate claims settlement process for victims. Further, this lack of uniformity is a serious impediment to trade as it creates a lot of uncertainty for suppliers by making it difficult for them to accurately gauge the risk portfolio associated with pursuing new build in a particular country in the form of uncertainty about the nature and extent of liability. These issues will be

[165] S. Burns, Reformed and reforming: Adapting the licensing process to meet new challenges, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1

[166] F, Paris and N Ghei, The Role of Reciprocity in International Law, Cornell International Law Journal Vol. 6 Issue 1 Spring 2003 Article 4 at p. 100

[167] *Ibid.*

[168] N. Pelzer, Facing the challenge of nuclear mass tort processing, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1

discussed in greater detail later in this section.

Before analyzing the different treaties, it is imperative to understand the law of treaties to see the functionality of different international conventions and their role in shaping domestic law.

The foundation of the law of treaties lies in the principle of *pacta sunt servanda.*[169] This principle is enshrined in Article 26 of the Vienna Convention on the Law of Treaties which states that: 'Every treaty in force is binding upon the parties to it and must be performed by them in good faith.[170] However, while to be performed in good faith, it is ultimately upon sovereign states to determine the means they choose to fulfil their international obligations.[171] Thus, international law leaves it to the domestic legal order of a sovereign to determine how it gives effect to its treaty obligations in the domestic legal arena. However, whichever means a contracting state to a treaty adopts, it cannot invoke its internal law as justification for a failure to perform as per Article 27 of the Vienna Convention on the law of treaties.[172]

There are two main approaches to align domestic law with an international instrument: the transformation approach and the incorporation approach. The transformation approach consists of adopting specific rules, through national legislation or regulations/ordinances to implement the provisions of an international instrument. Through this process, the rules stipulated in an international instrument are transformed into domestic law which can be enforced through the national administrative and judicial infrastructure of a state. The transformative approach is based on the ideas that a state while drafting national legislation, intends to ensure that all its obligations under treaties it is a party to, are implemented. Next, under the incorporation approach, there are two ways through which international treaties are brought into effect domestically. The first way is through a constitutional or legislative provision which automatically makes treaties adopted a part of the national legislative framework. Another way is when ad hoc legislation[173] is required for each international instrument.[174]

Also, certain international instruments contain provisions that identify a need for a State to enact national legislation. Examples of such instruments in nuclear law include the Vienna Convention on Civil Liability for Nuclear Damage (VC)[175], the Convention on the Physical Protection of Nuclear Material (CPPNM)[176] and the International Convention for the Suppression of Acts of Nuclear Terrorism.[177]

Now coming back to the discussion on liability conventions, the reason why these are so important is related to the discussion above about the disastrous impact of Chernobyl. As also mentioned above, the claims settlement process after Chernobyl was just as disastrous as the

---

[169] Hans Wehberg, The American Journal of International Law , Oct., 1959, Vol. 53, No. 4 (Oct., 1959), pp. 775-786 and Josef L. Kunz, The Meaning and the Range of the Norm Pacta Sunt Servanda, 39 AM. J. INT'l L. 180 (1945).

[170] Article 26 of the Vienna Convention on the Law of Treaties 1980

[171] M. Mendez., The Legal Effects of Treaties in Domestic Legal Orders and the Role of Domestic Courts, Oxford University Press 2013 ISBN-13: 9780199606610

[172]Article 27, Vienna Convention on the Law of Treaties.

[173] Ad hoc legislation is a law that is enacted especially for the purpose of making the provisions of an adopted treaty binding under domestic law.

[174] C. Stoiber, A. Cherf, W. Tonhauser, M. De Lourdes, Handbook on Nuclear Law, IAEA 2010 at p. 20

[175] Vienna Convention on Civil Liability for Nuclear Damage, INFCIRC/500, IAEA, Vienna (1996).

[176] Convention on the Physical Protection of Nuclear Material, INFCIRC/274/Rev.1, IAEA, Vienna (1980).

[177] International Convention for the Suppression of Acts of Nuclear Terrorism, United Nations General Assembly Resolution A/RES/59/290, UN, New York (2005).

accident itself for victims. There was no specific law to specify the forum for claims, liable entity, and rights of victims in neighboring countries. To unpack, this problem was two-fold. First, the lack of specification in domestic law to deal with liability and claims in the aftermath of a nuclear accident. Secondly, lack of treaty relations between neighboring countries to recognize and protect the rights of victims outside the territory of the state where accident occurred.

To remedy this, it was recognized that having a comprehensive domestic law that defines liability for operating a nuclear installation, assigning the competent authority or forum for claims settlement, and other principles governing the nuclear industry was considered vital. International conventions on nuclear liability also play a role in this. They lay down certain basic principles of nuclear liability that then contracting states adopt in their domestic law. This ensures two important things. Firstly, that all states especially neighboring states treat nuclear liability similarly in terms of amount liable parties etc., and that there is consensus in the claim settlement process. Secondly, that treaty relations are established between neighboring countries that may be affected by transboundary nuclear damage. There are several different ways to achieve these two objectives through international law and they will be discussed in greater detail below.

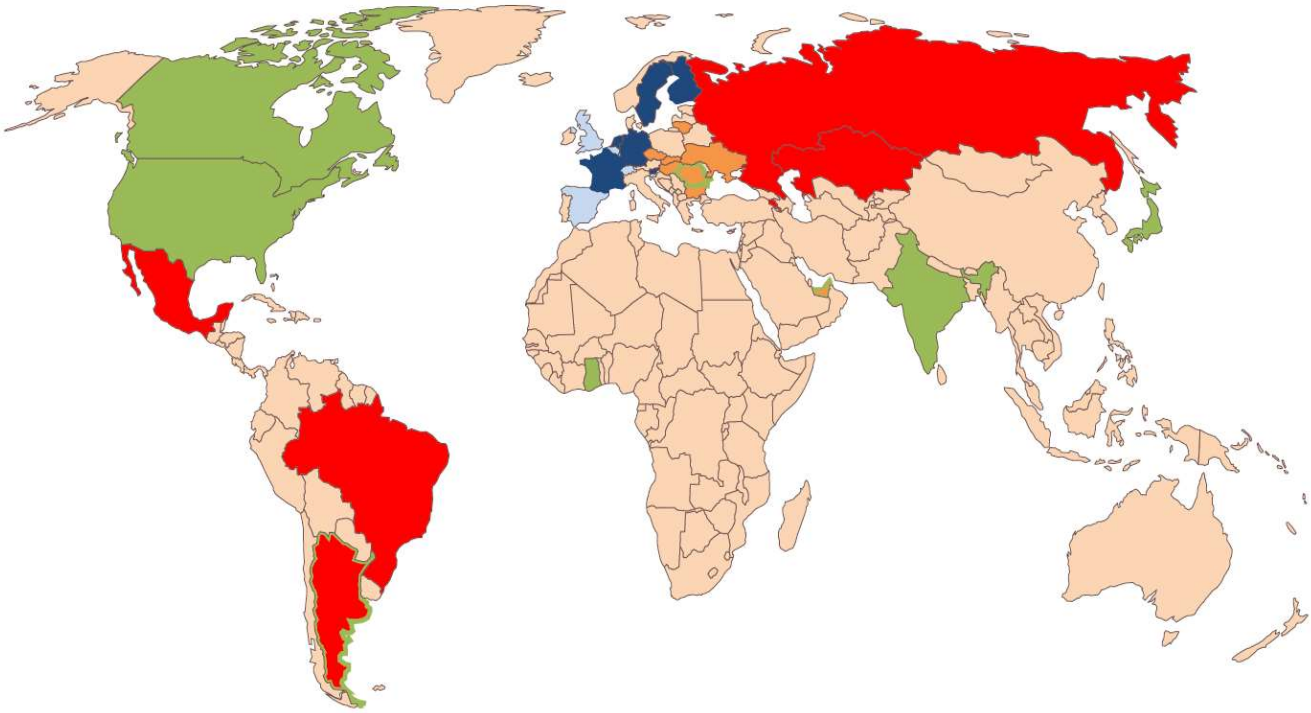
Vienna Convention (VC) on Civil Liability for Nuclear Damage, 1963 (entered into force in 1977), the OECD's Paris Convention (PC) on Third Party Liability in the Field of Nuclear Energy of 1960 (entered into force in 1968), the Brussels Supplementary Convention,1963 (BSC) and the Convention on Supplementary Compensation, 1997 (CSC) are the main treaties governing nuclear liability. Vienna Convention and CSC were adopted under the auspices of the IAEA and is of a more global character unlike the Paris Convention which is under the auspices of OECD-NEA, which is a regional organization. Beyond these conventions, the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention (JP) was adopted in 1988 to create a link between VC and PC (to be discusses later). Each of these treaties embodies the basic principles of civil nuclear liability. Precisely, these principles prescribe compensation without discrimination, strict and exclusive liability of the operator so that the victim is relieved from proving fault and that in the case of an accident, and all claims are to be brought against the nuclear operator. Each of these principles will be discussed in detail in the next section. Both Paris and Vienna Convention provide that there should be limitation of liability for the operator of a nuclear power plant and beyond that stipulate that the installation state is responsible. CSC does the same, but with an additional step. The CSC in addition to limiting the operator’s liability, also limits the liability of the installation state and provides for a fund to be established between all contracting states. This fund is to be utilized for paying claims that fall beyond even the installation state’s liability. This fund is created through contributions from all contracting states based on a calculation method that is provided within the CSC.

The table below shows the latest status of adoption of each of these treaties in different countries. The table and the map below also show the problem of lack of reciprocity between neighboring states and the lack of participation from some major nuclear economies like China.

Country	Liability Convention	Country	Liability Convention
Argentina	VC, CSC	Lithuania	VC, JP
Armenia	VC	Mexico	VC
Belgium	PC, BSC	Netherlands	PC, BSC, JP
Brazil	VC	Pakistan	
Bulgaria	VC, JP	Romania	VC, JP, CSC
Canada	CSC	Russia	VC
China		Slovakia	VC, JP
Czech Republic	VC, JP	Slovenia	PC, BSC, JP
Finland	PC, BSC, JP	South Africa	
France	PC, BSC, JP	Spain	PC, BSC
Germany	PC, BSC, JP	Sweden	PC, BSC, JP
Ghana	CSC	Switzerland	PC, BSC
Hungary	VC, JP	Taiwan	
India	CSC	Ukraine	VC, JP
Iran		UAE	VC, CSC, JP
Japan	CSC	United Kingdom	PC, BSC
Kazakhstan	VC	United States	CSC
Korea			

Table 1. Nuclear power states and liability conventions to which they are party

Source: World Nuclear Association - Liability for Nuclear Damage *https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/liability-for-nuclear-damage.aspx*



ch

Figure 1 – Map depicting the status of adoption of different nuclear liability conventions (VC with JP in orange, PC with JP in blue, VC without JP – red, PC without JP light blue, and CSC in green and green outline where adopted alongside another treaty).

As emphasized several times in the discussion above, it is likely that a nuclear accident will affect neighboring countries and therefore it is important establish reciprocity with regard to recognition of victim's rights between these countries. Beyond this, if neighboring countries stick to uniform rules the purpose of reciprocity can be served better at the residents of each of those states can be equally covered. This is just one part of the problem though. The other facet of the problem is that several states with significant nuclear power programs like China are still not covered by any nuclear liability convention which means that there are no internationally recognized principles that define the rights of victims from neighboring countries. The discussion below aims to unpack the various aspects of these two problems.

Precisely, the question to explore here is what is the best way both domestically and internationally to manage civil nuclear liability? Is it through creating reciprocity between neighboring countries or ensuring that all countries are covered under the same treaty? This is a dilemma that is seen in the evolution of the global nuclear liability regime as discussed below.

The law on nuclear liability has evolved over the last 60 years and it has been greatly influenced by the Chernobyl accident. For the sake of convenient understanding, analysis on the law on nuclear liability can be classified into two sections – pre and post Chernobyl. Pre-Chernobyl era was characterized by parallel regimes of first-generation conventions and post Chernobyl one, separated from the former by the gravest nuclear disaster of its time, has been dedicated to synchronization of these regimes.

2.5.1 Pre-Chernobyl First-Generation Conventions

In the early days of the development of the nuclear industry, governments realized the need to protect the public from risks posed by the hazards of nuclear industry, the economic benefits of a nuclear power, and the need to protect investors and suppliers from ruinous claims for damages. It quickly became obvious that the answer lay in removing the legal and financial impediments to industrial development while at the same time ensuring adequate compensation for any damage that might be suffered by innocent third parties.[178]

The Brookhaven Report of 1957[179] was the prime document that dealt with the assessment of risks involved in operating civilian nuclear power and made an impact analysis of the ensuing corollaries of a nuclear incident.[180] From the findings of Brookhaven Report, it was ascertained that the possibility of a nuclear incident however remote, could not be disputed. On these grounds, the foundation of special nuclear liability regimes was laid and work began at the OECD towards drafting the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 29 July 1960[181] (Paris Convention). The Paris Convention was supplemented by Brussels Supplementary Convention of 1963[182] (Brussels Convention), which was further revised by an Additional Protocol of 1964 and a Protocol of 1982 under the auspices of the OECD. Beyond the OECD efforts, Vienna Convention on Civil Liability for Nuclear Damage of 21 May 1963[183] (Vienna Convention) came into effect IAEA. [184]

Before getting to a detailed discussion about provisions of each of these conventions, below are some of the basic principles[185] of civil nuclear liability that these conventions together established. Most domestic and international laws relating to nuclear liability are based on these principles:

Fundamental Principles of Nuclear Liability

- Strict liability of the nuclear operator.
- Exclusive liability of the operator of a nuclear installation which means that no other party except the operator of a nuclear power plant assumes monetary liability for damage occurring to third parties in the event of a nuclear accident.
- Compensation without discrimination based on nationality, domicile or residence.
- Mandatory financial coverage of the operator's liability.

---

[178] Wolff, K., The Vienna International Conference on Civil Liability for Nuclear Damage, in Weinstein, J. (ed.) Progress in Nuclear Energy, Pergamon Press: Oxford 1966, on p. 7

[179] Brookhaven National Laboratory Annual Report, 1957
See at http://digital.library.unt.edu/ark:/67531/metadc67224/

[180] N. Pelzer, Concepts of Nuclear Liability Revisited: A Post-Chernobyl Assessment of the Paris and the Vienna Conventions, in Nuclear Energy Law after Chernobyl 98 (P. Cameron, L. Hancher and W. Kuhn, ed., London: Graham & Trotman Limited, 1988).

[181] Paris Convention 1960 entered into force on 01 April, 1968.

[182] supplements Paris Convention 1960.

[183] Vienna Convention entered into force on 12 November 1977.

[184] Stephen G. Burns, "A Global Nuclear Liability Regime: A Journey Or A Destination?", at the 2012 INLA Inter Jura *See http://www.burges-salmon.com/INLA_2012/10156.pdf*

[185] IAEA Handbook on Nuclear Law vol. 1, p. 99

- Exclusive jurisdiction (only courts of the State in which the nuclear accident occurs have jurisdiction).
- Limitation of liability in amount and in time.[186]

Principle I: Strict Liability of the Nuclear Operator

Strict liability means that the victim is relieved from proving fault. In the case of an accident, the operator is liable whether or not any fault or negligence can be proved. This simplifies the process, removing any obstacles prolonging the litigation, especially such as might exist with the burden of proof, given the complexity of nuclear science. In layman's terms: strict liability means that a claimant does not need to prove how an accident occurred.

Principle II: Exclusive liability of the Nuclear Operator

Exclusive liability of the operator implies that in the case of an accident, all claims are to be brought against the nuclear operator. This legal channeling is regardless of the accident's cause. By inference suppliers or builders of the plant are protected from public litigation in the case of an accident. Again, this simplifies the process because claimants do not have to figure out who is responsible as under law it will be the nuclear operator. This principle in most national legislations is intended to make sure that the liability for nuclear damages stays primarily with the operator, who as the license-holder is in the best position to prevent the damage and to provide insurance if damage occurs.

Under the ordinary rules of civil liability, should an incident occur due to a defect in services, material or equipment supplied, the persons suffering damage may well have a right of action against any person who has supplied or manufactured such services, material or equipment in connection with the planning, construction or operation of a nuclear installation.[187] For example, such a right may derive from rules relating to so-called "product liability". [188]Treatment for civil nuclear liability is different. For instance, Article II.5 of the Vienna Convention, provides that no person other than the operator can be held liable for nuclear damage.[189] Under Article II.1, the operator is exclusively liable both where the accident occurs in his/her nuclear installation or in the course of transport of nuclear material to or from that installation. In the latter case, the operator's liability excludes the liability of the carrier, who would otherwise be liable at common law.[190] More specifically, liability is imposed on the sending operator until the operator of another nuclear installation has assumed liability pursuant to the express terms of a written contract. In the absence of such express terms, liability is assumed when the operator of another installation has

[186] M. J. L. Hardy, Nuclear Liability: The General Principles of Law and Further Proposals, 36 Brit. Y. B. Int'l L. 223 (1960).
[187] Liability for Nuclear Damage - An International Over view, OECD-NEA 1994 at p. 16 *https://www.oecd-nea.org/law/pubs/1994/liability-compensation-nuclear-damage.pdf*
[188] Most legal systems legal systems rely on the concept of product liability with regards to manufactured. Under the product liability concept, the manufacturer would be liable without fault. Under this rule, liability does not depend upon the behavior of the actor and is rather termed strict or objective. All that is required for the victim to obtain compensation is establishing of causality that is, a causal link between the injury suffered and action of the defendant.
[189] Article II.5, Vienna Convention on Civil Liability for Nuclear Damage, 1963
[190] Article II.1, *Ibid.*

taken charge of the material. In order to facilitate the transport of nuclear material, especially in the event of transit through a number of countries, Article III provides that in respect of each carriage the operator liable must provide the carrier with a certificate issued by or on behalf of the insurer, or other person providing the financial security required by the Convention.[191]

Like the principle of strict liability, the principle of exclusive liability of the operator facilitates bringing of claims on the part of the victims of a nuclear incident, since it relieves them from the burden of proving the liability of parties other than the operator. But the principle also favors the manufacturer, supplier or carrier of the material or equipment, since it protects them, as well as any other person who may have contributed to the nuclear incident.

Principle III: Compensation without Discrimination

Non-discrimination of victims on the grounds of nationality, domicile or residence is another basic principle of nuclear liability. The claims for damages are equitably recoverable by the victims in line with the non-discrimination principle, though it is permissible for installation state to exclude damages in non-contracting states (discussed in more detail in a later section).

Principle IV: Mandatory Financial Coverage

Another basic principle of nuclear liability is that the operator must be required to have and maintain financial security in order to meet his liability towards victims. Mandatory financial coverage means that the operator must maintain insurance cover, and it ensures that funds will be made available by the operator or their insurers to pay for damages. The minimum amount of protection required is set by national laws which, in turn often depends on international treaty obligations. Over time the amount of this mandatory protection has increased, partially adjusting for inflation and partially allowing for an increased burden of responsibility to be passed on to nuclear operators.

Principle V: Exclusive jurisdiction of Courts of Installation State

Contracting party's (installations state) courts shall have exclusive jurisdiction over claims brought under the Convention and recognized by those of another. Where the incident occurs within a maritime area coextensive with an exclusive economic zone that has been or could be established by a Contracting State i.e., an area extending seaward up to 200 nautical miles from the baselines from which a State's territorial sea is measured. Thus, the courts of the "coastal Contracting State" exercise exclusive jurisdiction vis a vis the courts of the other Contracting Parties.

Principle VI: Limitation of Liability

The operator's liability can be limited in amount. The limitation of the amount of his liability is clearly designed as an advantage for the operator, in order not to discourage nuclear-related activities. It is important to point out, however, that, unlike the 1960 Paris Convention,[192] the Vienna Convention does not establish a maximum liability amount and the Installation State

[191] Article III, *Ibid.*

[192] Article 7(b), Paris Convention on Third Party Liability in the Field of Nuclear Energy, 1960

is, therefore, free to impose a higher amount of liability and even unlimited liability.[193] In practice, few States have opted for unlimited liability, which could easily lead to the ruin of the operator without affording any substantial contribution to the compensation of the damage caused. Indeed, even where the operator's liability is unlimited in amount, insurance cover cannot be unlimited.[194]

Finally, the operator's liability is also limited in time. In view of the fact that physical injury from radioactive contamination may not manifest itself for some time after the nuclear incident, the adoption of too short a period of limitation would clearly be inequitable. On the other hand, this very fact, combined with the difficulty of proving that long-term radiation damage is due to a given source, has resulted in the adoption of a term shorter that those usually provided for under the general rules of tort law.

All of the abovementioned principles laid out in the Paris and Vienna Convention became established as globally accepted governing principles reflected in national legislation as well. Below is a brief discussion on the specifics of Paris and Vienna Convention. Thus, the 1963 Vienna Convention on Civil Liability for Nuclear Damage and the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy are based on the same principles and before their abridgment through the 1988 Joint Protocol, ran parallel to each other with a probable conflict in their operation.

2.5.2 Paris Convention on Nuclear Third-Party Liability, 1960 (As supplemented by Brussels Convention, 1963)

The Paris Convention limits the liability of an operator to 15 million Special Drawing Rights (SDRs).[195] However, discretion has been granted to member states to increase the quantum of the operator's liability through their domestic legislation.[196] Recognizing the existence of a possibility that the financial security might be exhausted by the claims of victims of the installation state an additional layer of indemnification was deemed useful. The *Brussels Supplementary Convention was along these lines,* providing additional funding beyond the amount available under the *Paris Convention* up to a total of 300 million SDRs, consisting of contributions by the Installation State and contracting parties. With respect to time, the right of compensation extinguishes beyond ten years of a nuclear accident, if no action is brought. In addition, States may limit the operator's liability to not less than two years from the time when the damage and the operator liable become known to the victim or ought reasonably to have become known.

---

[193] Article V, Vienna Convention on Civil Liability for Nuclear Damage, 1963

[194] Only a few countries at present have provided for unlimited liability under their nuclear liability legislation: e.g. Finland (only for those damages suffered within its territory), Germany, Switzerland and Japan.

[195] Special Drawing Right or SDR is a unit of account defined by the International Monetary Fund (IMF) based upon a basket of key international currencies. The currency value of the SDR is calculated daily and the valuation basket is reviewed and adjusted every five years. As of July 25, 2020, one SDR is currently equivalent to USD 1.4. www.imf.org/external/np/fin/data/rms_sdrv.aspx.

[196] The OECD Steering Committee for Nuclear Energy, the governing body of the Nuclear Energy Agency (NEA), recommended that Contracting Parties to the Paris Convention should aim at setting the maximum liability at not less than 150 million SDRs.

2.5.3 The Vienna Convention on Civil Liability for Nuclear Damage, 1963

The Vienna Convention was focused on bringing uniformity between national legislations relating to third party liability for nuclear damage by prescribing a set of general rules to be applied by all Contracting Parties. Undoubtedly, the enforceability of this Convention is restricted to its Contracting Parties and a non-Contracting State is not bound to adhere to the principles established therein. But the Vienna Convention states are not obliged to recognize and enforce judgements entered by the courts of such a State. In so far as its provisions are self-executing, each Contracting Party can choose between the incorporation of the Convention in the domestic legal system, thus allowing for its direct application, and the adoption of national legislation directly implementing the Convention. This is also the case with the Paris Convention. But in its entirety, the Convention does not bring about specific legal guidance; rather, as is stated in its Preamble, it establishes "some minimum standards to provide financial protection against damage resulting from certain peaceful uses of nuclear energy" while leaving it upon the contracting states to incorporate the same in their domestic law, hence leaving scope for deliberation. The most important function to take note of for the Vienna Convention is that fact that it creates reciprocity between neighboring states to honor claims of each other's citizens in the event of a nuclear accident.

2.6 Chernobyl Accident - Hard Realization

The abovementioned complexity created by this discord between Paris and Vienna Convention continued unrealized until exposed by the Chernobyl incident. It was a confusing scenario where, Vienna and the Paris Convention were like two nearly identical conventions and a bridge needed to be built between them to synchronize their operation, thus avoiding a conflict. The cumbersome claims settlement in the aftermath of Chernobyl was a clear example of why having legal clarity and why treaty relations between neighboring countries is so vital. When Chernobyl occurred in 1986, there was no specialized Soviet law that defined nuclear liability. The Soviet Union was also not party to any international convention on nuclear liability that provided compensation after its collapse to victims in the successor countries of Ukraine, Belarus and Russia which were heavily affected. As a result, the victims were left to rely on political will of their respective governments to seek any relief.[197]

Quarter of a century later, while preparations were underway at the IAEA headquarters in Vienna to celebrate 25 years of accident-free nuclear power generation worldwide, a tsunami hit the Fukushima Daiichi Nuclear Power Plant in Japan. While the resulting effects of Fukushima were not as extreme as Chernobyl, the lack of established reciprocity between Japan (which was not party to any liability conventions until 2015 when it joined CSC) and other nations caused complications in the claim settlement process and the need for global efforts to align national viewpoints was realized.[198]

The occurrence of Chernobyl accident necessitated urgent actions to be taken in the area of nuclear liability regimes, and work began towards harmonizing the nuclear liability regime. Further lessons learnt from Fukushima expanded the scope of work on establishment of a global

[197] Adriana Petryna, Knowledge and Compensation in the Chernobyl Aftermath, Anthropology Now, September 2009, Vol. 1, No. 2, Special Atomic Issue (September 2009), pp. 30-39.
[198] Julia A. Schwartz, International Nuclear Third Party Liability Law: The Response to Chernobyl, International Nuclear Law in the Post-Chernobyl Period OECD-NEA 2006

nuclear liability regime.

2.6.1 Post Chernobyl Era of Synchronization - Second Generation Conventions

The 1986 Chernobyl accident was a landmark event in the history of civil nuclear industry. The incident exposed the flaw in the first-generation liability regimes which were not subscribed to by some major nuclear economies like the USSR. It gave a clearer picture of how destructive and fatal a major nuclear accident could be. The effects of this were evident in the accelerated time within which Joint Protocol was created to link the two liability regimes. International Atomic Energy Agency (IAEA) began work on all aspects of nuclear liability with a view to improving the basic Conventions and establishing a comprehensive liability regime. In 1988, as a result of joint efforts by the IAEA and OECD-NEA, the Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention was adopted, establishing a link between the two Conventions combining them into one expanded liability regime. Parties to the Joint Protocol are treated as though they were Parties to both Conventions and a choice of law rule is provided to determine which of the two Conventions should apply to the exclusion of the other in respect of the same incident. Till, 1997 the international liability regime was thus embodied primarily in two instruments[199] linked by the Joint Protocol adopted in 1988.

Another issue was that the Paris as well as the Vienna Convention restricted themselves to the territories of their respective member states. As stipulated under Article 29 of the Vienna Convention and Article 2 of the Paris Convention, in order for a victim of a nuclear incident to be entitled to legal redress, the injury would have to be suffered in the territory of a party to the Convention. This left out nuclear accidents that occur on the high seas, or ones that cause transboundary damage.

Beyond the lack of uniformity, some states felt that the compensation regime provided for by the Convention should benefit only persons in states which were party to the Convention. In other words, indemnification in case of a nuclear incident should be an incentive for states to join a nuclear liability regime. It was argued that, only those persons should be entitled to compensation through the machinery of the Convention, who belong to states which accept not only the benefits, but also the obligations, of the Convention.[200] This came to be known as the "territoriality" principle.[201]

However, the representatives of other states regarded this approach as inadequate. It was contended that only states which operate a nuclear-power industry operate an inherently risky venture and should be made responsible to compensate victims regardless of where they are citizens of states party. Further, it was said that states that do not benefit from nuclear energy and do not, therefore, contribute to the risk of a nuclear accident, should not be deprived of compensation just because they have not acceded to the Convention. The right to compensation should derive from the fact of suffering damage from an activity beyond the control of the state

[199] The Vienna Convention on Civil Liability for Nuclear Damage of 1963 and the Paris Convention on Third Party Liability in the Field of Nuclear Energy of 1960 which was later built up by the 1963 Brussels Supplementary Convention.

[200] Liability and Compensation for Nuclear Damage - An International Overview, OECD-NEA at p.102

[201] Gerhard Kegel & Ignaz Seidl-Hohenveldern, On the Territoriality Principle in Public International Law, 5 Hastings Int'l & Comp. L. Rev. 245 (1982).

where the damage is suffered, especially in the case of an ultra-hazardous activity. [202] This ideology evolved into the universality principle.[203]

It is essential to note that, the 1963 Vienna Convention had no provisions regarding damage suffered beyond the territorial waters. This issue was resolved by upholding the principle of reciprocity.[204]

2.6.1.1 Background of the 1997 Protocol to Amend the Vienna Convention and the 1997 Convention on Supplementary Compensation

After the synchronization between the two conventions had been attained through the1988 Joint Protocol, need was felt to revisit the Vienna Convention in order to calibrate it with changing times. This was stated in Resolution GC (XXXII)/RES/491 of the International Atomic Energy Agency's General Conference on 23 September 1988, which pointed out that the existing civil liability regime "does not cover all liability issues that might arise in the event of a nuclear accident." The liability amount requirements under both the Vienna and Paris Conventions were low (approx. USD 21 million[205] in Paris and USD 5 million in Vienna Convention) and they left much discretion upon contracting parties to determine what kinds of damages would be covered.

---

[202] There are numerous precedents, both in conventions and in international case-law, for the proposition that one state causing damage to another gives rise to an obligation to compensate victims of damage. These include the following:

1. Article 11 of the Convention on International Liability for Damage caused by Space Objects which provides that:

"A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight".

2. Article 235 of the United Nations Convention on the Law of the Sea states:

"1. States are responsible for the fulfilment of their international obligations concerning the protection and preservation of the marine environment. They shall be liable in accordance with international law.

2. States shall ensure that recourse is available in accordance with their legal systems for prompt and adequate compensation or other relief in respect of damage caused by pollution of the marine environment by natural or juridical persons under their jurisdiction."

3. Principles 21 and 22 of the Stockholm Declaration state:

"21. States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."

22. States shall cooperate to develop further the international law regarding liability and compensation for the victims of pollution and other environmental damage caused by activities within the jurisdiction or control of such states to areas beyond their jurisdiction."

4. Cases in which states have been declared entitled to compensation for trans boundary damage include the Trail Smelter Arbitration, 33 A31L (1939) 182; 35 A31L (1941), 684, and the Gut Dam Arbitration, 8 ILM (1968), 118.

[203]James Hamilton, "Access by Victims to the Compensation Regime of the Vienna Convention on Civil Liability for Nuclear Damage - Question of Geographical Scope" at the Budapest Symposium, 1999

[204] James Hamilton - Access by Victims to the Compensation Regime of the Vienna Convention on Civil Liability for Nuclear Damage the Question of "Geographical Scope" at the International Symposium on Reform of Civil Nuclear Liability at Budapest, Hungary,1999

[205] Liability amount in USD has been converted from Special Drawing Rights (SDR) which means the unit of account defined by the International Monetary Fund and used by it for its own operations and transactions.

Also, Joint Protocol which was meant to create reciprocity between states to prevent lack of recognition of claims like after Chernobyl enjoyed sparse participation from only 24 state-signatories altogether since not all parties to Paris Convention and Vienna Convention ratified the Joint Protocol. Therefore, there was immediate need to update the liability regimes to reflect the lessons learnt from the Chernobyl incident.

Consequently, the IAEA Board of Governors, by a decision adopted on 21 February 1990, established an, open-ended Standing Committee on Liability for Nuclear Damage with an object to fortify and revise the existing nuclear liability regime and conferred upon it a wide mandate to "consider international liability for nuclear damage, including international civil liability, international state liability, and the relationship between international civil and state liability." In the work of the Standing Committee, experts from more than 55 states took part, and the representatives of several international organizations were present as observers. Initially, the only goal was to amend certain provisions of the Vienna Convention. It was only later during these deliberations that the idea emerged of devising a new supplementary convention for provision of additional funds by the international community of states as it was felt that the nuclear liability regime of the Vienna Convention, as amended, would really serve the interests of potential victims of nuclear incidents only if it were supported by an international supplementary fund providing additional compensation for nuclear damage to that provided by the operator. Thus, the Standing Committee started to consider the establishment, under the Vienna Convention, of a mechanism for mobilizing additional funds for compensation of nuclear damage. During the negotiations it was deemed necessary to establish a separate treaty[206] for such a supplementary fund, and indeed, efforts were undertaken to draw up such an instrument concurrently[207] with the revision of the Vienna Convention.

According to the Protocol, the liability of the nuclear operator may be limited by the installation state, either to not less than $ 400 million; or to not less than $ 200 million provided that in excess of that amount and up to at least $ 400 million, public funds are made available by the installation state to compensate nuclear damage; or, for a maximum of 15 years, to a transitional amount of not less than $ 130 million. An amount lower than $ 130 million may however be established, provided that funds are made available by the installation state to compensate nuclear damage between that lesser amount and $ 130 million.

After more than eight years of negotiations within the framework of the Standing Committee, at a Diplomatic Conference at IAEA Headquarters in Vienna, in 1997, delegates from over 80 States adopted a Protocol to amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage and also adopted a Convention on Supplementary Compensation for Nuclear

[206] IAEA Doc. IWG/4/4, See IAEA Doc document SCNL/12/INF.6, pp. 2–5, see IAEA Doc SCNL/13/INF.3

[207] A detailed proposal in the form of a new draft convention was presented by the United States at the fourth meeting of the Inter-sessional Working Group and became known as the "umbrella draft", which was negotiated along with the "collective State contributions draft". The prevailing view within the Standing Committee was that the two drafts were not mutually exclusive and, after an informal drafting meeting which took place in May 1995, a decision to merge the two drafts in a single "merged draft", containing the "grandfather clause", was taken at the twelfth session new draft convention (the September draft), which first had an Annex setting forth the principles of nuclear liability for States not party to either the Vienna or the Paris Convention, emerged from another informal meeting which took place in September 1995, and was adopted at the thirteenth session. On the basis of this "September draft", the Convention on Supplementary Compensation (CSC) was eventually adopted.

Damage.[208] The Protocol sets the possible limit of the operator´s liability at not less than 300 million SDR (roughly equivalent to 400 million US dollars). The Protocol contains inter alia a better definition of nuclear damage (now also addressing the concept of environmental damage and preventive measures), extends the geographical scope of the Vienna Convention to include Paris Convention countries as well, and extends the period during which claims may be brought for loss of life and personal injury. It also provides for jurisdiction of coastal states over actions incurring nuclear damage during transport. Taken together, the two instruments should substantially enhance the global framework for compensation well beyond that foreseen by existing Conventions. However, in spite of all the efforts made to solicit wider acceptance, many states[209] are yet to become signatory to this legal instrument.

Moreover, the 2004 Protocols to amend Paris Convention and Brussels Convention have made commendable improvements as well just like 1997 Protocol to Vienna Convention. Under the 2004 Protocols to the Paris Convention and Brussels Convention, the operator's minimum liability amount (1st tier) is increased to 700 million Euros while for low risk installations (the Protocol itself does not provide any guidance about what a low-risk installation is, but leaves it upon the contracting states)[210] and transport minimum liability amounts are 70 million Euros and 80 million Euros respectively. The Contracting State of 2004 Protocol to the Paris Convention is required to pay for nuclear damage if the operator's insurance or financial security is insufficient or unavailable. In addition to this, under the 2004 Protocol to Brussels Convention, the installation state (2nd tier) will provide 500 million Euros and also public funds of 300 million Euros would be made available by Contracting States (3rd tier) to pay for nuclear damage if the operator's financial security is insufficient. Furthermore, the time limit is increased to 30 years for loss of life and personal injury claims under the 2004 Protocols to Paris and Brussels Conventions.

Apparently, several efforts were made in the aftermath of the Chernobyl incident to best cover potential victims and filling out the gaps in the nuclear liability regime.[211] But, even though carried out with the best intentions, these reforms have made further complicated the situation because some states remain party to the Paris Convention, 1960 and Vienna Convention, 1963 without joining the 1997 Protocol and 2004 Protocols or vice versa, or being party to the

---

[208] IAEA PRESS RELEASES: DIPLOMATIC CONFERENCE ON NUCLEAR LIABILITY CONCLUDES, 12 SEPTEMBER, 1997 1997/21

[209] Many states participated during the negotiation stage of VC Protocol but did not sign it. Even some contracting states of the 1963 VC are yet to sign the 1997 VC Protocol.

[210] Article 7(b) of the Paris Convention reads as follows:

b. The maximum liability of the operator in respect of damage caused by a nuclear incident shall be 15 000 000 Special Drawing Rights as defined by the International Monetary Fund and used by it for its own operations and transactions (hereinafter referred to as "Special Drawing Rights"). However,

i. any Contracting Party, taking into account the possibilities for the operator of obtaining the insurance or other financial security required pursuant to Article 10, may establish by legislation a greater or lesser amount;

ii. any Contracting Party, having regard to the nature of the nuclear installation or the nuclear substances involved and to the likely consequences of an incident originating therefrom, may establish a lower amount

[211] N. Pelzer, Concepts of Nuclear Liability Revisited: A Post-Chernobyl Assessment of the Paris and the Vienna Conventions, in Nuclear Energy Law After Chernobyl 98 (P. Cameron, L. Hancher and W. Kuhn, ed., London: Graham & Trotman Limited, 1988).

1997 Protocol and 2004 Protocols without joining the Paris Convention, 1960 and Vienna Convention, 1963, or be a party to both the Conventions and the Protocols without joining the Joint Protocol.

2.6.1.2 Convention on Supplementary Compensation for Nuclear Damage, 1997

The Preamble to the 1997 Convention on Supplementary Compensation makes it clear that the purpose of the new Convention is the establishment of a worldwide liability regime "to supplement and enhance" measures provided not only in the Vienna Convention and in the Paris Convention, but also in national legislation "consistent with the principles of these Conventions".[212] CSC contains specific provisions on civil liability for nuclear damage in an Annex, and Article II.3 states that the Annex constitutes an integral part of the Convention.

Pre-Conditions to Membership

There are only two basic requirements that need to be satisfied for a state to be eligible for acquiring membership to the CSC[213]:

(a) Implementation of the Paris Convention or the Vienna Convention[214]; or

(b) Compliance with provisions of the Annex (explained later).[215]

This makes CSC an instrument that can cover all States regardless of whether they are parties to any existing nuclear liability convention or have nuclear installations within their territories.

Incentives to Joining CSC

Creates Legal Certainty

The CSC achieves legal certainty by requiring each member country to have national law on nuclear liability that is based on the Paris Convention, the Vienna Convention or the Annex to the CSC and that incorporates the provisions in the CSC on jurisdiction, compensation and the definition of nuclear damage. This requirement ensures that the national law of each member country will reflect the basic principles of nuclear liability law as also discussed earlier in the section describing the basic principles of civil nuclear liability.[216]

Exclusive jurisdiction

The CSC conforms to the principle of exclusive jurisdiction of courts of the installation state. Further, CSC also requires other member countries to recognize the exclusive jurisdiction[217] of the courts of the member country where a nuclear incident occurs and to refrain from asserting jurisdiction over the incident. The CSC also requires member countries to recognize and enforce judgments rendered by the courts of the member country with jurisdiction.

Facilitates Additional Indemnification

CSC not only creates an effective mechanism for claims settlement but also provides

---

[212] Article II.1

[213] IAEA Explanatory Texts on The 1997 Vienna Convention on Civil Liability for Nuclear Damage and the 1997 Convention on Supplementary Compensation for Nuclear Damage by the INLEX

[214] Articles XVIII

[215] Article XIX

[216] Channeling all legal liability for nuclear damage exclusively to the operator; Imposing liability on the operator without the need to demonstrate fault, negligence or intent, Granting exclusive jurisdiction to the courts of the country where a nuclear incident occurs; Permitting liability to be limited in amount and in time; and Compensating damage without any discrimination based upon nationality, domicile or residence.

[217] Article XIII

an additional layer of indemnification to compensate the damages caused by a nuclear incident. It assures the availability of a meaningful amount of compensation for nuclear damage in member countries by providing for two tiers of compensation. The CSC fixes the amount of the first tier to be provided by the installation state, which constitutes the "minimum national compensation amount" at 300 million Special Drawing Rights (SDRs). This makes up the first tier of compensation.[218] Beyond this, the CSC requires the Installation State to make public funds available to cover the difference. For this, an international supplementary fund has been provided for in CSC[219] to which all of its Contracting Parties are obligated to make contributions, hence forming the second tier of compensation. These contributions are to be 300 SDR per "unit of installed capacity,"[220] and an additional amount equal to 10% of the former amount[221]calculated as per a distinct formula [222] provided there under, allocates one half of the international fund for the compensation of damage in all Contracting Parties without differentiation[223] but priority has been given to the compensation of "trans boundary damage." If claims for trans boundary damage do not exhaust this part of the fund, the balance becomes available for compensation of other claims i.e., damage within the Installation State.[224]

Wider Scope of Coverage of Nuclear Damage

The CSC requires member countries to adopt a broad definition of nuclear damage. It specifically provides that nuclear damage must include not only personal injury and property damage, but also certain categories of damage relating to impairment of the environment, preventive measures, and economic losses. The CSC also provides that the definition of nuclear incident includes situations where preventive measures are taken in response to a grave and imminent threat of a release of radiation, even though no actual release has occurred.[225]

Encompassing Grandfather Clause

Reflections of the fundamental principles of nuclear liability can be found in the Annex to CSC. It provides for exclusive liability of the operator of the nuclear installation ().[226] In order to allow for the participation of the US without changing its legislation, which is based on the concept of "economic", as opposed to "legal", channeling of nuclear liability, a so-called "grandfather clause" was inserted in the Annex[227] which though takes within its purview each State whose national law contained certain provisions on 1 January 1995, and the US appears to be the only State whose legislation contained those provisions on that date.

Under Article 2.1, the national law of a Contracting Party is deemed to be in conformity with the provisions of Articles 3, 4, 5 and 7 of the Annex if, on 1 January 1995, it contained provisions that: (a) provide for strict liability for substantial off-site nuclear damage; (b) require the indemnification of any person other than the operator liable in so far as that person is

[218] Article III Paragraph 1(a)
[219] Paragraph l (b)
[220] Paragraph l(a)(i)
[221] Paragraph l(a)(ii)
[222] Article IV
[223] Article IX Sub-paragraph l(a)
[224] Sub-paragraph 1(b)
[225] Ben McRae, "The Compensation Convention: Path to a Global Regime for Dealing with Legal Liability and Compensation for Nuclear Damage", Nuclear Law Bulletin No. 61 (1998)
[226] Article 3.9 and 10
[227] Article 2

liable to pay compensation; (c) ensure the availability for such indemnification of at least 1000 million SDRs in respect of a civil nuclear power plant and at least 300 million SDRs in respect of other civil nuclear installations.

Potential Global Nuclear Liability Regime

The Preamble to the CSC recognizes the existing international instruments and national legislations which form the legal context within which it was designed to operate. Its prime objective is to create a worldwide liability regime and increasing the amount of compensation for nuclear damage. Article II makes clear that the Annex is an integral part of the Convention. Paragraph 1 of the Article states that the Convention's purpose is to supplement (explained at the beginning of this section) the system of compensation provided pursuant to national law that implements the Vienna or Paris Convention or that complies with the CSC's Annex.

Annex conforming to Fundamentals of Nuclear Liability

CSC has a wide scope of coverage in all terms and is a potential global nuclear liability regime which many states may find beneficial to subscribe as it acknowledges the existing regimes and extends beyond their operational frontiers. The Annex provides, in particular, for: "absolute" and exclusive liability of the operator of a nuclear installation (Article 3); limitation of liability in amount and/or of liability cover by insurance or other financial security (Articles 4 and 5); limitation of liability in time (Article 9).[228] Article 3 states that the liability of the operator for nuclear damage shall be absolute. Paragraph 9 of this Article states that the right to compensation for nuclear damage may only be exercised against the operator liable, or if national law permits, against any supplier of funds made available under national law to ensure compensation. Article 5 deals with financial security to be provided by operators. Under sub-paragraph l(a) operators in Installation States that are Contracting Parties subject to the Annex must be required to obtain financial security e.g., insurance to cover their liability for nuclear damage in such amount, of such type, and under such terms as the Installation State may require. Claims that exceed the yield of financial security maintained by the operator must be met through the provision of public funds, up to the applicable limit if any, established under Article 4. When an Installation State has not limited the liability of an operator, the amount of financial security that operator is required to obtain may not be less than 300 million SDRs. Again, if the yield of financial security is insufficient to meet claims up to the amount of security required, the difference must be made up through public funds.

The presence of the "grandfather clause." gives the CSC a distinct international character and opens the door for several states including the US, which could not find themselves covered by an international nuclear liability regime.

2.6.1.3 Joint Protocol – whether an alternative to CSC

With a view to ensuring a wider international acceptance of the civil liability regime, discussions centered, first of all, on the need to avoid the unnecessary duplication created by the existence of two different conventional regimes based on very similar principles: the regional Paris

[228] See IAEA Explanatory Texts on the 1997 Vienna Convention on Civil Liability for Nuclear Damage and the 1997 Convention on Supplementary Compensation for Nuclear Damage at http://www.iaea.org/About/Policy/GC/GC48/GC48InfDocuments/English/gc48inf-5-att1_en.pdf

regime, on the one hand, and the Vienna regime, on the other. This question was discussed for some time within the Secretariat of the IAEA in close cooperation with the Secretariat of the OECD Nuclear Energy Agency (NEA), which is in charge of the Paris Convention. Various possibilities were envisaged, but both organizations eventually came to the conclusion that the best solution would be the adoption of a new conventional instrument aiming at linking the two conventions. Expert groups of both organizations endorsed this solution, and, on 21 September 1988, a Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention was adopted by a diplomatic conference jointly convened in Vienna by the IAEA and the OECD. The Joint Protocol entered into force on 27 April 1992.[229]

The Joint Protocol provides for a bilateral determination of liability. For instance, if a nuclear incident occurs for which an operator is liable under the Vienna Convention as well as the Joint Protocol, he shall be liable for damages suffered under the Vienna Convention not only not only in the parties thereto, but also in the territory of parties to the Paris Convention and vice versa. This tackled the discrepancies in their practical application.[230]

Thus far, the Joint Protocol has proven to be an important measure in building a link between countries that adhere to the Vienna and Paris Conventions and can continue to serve that purpose in the interim before widespread adherence to the CSC is achieved. However, it cannot serve as the basis for a global regime since it does not mandate the same treatment with respect to minimum compensation amounts, jurisdictional rules and the definition of nuclear damage. Most non-generating States, as well as many generating States, are unwilling to adhere to any instrument that would put them in treaty relations with other countries that could continue to follow the compensation and jurisdictional provisions in the 1960 Paris Convention or the 1963 Vienna Convention. In addition, unlike the CSC, the Joint Protocol does not contain any mechanism to supplement the funds available to compensate nuclear damage.

2.7 Need for a Global Nuclear Liability Regime

A global regime simplifies international nuclear trade by ensuring that the all the stakeholders are covered by identical liability rules, especially because of the existence of the principle of legal channeling of liability to the operator which not only helps the victims make their claims but also encourages the industry, the suppliers in particular. Moreover, the elimination of conflict of jurisdiction further creates greater certainty.[231]

Review of various Nuclear Liability Regimes in force in different parts of the world and the ones which are yet to come into force and national approaches in different states reveals that a consensus on an ultimate Nuclear Liability Regime is yet to go through a long process of

---

[229] Ibid.

[230] Otto von Busekist, "A Bridge Between Two Conventions on Civil Liability for Nuclear Damage: the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention

[231] Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX).
See: http://ola.iaea.org/ola/treaties/documents/liability_regime.pdf

metamorphosis. The Chernobyl accident[232] was an eye-opener to the need for a viable and more effective international nuclear liability and compensation regime. Efforts have been made nationally, regionally and internationally as evident in the amendments and creation of newer nuclear liability regimes.[233] Notwithstanding these efforts, there are still big lacunae in the nuclear liability regime. The Paris and Vienna Convention have although been bridged by the 1997 Joint Protocol, these Conventions have mostly been ratified by European nations. This leaves several advanced as well as embarking states uncovered by any uniform globally recognized instrument on managing nuclear liability. In Asia alone, China, South Korea, Taiwan, Iran, and Pakistan are all not party any nuclear liability convention. This is quite problematic if one factors in the possibility of transboundary damage. Absence of reciprocity or cooperation regarding claims settlement etc. between these states especially endangers the victims and industry stakeholders.

2.8 Nuclear Law in Southeast Asia and sub-Saharan Africa

Currently, there is no uniform nuclear liability regime in Southeast Asia and sub-Saharan Africa. Out of the nine countries[234] within the scope of this thesis, only Nigeria (Vienna Convention), Ghana (CSC), and the Philippines (Vienna Convention) are parties to international instruments on nuclear liability. Thus, there are no treaty relations between most nations pursuing their nuclear power programs in these two regions. Each of these countries has their domestic legislation governing nuclear energy both on regulation and liability. With regards to nuclear safety, security, and non-proliferation, most of these countries are parties to the Convention on Nuclear Safety (except Kenya, Malaysia, and the Philippines), Convention on Physical Protection of Nuclear Materials (except Malaysia), and the NPT which has majorly shaped their domestic nuclear safety and regulatory regime.[235] The structure of the regulatory bodies in each of these countries while different embodies the principles of regulatory independence, non-proliferation and security of nuclear and other radioactive materials. Specificities of the nuclear law in these countries and its impact on stakeholders will be discussed in later chapters.

2.9 Conclusion

Summing up, balancing the protection of the liable operator (economic interest) and the protection of victims (public interest) was a herculean task that the drafters of liability conventions had to maneuver through. Initially, it started in favor of the nuclear industry, i.e. preferring

[232] Chernobyl Accident 1986, (Ukraine) at:
http://www.world-nuclear.org/info/chernobyl/inf07.htm (Last visited, June 25th, 2009).
[233] The Joint Protocol 1988, the New Vienna Convention 1997, the New Paris Convention 2004 and Convention on Supplementary Compensation 1997.
[234] Nigeria, Ghana, South Africa, Kenya, Indonesia, Malaysia, Philippines, Viet Nam, and Thailand.
[235] Nigeria Nuclear Safety and Radiation Protection Act 1995; Ghana Nuclear Regulatory Authority Act 2015; South Africa National Nuclear Regulator Act 1999; Kenya Nuclear Regulatory Act 2019; Indonesia National Nuclear Act 1997; Malaysia Atomic Energy Licensing Act 1984; Philippines Atomic Energy Regulatory and Liability Act 1968 (a bill to update the current framework has been proposed - Comprehensive Nuclear Regulatory Framework Bill 2019); Viet Nam's law on Atomic Energy 2008; Thailand Nuclear Energy for Peace Act 2016.

economic interest to public interest. Later on, it started shifting towards and in favor of public interest over economic interest.

Initially, the nuclear industry enjoyed a special policy treatment in order to allow the industry to grow. With concepts like limited liability and waiver of supplier's liability, legal regime on nuclear liability was devised such that it encourages trade in the nuclear industry. Now however, that is changing. While devising their nuclear energy policies, countries are giving higher importance to ensuring public interest. For instance, India in 2011 enacted its nuclear liability legislation[236] which challenged one of the internationally recognized principles of nuclear liability. As discussed above, it is customary that the liability for a nuclear accident fall on the operator of the installation and not on any of the suppliers involved. This principle is highly beneficial to entities which are involved in selling nuclear reactors and other equipment as they become completely insulated for any of the risks in case of an accident. However, this does not safeguard the interest of say an embarking nation who has purchased nuclear equipment from a foreign entity, since they end up assuming all the liability. Basically, the country receiving such reactor technology absorbs all monetary and physical risks associated with the equipment and the foreign suppliers walk away without consequences. Citing this, India has taken a different approach towards managing nuclear liability. Section 17, clause (b) read with Rule 24 of India's Civil liability for nuclear Damage Act. 2011 holds suppliers of nuclear equipment just as liable as the operator for nuclear accidents that can be attributed to their fault. The underlying principle behind clause (b) of the aforesaid section 17 appears to be product liability which is prevalent in all other industries even the highly technical space insurance industry.[237] Similarly, South Korea[238] has also adopted the concept of Suppliers' fault based liability and allows Right of Recourse to the Operator against a supplier in absence of a special agreement to the contrary. Thus, both Indian and South Korean approaches towards civil nuclear liability differ from the norm.

National approaches of individual states seem inspired from the respective international instrument subscribed by them. Those states who are yet to join any Convention have adopted own approaches towards managing liability, as also in determination of limits of compensation both in terms of quantum as well as duration, jurisdiction and procedure for adjudication of claims. But worrisomely, these liability regimes do not have a common mechanism which links them all together. As the need to balance the interests of all stakeholders (including national governments, industry, and the general public), it is expected that one uniform global liability regime would be best alternative to the present ailing liability regime systems – with a lot of complications and complexities.

In the event of a nuclear accident regardless of whether there is transboundary damage or not, having a system in place to facilitate claims settlement between the affected nations is of utmost importance. Having a uniform nuclear liability regime provides the necessary treaty

relations between the affected states to clarify the applicable law, define jurisdiction, enforcement of awards, and ensuring availability of funds to compensate victims.[239]

---

[236] Civil Liability for Nuclear Damage Act, 2011

[237] Richard D. McClure, A Review of Nuclear Energy Insurance

[238] Article 4, Act on Compensation for Nuclear Damage, 1969

[239] Civil liability for nuclear damage: Advantages and disadvantages of joining the International Nuclear Liability Regimes – A paper by the International Expert Group on Nuclear Liability (INLEX)" (undated), available at: ola.iaea.org/ola/treaties/documents/liability_regime.pdf

Beyond safeguarding the interests of victims, a global nuclear liability regime is also beneficial to nuclear trade. Greater legal clarity and certainty in a highly globalized market to understand the risks associated with participation in a nuclear power project. A global nuclear liability regime may be achieved if all states with nuclear installations and as many states as possible that may be affected by a nuclear accident establish treaty relations.[240] Absence of treaty relations and lack of uniformity in governing laws has been seen to impede trade. The most recent example of this was seen in India where all trade in nuclear energy remained stalled between 2012 and 2015 because of the introduction of supplier's liability in their law as discussed above.

A global regime simplifies international nuclear trade by ensuring that all the stakeholders are covered by identical liability rules, especially because of the existence of the principle of legal channelling of liability to the operator which not only helps the victims make their claims but also encourages the industry, the suppliers in particular. Moreover, the elimination of conflict of jurisdiction further creates greater certainty.[241] Currently, there is no such uniform nuclear liability regime in Southeast Asia and sub-Saharan Africa and consequently there are no treaty relations between most nations pursuing their nuclear power programs in these two regions. Each of these countries have their domestic legislation governing nuclear energy. The upcoming chapters will examine how the existing legal framework in these countries impact different stakeholders involved in their nuclear power program, as well as what the lack of treaty relations means for them.

[240] OECD-NEA Nuclear Law Bulletin No. 93, 2014 at p. 18

[241] Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX).
See: http://ola.iaea.org/ola/treaties/documents/liability_regime.pdf

3 CHAPTER III – FOREIGN VENDORS OF NUCLEAR REACTOR TECHNOLOGY – TRANSACTIONAL CHALLENGES IN MULTI-CULTURAL AND MULTI-JURISDICTIONAL CONTEXT

This dissertation seeks to analyze relevant international instruments and domestic policies pertaining to nuclear energy and investigate the legal and policy aspects of nuclear safety, regulation, nuclear non-proliferation, and liability management that act as barriers to nuclear energy investment in Southeast Asia and sub-Saharan Africa. Chapter I analyzed the significance of nuclear energy in Southeast Asia and sub-Saharan Africa by looking into the challenges of meeting electricity demand, reducing expenditure on importing energy, and ensuring constant economic growth while lowering carbon dioxide emissions that the countries in these regions face. Then, Chapter II of this dissertation looked into some of the legal obstacles that are currently thwarting the application of advanced nuclear technology in developing countries. One of them is the establishment of a credible, transparent, and reliable regulatory regime that is configured to each country's respective institutional requirements while also being in consonance with the internationally recognized principles. The second issue pertains to creation of an equitable international civil nuclear liability framework to manage the potential risks of transboundary nuclear damage.

Effective implementation of a national nuclear program requires the cooperation of many stakeholders, from industry players, technical and scientific and design institutions to different governmental bodies at local, regional, and national levels. Developing states face unique challenges and often lack the finances, institutional capacity, and physical infrastructure to support a large-scale, multibillion-dollar nuclear power plant project, even if the costs are spread out over several years. There is no precise way to measure whether a country can afford a nuclear power plant, especially since decisions may be driven by factors such as politics, national perspectives, level of energy security, industrialization strategy and proliferation risks. Although stretching a national budget to buy a nuclear power plant may in theory be possible, this always implies opportunity costs, especially in the energy sector. Also, these financial hurdles become even higher when development banks do not lend for nuclear energy projects, making private investors likely to be wary. Consequently, countries within the scope of this dissertation often lack the technology as well as finances to independently launch their nuclear power program without involvement or support from vendors from other countries with more mature nuclear power programs like South Korea, China, Russia, and France. The focus in this Chapter is to explore the challenges that are unique to deploying nuclear facilities in developing states by studying the specific issues that emerge in the context of foreign investment and involvement of multiple foreign entities in nuclear power projects in Southeast Asia and sub-Saharan Africa.

To provide a full picture of the factors that affect nuclear investment, this chapter covers the timeline between a state's decision to embark on a nuclear power program to procurement of its first nuclear reactor. It underlines the considerations that go into deciding to embark on a nuclear power program, both from the state and investor/suppliers' perspectives. The first section of this chapter will talk about the structure of nuclear power project as that tends to be one of the first considerations in nuclear energy investment. The structure of the nuclear power

project will determine the ownership of the power plant and the method of procurement of the nuclear equipment. The next part of this chapter will talk about the economic considerations that come into play once the structure of the project has been decided. These economic considerations include the structure of the electricity markets which determine what kind mechanisms are set up to recover the costs for the project. Beyond project structure and economic factors, there are other factors to consider like the specific risks of investing in the nuclear power project of the host country, nuclear liability, currency fluctuations, non-proliferation, and other reputational risks, that can affect foreign investment in nuclear energy. Lastly, this chapter will discuss the process of procurement. Once all the terms about the project structure have been finalized and after all the economic factors affecting investment have been considered, the terms of procurement are negotiated. These terms include delivery of nuclear equipment, construction, and payments.

3.1 Structure of Nuclear Power Projects

As mentioned earlier, the nuclear industry is becoming more international and private entities from different countries are becoming significantly involved in nuclear power programs. New arrangements are emerging in the form of public-private partnerships to incentivize technology development through collaboration between new technology developers to share risk with the government to accelerate deployment[242]. These partnerships may take several forms including turnkey, build own operate (BOO), and build own operate transfer (BOT) schemes.

3.1.1 Turnkey

Under the turnkey structure, the reactor vendor assumes all technical and commercial risks (including design, construction, safety checks, and meeting regulatory requirements) in delivering a functioning plant on time for various types of cost reimbursement models. Under this structure, a vendor/contractor designs as well as builds the entire power plant and hands it over upon completion of construction and all other safety checks such that the owner needs to only turn the key to start operating the plant.[243] The contractors in a turnkey project are reimbursed for their services based on the actual costs of the project with a fixed fee. [244] Turkey's Akkuyu nuclear power project was initially proposed as a turnkey project with Russia's Rosatom, but was later changed to a build operate transfer model.[245]

During turnkey arrangements a host government that commissions a nuclear power plant has the right to control the implementation and the progress of the investment at any stage of its implementation. For example, States often impose certain import restrictions to protect the local economy.

---

[242] Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)
[243] H. Stuart Burness, W. David Montgomery and James P. Quirk Source: Land Economics , May, 1980, Vol. 56, No. 2 (May, 1980), pp. 188-202
[244] The Financing of Nuclear Power Plants, NEA No. 6360, OECD 2009 at p.44
[245] Nuclear Power in Turkey, World Nuclear Association (Updated March 2021) https://www.world-nuclear.org/information-library/country-profiles/countries-t-z/turkey.aspx

3.1.2 Build, Own, Transfer (BOT)

Owing to the large scale at which nuclear power projects are undertaken, the vendor may create a consortium to build, own and transfer the plant. In this arrangement, the investor raises equity to build a plant, operates the plant and sells the output under a pre-agreed contract to recover costs before transferring it to local ownership (either a state-owned body or a private investor).[246] This is different from the turnkey approach because in a turnkey project a contractor hand over the plant upon completion of construction and initial safety tests and recovers its investment through a fixed fee. On the other hand, in a BOT project structure instead of a fixed fee the vendor recovers costs through selling electricity from the plant at a fixed price for a pre-determined period at the end of which ownership is transferred to either another investor or a state-owned utility.

3.1.3 Build, Own, Operate (BOO)

When the investor builds, owns and operates a plant to recover its investment by selling the power output at an agreed price to local utilities under a Power Purchase Agreement (PPA), it is referred to as a build own operate model (BOO). [247] Under this project structure, there is no immediate transfer of ownership at the end of construction and the investor/vendor has complete control of the nuclear power plant and there may be a concern about how fairly the different aspects of the project including siting and PPA are negotiated between the investor and the host government (discussed in more detail in a later Chapter).

3.2 Economic Considerations

3.2.1 Market Structure

A fundamental consideration in assessing the viability of a nuclear power project (NPP) is the structure of electricity market within the country.[248] Two options are available: regulated and deregulated markets (and, if the electricity market is large enough, it can have elements of both, as is the case in the United States). Historically, electricity markets were regulated, allowing a utility servicing a particular area to enjoy a monopolistic position that was offset by the legal requirement that electricity rates be established through a rate-setting review process, as opposed to letting rates be determined by the market. However, many countries have moved away from regulated structures, based on the concept that competitive markets are more likely to create efficiencies and drive down the price of electricity. This may impact the feasibility of nuclear energy.

In regulated markets, operators of nuclear power plants recoup project costs and obtain a pre-determined rate of return on the project. In such a non-competitive environment, it can be easier to invest in a nuclear power project as long as the rates recovered through electricity markets can support a secure and certain rate of return. In deregulated markets, nuclear power plant

---

[246] N. Barkatullah, A. Ahmad, Current status and emerging trends in financing nuclear power projects, Energy Strategy Reviews, Volume 18, 2017, Pages 127-140, ISSN 2211-467X, https://doi.org/10.1016/j.esr.2017.09.015.
[247] *Supra* note 3 at p.52
[248] Economic Assessment of the Long-term Operation of Nuclear Power Plants: Approaches and Experience, IAEA Nuclear Energy Series No. NP-T-3.25 at p.19
https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1813_web.pdf

operators find it difficult to compete with less expensive sources of electricity generation like natural gas, subsidized renewable energy.[249] In the US, restructuring has driven down the price of electricity which made nuclear less competitive. For example, in 2017 Exelon's Three Mile Island's Unit 1 did not clear interconnection auction for 2020-21 and has also been non-profitable for five years which may lead to its early retirement. The same is true for several other nuclear power plants in the US.[250] However, even in deregulated markets, host governments could guarantee a minimum price for electricity, thereby creating a level of price certainty for NPP developers.[251] Turkey for example has significantly restructured its electricity market from vertically integrated to regulated competition model. Its Akkuyu nuclear power plant was provided by Russia's Rosatom with payback period of 19 years through a project company of which Rosatom holds 93% of the shares. This project company has also signed a fixed PPA[252] for 15 years.

Both regulated and deregulated markets have their pros and cons. A deregulated market allows for more competition unlike a regulated market where utilities tend to have significant control. In such a market, it is possible for nuclear power plant operators to sell their electricity at competitive rates without being completely dependent on a utility. When it comes to nuclear power projects, while deregulation gives an opportunity for free market in some ways it may also lead to a tendency for market players[253] to prioritize bigger profit margins over nuclear safety.[254] In addition to regulated and deregulated markets, a third category of electricity markets that exists within the target regions are state-owned systems in which the electricity market is centered around state-owned electricity generation authorities that are responsible for generating, distributing, as well, as wholesaling electricity. In state-owned markets, the operator of nuclear power plants will usually be a government-owned company. The countries within the scope of this dissertation have wide-ranging kinds of electricity markets including regulated, re-structured, and state-owned.[255] The Philippines[256] for example, has transitioned from a vertically integrated market to a

[249] MIT Energy Initiative, The Future of Nuclear Energy in a Carbon-Constrained World (2018)
[250] World Nuclear Association, Nuclear power in the US, May 2021
https://world-nuclear.org/information-library/country-profiles/countries-t-z/usa-nuclear-power.aspx

[251] The New Economics of Nuclear Power, World Nuclear Association Report 2005
https://www.nrc.gov/docs/ML1000/ML100050089.pdf
[252] Under a fixed PPA, a utility and the provider agree on a fixed price for the output for the duration of the agreement.
[253] J. Oosten et. al., Impacts of Market Restructuring & Deregulation on Nuclear Safety: Lessons Learned from Rail, Aviation, and the British Experience INIS – FR—727, International Atomic Energy Agency (IAEA)
https://inis.iaea.org/collection/NCLCollectionStore/_Public/33/010/33010790.pdf

[254] Sinclair A., Palinkas P. (1999) Vertical Integration in the Electricity Supply Industry: Competition and Investment Issues. In: Welfens P.J.J., Yarrow G., Grinberg R., Graack C. (eds) Towards Competition in Network Industries. Springer, Berlin, Heidelberg as p. 27. https://doi.org/10.1007/978-3-642-60189-7_14

[255] Sioshansi, Fereidoon P.. (2008). Competitive Electricity Markets - Design, Implementation, Performance - 1.3.1.3 Lessons Learned. Elsevier.
https://app.knovel.com/hotlink/pdf/id:kt0067BYG1/competitive-electricity/lessons-learned

[256] Hugh Rudnick and Constantin Velasquez, Learning from Developing Country Power Market Experiences: The Case of the Philippines, Policy Research Working Paper 8721, World Bank January 2019

deregulated one, while in Thailand[257] the state through state-owned utilities is much more heavily involved in both electricity generation and distribution, with the exception of small power producers (10-90 MW).

From the perspective of a foreign investor the market structure is important for them to be able to calculate how they would be able to get returns on their investment into a country's nuclear power program. Assuming that a Build, Own, Operate model is adopted, in a regulated market an investor will have limited options regarding to whom they can sell their electricity. This can be both good and bad. It is good because it adds a layer of certainty for the investor because they can enter a long-term PPA with a state-owned utility. On the other hand, though it is also bad because an investor's ability to recover costs is dependent upon the state-owned utility's treatment of them since the rate of return on investment would be determined by the agreement the investor makes with the local utility.

There is also the concern of corruption that might make negotiating nuclear power projects tricky. This is a major obstacle for both investors and local populations as it causes uncertainty and corrupt practices to thrive. Empirical studies show that corruption has a mixed impact on foreign investment. For example, Thailand's Sino-Thai Construction Company and Mitsubishi Hitachi Power from Japan signed a contract to build a power plant in 2013. However, Thailand's National Anti-Corruption Commission (NAAC) found that in 2015 the executives of Sino-Thai had assisted government officials in demanding bribes of USD 20 million from Mitsubishi to allow it to use a local port when three of its ships delivering construction equipment were initially not allowed to dock.[258] This instance of corruption was only revealed when Japanese prosecutors began to investigate Mitsubishi.[259]

While in most cases, corruption acts as deterring factor for foreign investors, in some cases it can be seen by a foreign investor (especially if the parent company of a foreign investor is from a corrupt country as well) as a positive factor to maximize profit margins. [260]. Overall, corruption thwarts some investment and, on the flipside, where it does incentivize some investment, it compromises economic growth of the host state as the returns from such foreign investment are circumvented by corrupt practices which leads to diminished positive impact on the economy of the host state.[261] A few examples of corrupt practices being used to promote nuclear power projects have been seen in the US when in 2020 an Ohio politician was arrested for accepting the bribe of USD 61 million from an electricity utility called First Energy in relation to passage of a nuclear bailout bill to subsidize two of its declining nuclear power plants at additional costs to

---

http://documents1.worldbank.org/curated/en/428331548771494859/pdf/WPS8721.pdf

[257] Sector Overview, Grid-Parity Rooftop Solar Project (RRP THA 49087), Asian Development Bank https://www.adb.org/sites/default/files/linked-documents/49087-001-so.pdf

[258] Shares in Sino-Thai plunge after anti-graft body corruption allegation, Reuters November 13, 2019 (Accessed September 2, 2021) https://www.reuters.com/article/sinothai-stocks-corruption/shares-in-sino-thai-plunge-after-anti-graft-body-corruption-allegation-idUSL4N27T2LX

[259] Error gets firm off NACC bribery hook, Bangkok Post December 17, 2020 (Accessed September 2, 2021) https://www.bangkokpost.com/business/2036559/error-gets-firm-off-nacc-bribery-hook

[260] Adiya Belgibayeva and Alexander Plekhanov, Does corruption matter for sources of foreign direct investment?, European Bank of Reconstruction and Development Working Paper No. 176 (February 2015) at P. 23.

[261] Pupovic, Elvira (2012) : Corruption's Effect on Foreign Direct Investment - The Case of Montenegro, Economic Review: Journal of Economics and Business, ISSN 1512- , University of Tuzla, Faculty of Economics, Tuzla, Vol. 10, Iss. 2, pp. 13-28

ratepayers.[262] Another such example was seen in South Carolina where in 2009 its Public Service Commission approved a plan for a nuclear power plant called VC Summer by two utilities – SCANA and Santee Cooper. Although the project was to begin in 2012 at an estimated cost of USD 9 billion, and the first reactor was planned to go online by 2016, in 2014 it was announced that the project was facing delays. Then in 2020 SCANA executives pled guilty for committing fraud by lying about the progress of VC Summer in order to increase electricity rates for SCANA's ratepayers and qualify for about USD 1 billion dollars in tax credits. [263]

Overall, corrupt practices create risks for both the vendors, and host states, as well as, other stakeholders including project delays, cost overruns, and significant legal consequences. This is also not helpful in inspiring confidence among members of the public towards upcoming or proposed projects leading to further delays.

3.2.2 Financing

Any consideration by a country regarding the ownership of an NPP quickly becomes an analysis of whether it has the means to finance the development, technology acquisition, construction, and operation of the NPP (in addition to the costs of developing the overall nuclear power program, which would include the development of the nuclear regulatory authority). If the host government has the means to fund all activities relating to the development of the national nuclear power program and of the NPPs, then there is no need to consider other forms of ownership. However, if either the host government does not have the means to fund all necessary program and project activities, or the host government would prefer to leverage its resources and, thus, minimize the amount of equity that it wishes to commit to the NPPs, then it will need to consider the means by which it will finance NPP development. The latter is the case for the countries in Southeast Asia and sub-Saharan Africa.

Nuclear power plants on average cost between USD 4-10 billion and are also prone to cost overruns during implementation which makes them even more expensive.[264] The Philippines[265] and South Africa[266] for example have faced the issue of massive cost overruns in pursuing their nuclear power plans. [267] It is important to also point out that in addition to costs, the risk of potential

---

[262] Landon Stevens and Mark Pischea, Exposing the utility playbook: Ratepayers are stuck paying the bill for utility corruption, Utility Dive May 27, 2021 (Accessed September 1, 2021) https://www.utilitydive.com/news/exposing-the-utility-playbook-ratepayers-are-stuck-paying-the-bill-for-uti/600784/

[263] *Ibid.*

[264] Nuclear Power Economics, World Nuclear Association 2020 https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx#:~:text=Its%20November%202016%20report%2C%20Capital,%2FkW%20(overnight%20cost).

[265] S. Hoffman, Phillipines: Asia Pacific Energy Series Country Report, Energy Program Resource Systems Institute, November 1988 https://www.osti.gov/servlets/purl/6368191

[266] Sub-Saharan Africa and nuclear energy, World Nuclear Association, April 2018 https://www.world-nuclear-news.org/V-Sub-Saharan-Africa-and-nuclear-energy-23041802.html

[267] Ryan Collyer, acting CEO of Rosatom Central and Southern Africa, correspondence with *POWER Magazine*, Darrell Proctor, Philippines Taking New Look at Nuclear Power, Power Magazine October 1, 2020

nuclear accidents and the background of Three Mile Island, Chernobyl, and more recently Fukushima have also affected embarking countries' willingness to continue with their nuclear power programs. The Philippines for example was one of the first Southeast Asian countries to embark on a nuclear power program with the creation of the Philippines Atomic Energy Commission (PAEC) in 1958 however, its nuclear program has been halted since 1987. The first nuclear power plant in Philippines was commissioned to be imported from Westinghouse (US) during the oil crisis of 1973 during which an embargo was placed on oil supplies from the Middle East.[268] However, after construction of the Bataan began in 1976, it faced massive cost overruns and in the aftermath of the Three Mile Island nuclear accident a safety review was conducted at Bataan. The safety review revealed around 4000 technical defects and that the Bataan nuclear power plant stood very close to the fault line of an earthquake prone zone connected to the dormant volcano of Mount Natib. In addition to the safety concerns, major corruption issues connected to the procurement and construction of the Bataan nuclear power plant were exposed. Naturally, in 1979 the construction at Bataan was halted.[269] Finally in 1984, although the construction of the Bataan nuclear power plant was completed its cost had increased from USD 500 million to USD 2.3 billion. [270] The high cost and safety concerns at Bataan coupled with the Chernobyl accident of 1986 led to the decision by the government to not run Bataan and as a result it has never been fueled. Then in 2010, there was renewed interest in nuclear energy in the Philippines following an IAEA inspection of the Bataan nuclear power plant. Korea Electric Power Corporation (KEPCO) submitted a report to the Philippines National Power Corporation to rehabilitate the plant at Bataan. The cost for this was assessed at USD 1 billion. However, in 2011 it was announced that the Bataan nuclear power plant will remain open only as a tourist attraction. Both Thailand and Malaysia's nuclear power plans were also greatly affected after Fukushima in 2011.

Given the funding requirements to develop a nuclear power program (ranging from USD 10-15 billion)[271], as well as the financing requirements to construct a nuclear power plant (or multiple plants) within that program, financing of the NPP is, perhaps, the greatest challenge for NPP development, especially if external financing is needed. As such, it is important for both States and investors to consider financing options early in the program and project development processes. In pursuing the goal of an operational NPP, the host government, must structure the project in such fashion that it is financeable (discussed in first part of this chapter). Without taking such matters into consideration during the early planning stages, the planning organization runs the risk that it structures a project that cannot attract the available sources of financing. However,

---

https://www.powermag.com/russia-china-drive-africas-plan-for-nuclear-expansion/

[268] World Bank, Philippines Energy Sector Survey, Vol. 2 Annex 1980, p.2
[269] Commission on Nuclear Reactor Plants, Inquiry on the Safety to the Public of the Bataan Nuclear Plant, 1979 https://www.nrc.gov/docs/ML1927/ML19270H923.pdf
[270] S. Hoffman, Phillipines: Asia Pacific Energy Series Country Report, Energy Program Resource Systems Institute, November 1988 https://www.osti.gov/servlets/purl/6368191
[271] IAEA, Financing Arrangements for Nuclear Power Projects in Developing Countries, Technical Report Series No. 353 (1993) https://www-pub.iaea.org/MTCD/Publications/PDF/TRS1/TRS353_Web.pdf

while it is true that planning and implementing a nuclear power program is a long and capital-intensive process, the same has been accomplished at much faster rates in other countries. The Barakah nuclear power station of the United Emirates (in coalition with Korea's KEPCO) is one such example. From the expression of the UAE government's intent to embark its nuclear power program to the construction of the first unit at the plant, the process took around 10 years. That said, the cost for the program is still very high at USD 25 billion.

- Potential Solutions

In order to address some of the financial and political challenges to implementing nuclear power projects, embarking states may pick any or a combination of the below mechanisms (depending on their legal system or negotiations with foreign investors):

i. Rate-based assessments

To the extent that the State has a regulated electricity market, the costs of the NPP[272] can simply be built into the electricity price that is charged to end-users.[273] Such rate-based approaches were the means by which large infrastructure[274], in countries like the United States[275], were built.[276] These rate-based assessments can be done after completion of the project, when the costs of the project have been determined fully. An alternative approach would be to allow for NPP costs to be recovered during construction – a technique that has been employed in certain regulated markets within the United States.[277] Under such an approach, electricity rates are adjusted earlier in the process[278], so as to include the costs of construction in the rate base before the electricity generation begins. This is known as construction work in progress (CWIP) and differs from the traditional system in that the developers can begin to include costs of construction into the electricity rates before the plant begins operation.[279] This mechanism is helpful because it adds more certainty for vendors and investors by allowing them to recover costs for financing a NPP earlier.[280]

---

[272] Economics of Nuclear Power, World Nuclear Association March 2020
https://www.world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx
[273] Economic Assessment of the Long-term Operation of Nuclear Power Plants: Approaches and Experience, IAEA Nuclear Energy Series No. NP-T-3.25 at p.49
https://www-pub.iaea.org/MTCD/Publications/PDF/PUB1813_web.pdf
[274] Aaron Klein, Here are three ways to pay for new investments in infrastructure and end partisan gridlock, Brookings Institute December 12 2018
https://www.brookings.edu/blog/up-front/2018/12/12/here-are-three-ways-to-pay-for-new-investments-in-infrastructure-and-end-partisan-gridlock/
[275] U.S. Department of Energy, Energy Information Administration. The Changing Structure of the Electric Power Industry 2000: An Update. 2002. Online at: http://www.eia.doe.gov/cneaf/electricity/chg_stru_update/update2000.pdf.
[276] United States Electricity Industry Prime, U.S. Department of Energy DOE/OE-0017, June 2015
https://www.energy.gov/sites/prod/files/2015/12/f28/united-states-electricity-industry-primer.pdf
[277] IEA (2018), Electricity Information 2011, IEA Statistics, International Energy Agency, OECD, Paris, France
[278] IAEA, Financing Nuclear Power in Evolving Electricity Markets, April 2018
https://www.iaea.org/sites/default/files/18/07/financing-np-0418.pdf
[279] Volpe, Robert C. "The Role of Advanced Cost Recovery in Nuclear Energy Policy." Sustainable Development Law & Policy 15, no. 1 (2015): 28-38, 59-61 at p. 33.
[280] Koplow, Doug. "Subsidies to Factors of Production." NUCLEAR POWER: Still Not Viable without Subsidies, Union of Concerned Scientists, 2011, p.37. JSTOR, http://www.jstor.org/stable/resrep00072.9. Accessed 11 Aug. 2022.

Any sort of rate-based approach, however, will need to consider the electricity regulatory structure within a State (as discussed in Section II.a above). To clarify, the electricity regulatory structure is distinct from the nuclear regulatory structure. In a regulated market, rates are often approved by the regulatory authority (a public utilities commission), and these rates can be adjusted in the future, such that only prudent costs are passed through to the end-users.[281] Thus, in considering any rate-based approach, the host State will need to assess its underlying electricity market structure[282] (recognizing that recent trends have moved many countries to deregulate their electricity markets) and the means by which rates are determined. It will also need to consider whether the market price or consumer price of electricity will support the necessary economics to foster equity investment and service debt payments, recognizing that a large gap in these two benchmarks will necessitate a government-driven solution.[283] Rate-based assessment is a commonly used method of return on investment in Build Own Operate Projects by Rosatom and has been successful in the case of Turkey where Rosatom has a fixed 15-year PPA for the Akkuyu nuclear power plant that was commissioned under the BOO format. Nigeria has also indicated interest in adopting the same model for return of Rosatom's investment in its nuclear power program.[284] Another important consideration is to ensure that financing expensive nuclear power plants do not lead to an inequitable rise in electricity prices for ratepayers.

ii. Guarantees

Conventionally the government of a state tends to be the sole/main investor in a nuclear power project but given the increasing costs, many embarking states are looking towards partnering with private vendors to finance a nuclear power project. For example, Thailand already has a system wherein the private sector has been supplying electricity to the state-owned utility for a fixed return on investment backed by the government and the same is planned for nuclear power projects. [285]

Embarking states usually have a government-owned or sponsored company that is responsible for implementing its nuclear power program for e.g., Philippines National Power Corporation and the Nuclear Power Corporation of India (NPCIL). These government-owned companies can sign Memorandum of Understanding for research or enter into agreements for procuring nuclear reactors (based on any of the models mentioned at the beginning of this

[281] W.M. Warwick, A Primer on Electric Utilities, Deregulation, and Restructuring of U.S. Electricity Markets, US Department of Energy July 2000 https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-13906.pdf

[282] Rothwell, Geoffrey. Electricity Economics: Regulation and Deregulation. New York: Wiley-IEEE, 2002

[283] Financing arrangements for nuclear power projects in developing countries: a reference book. — Vienna: International Atomic Energy Agency, 1993. (Technical reports series, ISSN 0074-1914; 353) STI/DOC/10/353 ISBN 92-0-100993-3

[284] Rosatom: Nigeria's Nuclear Technologies Pact with Russia Comprehensive, Rosatom January 10, 2019. http://www.rusatom-overseas.com/media/mass-media-about-us/rosatom-nuclear-technologies-nigeria-s-pact-with-russia-comprehensive.html

[285] IAEA, : Impacts of electricity market reforms on the choice of nuclear and other generation technologies / International Atomic Energy Agency. IAEA TECDOC series, ISSN 1011–4289 ; no. 1789 : IAEAL 16-01039 | ISBN 978–92–0–103916–3 at p. 40

Chapter) with private entities including foreign suppliers.[286] These government companies are often backed by a sovereign guarantee which means that in case of default by the company, the government will discharge its liability. This encourages investors to enter partnerships with government companies for nuclear power project development. Such guarantees are different from subsidies and tax credits because instead of being monetary incentives, they are contingent liabilities of the government in case of default of a government-owned company. On the flipside though there is the challenge of a government's own liquidity and whether a sovereign guarantee can inspire much confidence especially given that the countries within the scope of this dissertation also do not enjoy very favorable credit rating.[287] Most of the western countries with advanced nuclear economies are wary of investing in NPPs in sub-Saharan Africa because they consider such investment extremely risky.

The UK government for example has been issuing loan guarantees to encourage nuclear energy investment. Most recently, the UK government has approved about GBP 2 billion in loans for the Hinkley Point C Nuclear Power Plant.[288] This however maybe challenging for the economies in Southeast Asia and sub-Saharan Africa to provide given the burden it would add to their economies. Ghana for example has had a high rate of default from its state-owned entities and has tightened its guarantee approval measures. In addition, there have also been significant instances of contingent liabilities arising out of public-private partnership projects in Ghana due to factors like contract termination and renegotiation (both of which are highly likely to be the case for nuclear power projects). [289]

iii. Taxes, Subsidies, and Price Support Mechanisms

An important factor that can help support financial sourcing for NPP development would be the imposition of a special tax. This would provide a dedicated revenue stream. A tax becomes a simple and direct way to generate revenue. However, a tax is not the only tool that can be used by a host government to support NPP development. Direct tax collection provisions would be most applicable to government-owned NPPs, but other tools would be applicable and attractive to non-government participants in NPPs. New Jersey (in the form of Zero Emission Certificates)[290] and Illinois[291] for example have extended favorable subsidies in

---

[286] Financing Nuclear Power in Evolving Electricity Markets, International Atomic Energy Agency, April 2018 at p.6
https://www.iaea.org/sites/default/files/18/07/financing-np-0418.pdf

[287] Ghana and Nigeria B-, South Africa BB-, Vietnam BB, Indonesia BBB-, Philippines BBB, Thailand, and Malaysia BBB+
According to Standard & Poor's countries with a BBB- or higher rating are considered to be investment grade and those with BB+ or lower are considered speculative or risky.

[288] Financing Nuclear Power in Evolving Electricity Markets, IAEA April 2018 at p.9
https://www.iaea.org/sites/default/files/18/07/financing-np-0418.pdf

[289]

[290] New Jersey regulators extend nuclear subsidies for PSEG/Exelon reactors, Reuters April 27, 2021 (Accessed September 4, 2021)
https://www.reuters.com/business/energy/new-jersey-regulators-extend-nuclear-subsidies-psegexelon-reactors-2021-04-27/

[291] Illinois approves $700 million in subsidies to Exelon, prevents nuclear plant closures, Reuters September 13 2021 (Accessed September 14, 2021)
https://www.reuters.com/world/us/illinois-senate-close-providing-lifeline-3-nuclear-power-plants-2021-09-13/

the form of Zero Emission Credits to their nuclear power plants to make them more financially competitive and prevent their closure.

- Subsidies

Subsidies have been used by governments throughout the world[292] to support renewable energy and clean energy projects in particular.[293] Subsidies would require special legislation. In addition, special consideration would need to be given to supra-national legal structures (e.g., European Union rules that prohibit subsidies, World Trade Organization rules, etc.) that impose limitations on a host government's ability to subsidize a particular industry.

- Tax credits or special tax treatment

Broadly construed, tax credits involve any sort of tax reduction, tax offset, or tax waiver that favors a particular type of activity. By legislative act, the host government could offer favorable tax treatment to prospective NPP developers, thereby enhancing the NPP economics for such developers. Along the same lines, special tax treatment could come in the form of accelerated depreciation mechanisms, which would enhance net present value determinations on asset value and, thus, return on equity calculations.

- Carbon economics

Because nuclear power constitutes "clean" (i.e., emissions-free, or carbon-friendly) energy, nuclear power development has been considered as one approach for meeting goals to reduce global warming (i.e., carbon caps or reductions). While, currently, nuclear power does not receive any credit under the Kyoto Protocol for reducing global warming, a host government could elect to pass legislation that could combine NPP development with clean energy mechanisms. Whether a tax[294] is placed on other forms of carbon-based generation, a carbon tax credit is given to nuclear power and renewable energy, or a cap-and-trade system is implemented (wherein nuclear power and renewable energy receive carbon credits), such principles would need to be embedded in national legislation. Such measures would either provide economic benefits to the developers of NPPs or they could make the NPPs more competitive with other forms of power generation (by raising the cost to generate power from carbon-based power plants).[295]

a. Ownership of the NPP

- Splitting Ownership and Operation

As also discussed under the different models the first section of this chapter, an NPP is an asset held by a corporate entity. Therefore, aspects of ownership consider both the privileges (revenue) and burdens (liabilities) of ownership. An NPP is also an operating instrumentality that has to be run by highly trained personnel, under a regulatory umbrella, whereby the operator is the

---

[292] Taylor, Michael (2020), Energy subsidies: Evolution in the global energy transformation to 2050, International Renewable Energy Agency, Abu Dhabi.
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2020/Apr/IRENA_Energy_subsidies_2020.pdf

[293] The deepest cuts, The Economist September 20, 2014 edition
https://www.economist.com/briefing/2014/09/20/the-deepest-cuts

[294] The Future of Nuclear Energy in a Carbon-Constrained World, MIT Energy Initiative 2018
https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf

[295] N. Bauer, R.. Brecha, and G. Luderer, Economics of nuclear power and climate change mitigation policies, PNAS October 16, 2012 109 (42) 16805-16810; https://doi.org/10.1073/pnas.1201264109

holder of an operating license issued by the nuclear regulatory body of the State. One of the prime considerations here is that of managing civil nuclear liability (as discussed in Chapter II). The entity that operates an NPP would have to cover the significant liability for any potential nuclear accidents and at the same time also provide proof of financial security to cover the same liability. This is a significant discouraging factor for a foreign developer. The most common approach to address this is for the owner and the operator to have the same corporate form. However, it is possible for the owner and the operator to be two separate corporate entities. By bifurcating ownership and operation, economic considerations and technical capabilities can be separated. Further, as noted in Chapter II, under both international nuclear liability regimes and national nuclear liability laws which follow a legal channeling approach, liability for nuclear damage suffered by third parties is channeled to the licensed operator of the NPP. By splitting ownership and operation, investors can be shielded (in part)[296] from third party nuclear liability exposure by sharing the burden of the amount of operator's liability. In a bifurcated structure, ownership of the asset (or rights in the asset, if ultimate ownership is retained by the government) would be through an investment vehicle.[297] This might not require a large complement of personnel to maintain, but an operating company would then need to be created to operate the NPP. Such an operating company would need to be adequately funded (including the maintenance of customary insurances) and staffed. Given that nuclear liability limits also function as requirements (in terms of maintenance of insurance or suitable financial security in lieu of insurance), and that such requirements are significant,[298] the operating company will need to have adequate means to maintain its technical complement of personnel, to manage operating and maintenance costs (both planned and unplanned; both nuclear and non-nuclear insurances), and to handle its liabilities (both present and contingent). A responsible nuclear regulatory authority will need to determine that the operating company is capable and sustainable, both technically and financially (possibly through project revenues in part; in later stages, an operating company could be funded in full through operating revenues).

- Government immunity versus Government as a commercial entity

In large infrastructure projects disputes are likely to arise and this poses a significant risk for foreign developers. If the host government elects to operate in the commercial arena to finance the NPP, whether by allowing non-government entities to hold equity stakes in the NPP or by sourcing debt from commercial banks and export credit agencies, it will need to recognize that such project participants will expect to have certain rights and remedies within the project documentation. Such parties will expect that the host government, as a commercial actor, would renounce any rights[299]

---

[296] As noted in Chapter II, that international regime on nuclear liability provides for limitation of liability from nuclear accidents in amount and time, and channels all liability to the operator, thus protecting other stakeholders. However, these protections are only available to states member to the respective treaty on civil nuclear liability. To the extent that nuclear damage is suffered in a country that is not within the treaty structure, the limitations of liability and channeling in favor of the licensed operator may not be available. This is a significant risk that must be considered by vendors and investors as they may potentially be exposed to significant liability arising out of a potential nuclear accident.

[297] Vagts, Dodge, Buxbaum, and Koh, Transnational Business Problem Sixth Edition, ISBN: 9781683286523 at p.147

[298] Under the Vienna Convention (1997 Amendments), the limit of liability is SDR 300 million.

[299] Vagts, Dodge, Buxbaum, and Koh, Transnational Business Problem Sixth Edition, ISBN: 9781683286523 at p.493 and 522

it would have in respect of sovereign immunity.[300] Further, such parties might wish to balance the level of influence that the host government would have[301], with such parties insisting that the commercial arrangements be governed by a neutral law (i.e., not the law of the host country) that reflects international commercial standards with a neutral dispute resolution forum (i.e., not the courts of the host State), whether through judicial means or arbitration. An example in this regard can be seen in Germany where in 2011 after Fukushima the German government decided to discontinue use of nuclear energy by 2022 through an amendment to the Atomic Energy Act which would cause early closure of the existing nuclear power plants without compensation. Consequently, Vattenfall Europe Nuclear Energy GmbH a Swedish utility that owned two nuclear power plants in Germany and Kernkraftwerk GmbH brought legal action against Germany in the German Federal Constitutional Court as well as an investment arbitration at the International Center for Settlement of Investment Disputes (ISCID). This dispute is however extremely complex and remains unresolved.[302] Another example of a dispute arising in relation to a nuclear power project with a government entity is from Taiwan where GE Hitachi that began construction of a USD 9 billion nuclear power plant in with a state-owned utility called Taipower. However, after Fukushima plans for the power plant were cancelled in 2014 and Taipower stopped making the agreed payment for the design and equipment provided by GE Hitachi. [303] Consequently, GE Hitachi filed an arbitration claim at the International Chamber of Commerce in Hong Kong and a USD 158 million award was made against Taipower.[304]

3.3 Analysis of Country Risk Factors

Each country presents a unique set of risks associated with investing there and reputational risks can sometimes even outweigh any economic incentive that a foreign investor in a nuclear power project may receive. For example, vendors of nuclear technology from western countries often consider it to be too much of a reputational risk to invest in the nuclear power programs of embarking countries. To attract foreign investment in capital intensive projects infrastructure like nuclear energy, the host countries will need to understand these risks from the investors' perspective and may also need to provide any necessary assurances. For this purpose, the discussion below will seek to categorize some of these risks to provide a general understanding of the thought-process of an investor.

---

[300] Abigail Hing Wen, Suing the Sovereign's Servant: The Implications of Privatization for the Scope of Foreign Sovereign Immunities, Columbia Law Review , Oct., 2003, Vol. 103, No. 6 (Oct., 2003), pp. 1538-1587

[301] K. R. Simmonds, Sovereign Immunity, The International and Comparative Law Quarterly, Jan., 1978, Vol. 27, No. 1 (Jan., 1978), pp. 252-254

[302] Daniela Páez-Salgado, A Battle on Two Fronts: Vattenfall v. Federal Republic of Germany, Kluwer Arbitration Blog, February 18 2021 (Accessed September 8, 2021)
http://arbitrationblog.kluwerarbitration.com/2021/02/18/a-battle-on-two-fronts-vattenfall-v-federal-republic-of-germany/

[303] GE seeks arbitration over Lungmen payments, World Nuclear News December 14, 2015 (Accessed September 10, 2021)
https://www.world-nuclear-news.org/C-GE-seeks-arbitration-over-Lungmen-payments-1412154.html

[304] King & Spalding, "GE Hitachi Nuclear Energy Wins a US$158 Million Award in ICC Arbitration Against Taiwan", 21 February 2019 (Accessed September 10 2021)
https://www.kslaw.com/news-and-insights/ge-hitachi-nuclear-energy-wins-a-us158-million-award-in-icc-arbitration-against-taiwan

3.3.1 Choice of Law

Foreign vendors who are familiar with conducting large-scale, cross-border business, will want to see that the contractual arrangements are governed by internationally[305] recognized customary law principles. Given the unfamiliarity with the national legal framework, foreign participants will feel less comfortable in transacting business under a legal system that they are not well-versed in. To the extent that such foreign participants need to account for the unpredictability of a local legal regime, such contingency planning could increase transactional costs and, taken to the extreme, discourage foreign participants from participating in the NPP. An example of this was seen in the construction of Belene nuclear power plant in Bulgaria by Rosatom where due to lack of investment and financing the Bulgarian government abandoned plans for the power plant which ended up leading to a lengthy arbitration but ended in settlement.[306] This example is especially relevant because several of the countries within the scope of this thesis like the Philippines, Vietnam, and Thailand have at several points abandoned their nuclear power programs which can be a significant risk for a foreign developer who would want to have a reliable mechanism for settling disputes arising out of the same.

Despite the choice of law for project documentation, the host government will also need to consider laws that have general applicability to business activities within the host country, giving due account to any provisions that might cause difficulties for foreign project participants. For example, unfavorable or unpredictable taxation law which can impact an investor's revenue margin and discourage further investment or even stall an ongoing project.[307]

3.3.2 Choice of Forum

Foreign participants will want to be sure that disputes are resolved through an acceptable procedure within an equitable, informed, and objective forum. A foreign participant will have a base level concern about any forum located in the host country, especially if the judiciary system is viewed as unproven, unsophisticated, unpredictable, corrupt, biased, or slow.[308] Given the complexity of nuclear transactions, foreign participants will be reassured by the presence of proven, sophisticated tribunals, perhaps even opting for arbitral dispute resolution mechanism where subject matter experts can serve on the mediation and/or arbitration boards. In many cases, this might be a more appropriate dispute resolution mechanism, given the highly technical and specialized nature of NPPs. This is not just important from a foreign vendor's perspective but also vital to ensure that any victims from a potential nuclear accident. In the aftermath of Chernobyl, the victims were left with the cumbersome process of having to establish their claims both in the Soviet Union and those in neighboring countries. This was a

[305] W. H. Upjohn, Choice of Law, The Cambridge Law Journal , 1926, Vol. 2, No. 3 (1926), pp. 321-339
[306] Russia wins 'half' of compensation claimed in Belene lawsuit, World Nuclear News, June 16 2016 (Accessed August 28, 2021)
https://www.world-nuclear-news.org/C-Russia-wins-half-of-compensation-claimed-in-Belene-lawsuit-16061601.html
[307] Ian Baxter, International Business and Choice of Law, The International and Comparative Law Quarterly, Jan., 1987, Vol. 36, No. 1 (Jan., 1987), pp. 92-115
[308] M. Kilejian and C. Edlund, Enforceability of Choice of Forum and Choice of Law Provisions, Franchise Law Journal, FALL 2012, Vol. 32, No. 2 (FALL 2012), pp. 81-94

result of the fact that there was no special legislation in place that provided for the mechanism of settling these claims or any special tribunals for the same.[309]

3.3.3 Exchange Rate

A basic economic factor for foreign participants in a transaction will be the stability of exchange rates over the life of their participation in the NPP. An exchange rate can be floating or fixed. To the extent that a floating currency has high variability, or a fixed currency is revalued (considering, too, the frequency of such revaluations), foreign participants will seek means for greater predictability (e.g., through including contingency provisions in the transaction, hedging the transaction, or having payments under the transaction made in a foreign currency). At some level, each approach involves a cost, or a risk associated with the NPP. Host governments will, therefore, need to consider exchange rate histories and their legal treatment, if they wish to attract foreign participants to the NPP.

3.3.4 Currency Controls

Countries with histories of balance of payment problems and currency inflation have turned to currency controls as a means of addressing such issues. Such measures often inhibit the ability of foreigners to transfer money out of the country or necessitate that payments be made in local currency. From a foreign participant's perspective, such currency controls restrict the foreigner's ability to do business in that country.

3.3.5 Reputational Risk

While not unique to NPPs, reputational risk is exceedingly important[310], especially to financial institutions, given the heightened scrutiny (and, depending on the host country and level of public involvement, unpopularity) directed at the nuclear industry. The concept of a "responsible" project takes into consideration both technical and more policy-level considerations such as non-proliferation and the environment. Thus, to the extent that a host government undertakes an NPP that gives due consideration and priority to International Regimes, which, in turn, addresses reputational risk factors, the host government will necessarily enhance the likelihood of outside participation in the NPP. Membership to international regimes on nuclear non-proliferation function as confidence building measures for the international community, recognizing the high-profile nature of NPPs in general. These risks include environmental, as well as nuclear non-proliferation concerns.

- Environmental & Social Issues/Sustainability

Environmental and social considerations have become a key aspect of infrastructure project development. NPPs have particular considerations in the environmental area, due to issues concerning the handling, storage, and disposition of spent fuel and nuclear waste, as well as

---

[309] Julia A. Schwartz, International Nuclear Third Party Liability Law: The Response to Chernobyl, International Nuclear Law in the Post-Chernobyl Period OECD-NEA No. 6146 (2006) ISBN 92-64-02293-7 at p. 38

[310] Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects, IAEA Nuclear Energy Series No. NG-T-4.6, 2017
https://www-pub.iaea.org/MTCD/Publications/PDF/P1765_web.pdf

the decommissioning of the project site.[311]

What is important for host governments to understand is that financial institutions take sustainability issues very seriously. Rosatom for example, suffered opposition from environmental groups while planning the Kudankulam nuclear power plant in southern India.[312] As a measure to show itself to be an environmentally conscious company, Rosatom has also agreed to consult with neighboring states for potential environmental impact of any projects it is planning.[313]

Reputational factors and sustainability issues are critical from an economic risk perspective for vendors as well and therefore they form an important aspect in decisions to invest in a nuclear power project. Lack of compliance with global non-proliferation and domestic environmental legislation can potentially cause delays and even shut down of projects. This is why, when it comes to sustainability issues, the planning extends beyond the tenure (i.e., the repayment period) of the debt; and, financial institutions will generally do a lifecycle analysis of the project. Under this lifecycle analysis, financial institutions (to ensure compliance with global non-proliferation standards) will want to see that consideration has been given to the long-term disposition of spent fuel and nuclear waste[314], as well as the final decommissioning (to include necessary funding arrangements) for the NPP site. Such issues will need to be reflected in the national legal and regulatory framework.

- Non-proliferation (and the 3 S's of Safety, Security, and Safeguards)

Nuclear non-proliferation is a major concern when a country decides to embark on a nuclear power program for both that country and any investors or suppliers involved an embarking country's nuclear power program. It constitutes not only a reputational risk but is also a question of compliance with internationally recognized principles of civil application of nuclear energy without which investment from international players may not be possible. This involves three elements also known as the three S concept – Safety, Security, and Safeguards (as explained in Chapter II). Precisely, safety refers to ensuring safe operation and management of nuclear facilities, and materials, while security refers to the physical security of nuclear materials, and lastly safeguards involve implementing measures to ensure nuclear non-proliferation.

Any entities involved in a project will want to see that the State developing a NPP has committed to the customary set of International Regimes in these areas, so as to demonstrate to third parties that the host country is aligned with international norms and "best practices" in these areas. Of these three areas, non-proliferation considerations become a threshold issue,

---

[311] Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects, IAEA Nuclear Energy Series No. NG-T-4.6 2017 at p.17

[312] The story of Kudankulam: From 1988 to 2016, The Hindu September 20, 2016 (Accessed 20 June 2022) https://www.thehindu.com/news/national/The-story-of-Kudankulam-From-1988-to-2016/article60528215.ece

[313] Russia's nuclear power company agrees to consult with neighbors on environmental impacts within framework of UNECE's Espoo Convention, United Nations Economic Commission for Europe (UNECE), May 30, 2011 (Accessed (September 1, 2021) https://unece.org/environment/press/russias-nuclear-power-company-agrees-consult-neighbours-environmental-impacts

[314] Safety refers to ensuring safe operating conditions at the nuclear power plant while security pertains to the physical safety of nuclear material, and lastly safeguards refers to ensuring that none of the nuclear fuel or equipment supplied is diverted to non-peaceful purposes.

much like nuclear liability. While the other two areas (safety and security) are just as important for participants in a NPP they come in at a slightly later point when the decision to embark on a nuclear power program has already been made. If a newcomer country were not committed to the peaceful use of nuclear energy in the first place, most of the nuclear industry would not even consider assisting a prospective NPP in such a country. While these three areas might not have a direct economic impact on a project participant, the Reputational Risk considerations are so high that the host government would severely limit its options if it were to fail to implement these principles as it proceeds with its nuclear program, including access to technology, know-how, and financing. [315] The consortium of vendors of nuclear technology called the Nuclear Suppliers Group follow a set of IAEA guidelines[316] for export of any nuclear material and also ensure that the host states taken appropriate measure for physical protection of these materials and for nuclear non-proliferation. Another example in this regard is that of the US as it requires host states to sign a 123 agreement[317] for any significant transfer of nuclear materials or equipment.[318] In the context of countries within the scope of this thesis, each of them are parties to the Convention on Physical Protection of Nuclear Materials (except Malaysia), and the NPT, which has encouraged global entities to explore them as potential markets.[319]

3.3.6 Nuclear Liability

As emphasized in Chapter II, for NPP participants, nuclear liability is a threshold question for participation. Without adequate protection with respect to third party liability for nuclear damage arising out of a nuclear incident at the NPP, project participants are left with an unquantifiable and uninsurable[320] project risk. By participating in the current international nuclear liability regimes or adopting a national legal framework consistent with the international regimes[321], the host government can help to channel and to limit the liability for project participants. Nuclear liability regimes bring economic rationality to an NPP. On the

[315] In September 2011, the world's nuclear power plant exporters established a code of conduct, with the goals of raising safety standards, preventing proliferation, and enhancing environmental protection. The code of conduct contains six principles, ranging from physical safety and security to ethics and compensation for damage in the event of a nuclear accident. The code is voluntary and not legally binding. The founding signatories were: AREVA (France), Atomstroyexport, Candu Energy, GE Hitachi Nuclear Energy, Korea Electric Power Company, Mitsubishi Heavy Industries, Toshiba, and Westinghouse.

[316] Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment or Technology, IAEA INFCIRC/254, February 1978 https://www.iaea.org/sites/default/files/infcirc254.pdf

[317] A 123 Agreement is an agreement required by the US to be signed by any state to which it is supplying nuclear fuel or equipment. Under a 123 agreement, a state agrees to ensuring safety of nuclear materials and ensuring compliance with non-proliferation standards.

[318] Section 123 of the U.S. Atomic Energy Act (AEA) of 1954

[319] Nigeria Nuclear Safety and Radiation Protection Act 1995; Ghana Nuclear Regulatory Authority Act 2015; South Africa National Nuclear Regulatory Act 1999; Kenya Nuclear Regulatory Act 2019; Indonesia National Nuclear Act 1997; Malaysia Atomic Energy Licensing Act 1984; Philippines Atomic Energy Regulatory and Liability Act 1968 (a bill to update the current framework has been proposed - Comprehensive Nuclear Regulatory Framework Bill 2019); Viet Nam's law on Atomic Energy 2008; Thailand Nuclear Energy for Peace Act 2016.

[320] Based on cost and/or general availability of such insurance.

[321] Ben McRae, "The Compensation Convention: Path to a Global Regime for Dealing with Legal Liability and Compensation for Nuclear Damage", Nuclear Law Bulletin No. 61 (1998)

one hand, they ensure that a responsible party exists and has adequate financial means to cover a predetermined level of liability, providing a means of material recourse to injured third parties. On the other hand, by channeling all liability to such a responsible party, other project participants are (theoretically) relieved from such risks and, thus, do not have to include the costs of such risks into the transaction.[322]

Thus, in embarking upon a nuclear power program, the host government will need to consider the economic consequences of the nuclear liability regime it chooses (or rejects).[323] Any nuclear liability regime would then need to align with both the liability laws of and the jurisdictional procedures within the host country.

Chapter II identified the gaps that presently exist in domestic and international nuclear liability regimes, when considering the possibility of cross-border damage in a non-treaty party state. Depending on the roles, risk profiles, and levels of sophistication of project participants, the host government might need to consider the possibility of sovereign indemnities or other accommodations to account for this uncovered risk.[324] Any sovereign indemnity would need to be evaluated both as a commercial matter and as a legal matter[325] (legally, in terms of permissibility, tenor (i.e., period of validity), amount, terms, and enforceability (governing law, dispute resolution, etc.). To the extent that gap risks are not addressed in commercial and/or legal terms by the host government, project participants might elect not to participate in the NPP or charge additional amounts (which are speculative at best) to account for such risk, if they are willing to assume such risk.

3.3.7 International Technical Guidelines

The IAEA technical standards are a series of documents containing guidelines on nuclear safety and all other aspects of operating nuclear facilities. However, they are not legally binding (except for certain Agency projects) but represent authoritative guidance on international best practice. Moreover, the term "IAEA technical standards" is sufficiently ambiguous that it needs to be clarified and made more specific in its application to specific projects or activities. Such standards are broad, not universally applicable in all cases, evolving, and partly subjective.[326] As a consequence, project participants will need to agree on

---

[322] Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX). http://ola.iaea.org/ola/treaties/documents/liability_regime.pdf

[323] An example of the economic consequences of a nuclear liability regime that does not align with current international practice of sole liability being channeled to the licensed operator is India, noting that foreign nuclear suppliers have made this deviation a key commercial point in negotiations to date with Nuclear Power Corporation of India Ltd (NPCIL) and the Government of India.

[324] Duncan E.J. Currie, The Problems and Gaps in The Nuclear Liability Conventions and An Analysis of How An Actual Claim Would be Brought Under The Current Existing Treaty Regime in The Event of a Nuclear Accident, Denv. Journal of International Law Vol. 35:1 Pp.85-127 (2005)

[325] Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX), IAEA 2012 https://www.iaea.org/sites/default/files/17/11/liability-regime.pdf

[326] Handbook on nuclear law : implementing legislation / Carlton Stoiber … [et al.]. Vienna : International Atomic Energy Agency, 2010.

what codes and standards, specifically will apply to the NPP. Such an agreement involves cooperation and understanding among the regulator, the developer (or program/purchasing authority), and the vendor/contractor. To the extent that relevant parties are not aligned on these issues, there is a high likelihood that the NPP will suffer cost overruns, schedule delays, quality/conformance issues, and disputes. Depending on the financing structure, such outcomes could be of major concern to lenders, and they will most certainly be of concern to investors. Further, selecting a set of codes and standards that aligns with international best practices addresses the reputational risk concern that project participants would have regarding the technical quality of the NPP itself, helping to answer the question, "Is this a good project?"

For stakeholders not directly involved in the engineering, fabrication, construction, and operation of the NPP, it is difficult to assess the technical aspects of the NPP, as well as the capability of the nuclear regulatory body in the host country.[327] Financial institutions either lack or possess very limited technical teams, especially with regard to nuclear power. As a result, they will rely on what is referred to as the lenders' technical advisor (LTA)[328] to review the technical aspects of the project and the competence and sufficiency of the regulatory regime. While helpful, the LTA approach by no means ensures a comprehensive assessment of all technical aspects of the project as was also seen in the case of UAE.[329] Consequently, the host government in order to attract more investment in their nuclear power program should consider other options available to it – certain confidence-building measures that are offered by the IAEA through outside assessments of the nuclear program. Examples of such reviews include Integrated Nuclear Infrastructure Review Missions (INIR), the Integrated Regulatory Review Service (IRRS), and the Operational Safety Review Team (OSART). All these programs provided by the IAEA are aimed at assessing the general (technical, legal, financial, and infrastructural) readiness of a country to embark on a nuclear power project through a series of inspections and studies. These programs also help boost investor confidence in the host country. The INIR missions are aimed at assisting Member States in evaluating the status of their overall national infrastructure for the introduction of a nuclear power program which includes grid capacity, technical facilities required for safe operation of nuclear power plants, and the institutional and legislative framework pertaining to nuclear energy.[330] The IRRS is also a similar program but mostly focuses on providing states assistance in enhancing their regulatory framework on radiation safety, transport, and waste management.[331] Finally, the OSART constitutes a team of international experts who conducts in-depth reviews of

---

p.70; STI/PUB/1456 ISBN 978–92–0–103910–1

[327] Handbook on nuclear law : implementing legislation / Carlton Stoiber … [et al.]. Vienna : International Atomic Energy Agency, 2010. p.27; STI/PUB/1456 ISBN 978–92–0–103910–1

[328] Financing Arrangements for Nuclear Power Projects in Developing Countries, IAEA 1993 at p.91 https://www-pub.iaea.org/MTCD/publications/PDF/trs1/trs353_web.pdf

[329] Atkins an adviser for UAE reactors, Kevin Brass, The National News Nov 17, 2011 (Accessed 2 July, 2022) https://www.thenationalnews.com/uae/atkins-an-adviser-for-uae-reactors-1.428357

[330] Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years IAEA-TECDOC-1779(, International Atomic Energy Agency (2015) https://www-pub.iaea.org/MTCD/Publications/PDF/TE-1779_web.pdf

[331] Integrated Regulatory Review Service Guidelines, IAEA Service Series 37, International Atomic Energy Agency (2018) https://www-pub.iaea.org/MTCD/Publications/PDF/SVS-37web.pdf

operational safety performance at a nuclear power plant including personnel and management of safety.[332] Multiple INIR missions have been conducted by the IAEA in both Southeast Asia[333] and sub-Saharan Africa.[334] Countries in both Southeast Asia and sub-Saharan Africa have consulted the IAEA in the technical aspects nuclear energy, as well as, in establishing a legal framework for the same. This support from the IAEA was also vital for the United Arab Emirates (UAE) for embarking on its nuclear power program.[335]

3.4 Procurement

Procurement can be defined as any activity dealing with purchase of goods, work, and services. It includes general preparations, technical specification, selection of suppliers, contract award, delivery, and payments. Procurement is one of the most sensitive areas for decision-making on financing investments in nuclear power development because of involvement of international entities, and most importantly because it is at this stage that the major terms for construction and operation of the nuclear power plant will be negotiated between all stakeholders.[336]

The procurement process always involves at least two parties: the investor and the State and may even be more complicated for nuclear power development given that extended to many other stakeholders like nuclear regulatory authorities, international organizations (who may want to ensure nuclear security and non-proliferation), and local communities. As discussed earlier in Section II.b financing nuclear power projects can require anywhere between USD 4-10 billion and countries in Southeast Asia and sub-Saharan Africa will need significant external financial support in terms of procuring nuclear equipment and creating an internal supply chain to maintain the power plant. This may also require more extensive procurement relationships on the part of the investor as well.

The main steps of the procurement process as per the IAEA[337] are summarized below. This

---

[332] Guideline Independent Oversight, International Atomic Energy Agency, and World Association of Nuclear Operators (2018)
https://www.iaea.org/sites/default/files/20/09/wano-guideline-independent-oversight.pdf

[333] Alex Nitzsche, IAEA and ASEAN Strengthen Cooperation in Nuclear Science, Technology and Applications, and Nuclear Safety, Security and Safeguards, IAEA Office of Public Information and Communication (September 16, 2019)
https://www.iaea.org/newscenter/news/iaea-and-asean-strengthen-cooperation-in-nuclear-science-technology-and-applications-and-nuclear-safety-security-and-safeguards

[334] Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)

[335] Matt Fisher, UAE's Nuclear Power Journey Has Lessons for Newcomers as IAEA Restarts In-Person Reviews, IAEA May 24, 2021 (September 2, 2021)
https://www.iaea.org/newscenter/news/uaes-nuclear-power-journey-has-lessons-for-newcomers-as-iaea-restarts-in-person-reviews

[336] Management of procurement activities in a nuclear installation, IAEA 1996, IAEA-TECDOC-919
https://inis.iaea.org/collection/NCLCollectionStore/_Public/28/024/28024078.pdf

[337] Steps to Nuclear Power, IAEA Technical Report Series No. 164
https://inis.iaea.org/collection/NCLCollectionStore/_Public/07/222/7222571.pdf
Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities, IAEA Nuclear Energy Series No. NP-T-3.21 (2016) at p. 34-87
https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1725_web.pdf

summary reflects the generally applicable approaches to procurement globally and are widely recognized within the industry:

i. General information about the forthcoming tender/selection

General information on a nuclear project is usually published in newspapers of high circulation and/or in other media accessible to the public. The purpose of the general information notice is to make the industry and other relevant stakeholders aware of the project so that they can make early decisions about possible participation in the forthcoming selection process.

For project requiring major investments (usually the case for a nuclear power plant programs), this general information should be published at least a half year before the start of the selection process. Various options are available for saving on costs of publication, the use of other media and the frequency of the advertisement.

ii. Invitation to tender and issuance of the tender documentation

The invitation for submission of proposals is the official start of the selection procedure at the end of which selected candidates will be invited to submit proposals.[338] Open tendering[339] is recommended by the IAEA in all nuclear development projects to encourage transparency and competition. If there is no justified reason for following certain selective approach under which bids would only be open to specific contractors, open tendering as procurement tool provides the wider competition for any investment programs. Open tendering provides all necessary conditions for selecting on a fully competitive basis, using a process that ensures the greatest transparency and reliability for all parties and participants. It is however important to note that although these steps and practice represent the ideal scenario, practically there is not a significant amount of options available to countries in Southeast Asia and sub-Saharan Africa when it comes to competitive selection of vendors which raises concerns about the effectiveness of open-tendering for procurement as a deal between South Africa and Rosatom to build a nuclear power plant was found unlawful.[340]

iii. Receipt, opening and assessment of proposals and contract award

In the case of nuclear power projects, Opening is a public event with the invitation of all tenderers, with the announcement and official recording of the names of all proposal makers, including a recording of the proposed price and (if necessary) all price components and all proposed price reduction factors as well. The Opening is a public event for demonstrating transparency and providing information to all tenderers on the competition. Proposals are assessed against evaluation criteria. The contract is awarded to the tenderer with eligible proposed technical content and of the cheapest proposed price.

iv. Contract award and administration

Once the selection has been made, contract negotiations start with the first ranked candidate. In the case of agreement, the contract will be signed. In the case of no agreement

---

[338] Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities, IAEA Nuclear Energy Series No. NP-T-3.21 (2016) at p. 60 https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1725_web.pdf

[339] Open tendering is a process where anyone can submit bids to supply works or services that are required for a project. The purpose of open-tendering is to create fair competition and ensure transparency.

[340] Russia's Rosatom says no 'secret deal' with South Africa, Reuters June 20, 2017 (Accessed September 8 2021) https://www.reuters.com/article/russia-safrica-rosatom-idAFR4N1JC007

the next in the rank candidate is invited to contract negotiations. The cycle of contract negotiations continues this way until agreement has been made.

The above steps recommended by the IAEA present an ideal situation. Nuclear power in Southeast Asia and sub-Saharan Africa has been dominated by several international players either in the form of joint ventures or build, own, operate model.[341] In the process to embark on its nuclear power program Thailand has collaborated with China. The Thai electricity generating authority and China's Light and Power Co (CLP) signed an agreement with China Guangdong Nuclear Power Corporation (CGN). This agreement would later result into CGN and China's Gunagxi Investment Group in 2015 signing an agreement with Ratch China Power, a subsidiary of Thailand's Ratchaburi Electricity Generating Holding Public Company (part of its electricity generation authority or EGAT), to establish a joint venture known as Guangxi Fangchenggang Nuclear Power (II) Co. Ltd. for developing, constructing, and operating units at China's Fangchenggang nuclear facility.[342] Additionally, in South Africa the plans to build nuclear power plants have continued to progress as the South African government is considering investment from China while furthering its collaboration with Rosatom. In fact, the major nuclear vendors in sub-Saharan Africa are from China, Russia, and South Korea with whom the nations in this region have signed several Nuclear Cooperation Agreements and Memoranda of Understanding for myriad purposes including research and development, human resources development, and power projects.[343] As also noted in previous chapters multiple sub-Saharan states have entered or are in talks to enter agreements (including Ghana, Zambia, Kenya, South Africa, the Republic of Congo, Rwanda, Tanzania) to collaborate on nuclear power projects with Russia's Rosatom.[344]

Some of the challenges that can derail the procurement process include all the above barriers mentioned in the discussion above including financing, country risk factors, reputational risks (non-proliferation and environmental concerns). Nuclear power plants are expensive infrastructure projects, and the above discussion has emphasized how embarking countries in Southeast Asia and sub-Saharan Africa are dependent upon vendor financing in pursuing their nuclear power programs. It is estimated the globally upcoming nuclear power projects by 2040 are expected to require capital expenditure of USD 972 billion under the reference scenario and ongoing new construction is valued at USD 220 billion. In addition, these projects will also have significant costs to maintain and ultimately decommission them.[345] Although vendor financing has been seen as a way for embarking countries to move forward with their nuclear power programs, the capital expenditure of constructing and maintaining nuclear power projects presents foreign investors with a daunting scenario of a long-term undertaking with several risks attached to it.

---

[341] Nur Azha Putra and Philip Andrews-Speed, Prospects for Nuclear Power in ASEAN, The Diplomat June 28, 2018 https://thediplomat.com/2018/06/prospects-for-nuclear-power-in-asean/

[342] Felix Todd, Analysing the development of nuclear power across Southeast Asia, NS Energy August 5, 2019 (Accessed January 3, 2021) https://www.nsenergybusiness.com/features/development-nuclear-power-southeast-asia/

[343] Sub-Saharan Africa and nuclear energy, World Nuclear Association, April 2018 https://www.world-nuclear-news.org/V-Sub-Saharan-Africa-and-nuclear-energy-23041802.html

[344] Ryan Collyer, acting CEO of Rosatom Central and Southern Africa, correspondence with *POWER Magazine*, https://www.powermag.com/philippines-taking-new-look-at-nuclear-power/

[345] World Nuclear Supply Chain: Outlook 2040, World Nuclear Association 2021

Most of the advanced nuclear economies like the US and France for example have considered it too risky to invest in nuclear power programs of embarking countries. Rosatom has however been less discouraged by these risks and has adopted a set of best practices which involve negotiating adequate project security with a host government and only proceeding to negotiation with other project stakeholders once the technical design and operational plans have been completed and the required licenses for the project have been received.[346]

This negotiation process between foreign nuclear vendors and the embarking countries of Southeast Asia and sub-Saharan Africa have raised concerns about just how much a state would have power in negotiating the different aspects of a nuclear power project including siting, construction, operations and power purchase agreements for the electricity sold in cases of a build-own-operate model.[347] As there are usually power imbalance, knowledge asymmetries and dissimilar negotiating situations that are impediments to an effective and fair negotiation process between a developing and developed country when negotiating a nuclear power project.[348] Therefore, it is important to keep this process transparent and cohesive with the involvement of host communities that may be potentially affected. But even if all participants engaged in the process on the basis of fairness and mutual trust there needs to be an agreed approach in the nuclear investment process to ensure that all stakeholders understand each other and have the same perspectives and approaches for resolving any issues that may arise. This process of building mechanisms to ensure fair and effective negotiation of nuclear power projects will be discussed in the next chapter.

3.5 Conclusion

Nuclear power projects are capital intensive ventures requiring billions of dollars in investment and involve several risks like that of a nuclear accident and proliferation. Deploying nuclear energy is still fraught with several challenges especially in Southeast Asia and sub-Saharan Africa. This chapter discussed these challenges from the perspective of foreign developers/investors to create a better understanding into issues that occur in the process of deciding to embark on a nuclear power program to procurement of the first nuclear reactor. From the perspective of foreign developers, a first consideration is about their level of involvement in the host country's nuclear power program. There are different models under which a nuclear power program can be established and since the countries in these regions are dependent on foreign developers for their nuclear power programs both financially and technologically, the most popular amongst them is the build, own, operate (BOO) model. This model allows for development of nuclear power projects in a way that does not require the host government to put in a huge investment at the beginning. However, this model also warrants significant involvement of a foreign developer in the nuclear power program. So, before getting involved in a BOO model, a foreign developer will have to consider the different risks which include economic considerations

[346] Rosatom sees wider financing options for new build, World Nuclear News September 11, 2020 (Accessed September 8, 2021)
https://world-nuclear-news.org/Articles/Rosatom-sees-wider-financing-options-for-new-build
[347] Discussion on project models in section I.
[348] Stephen D. Krasner, Third World Vulnerabilities and Global Negotiations, Review of International Studies, Vol. 9, No. 4 (Oct. 1983), pp. 235-249

(recovery of costs, sale of electricity, nuclear liability, financial incentives provided by the host government, and disputes settlement), reputational concerns which revolve primarily around ensuring surety and non-proliferation of nuclear materials.

All of that said, it is also important to note that a state's nuclear program is focused on achieving the maximum benefit to the State in which these facilities are to be constructed and operated, the participation of the local industry, local technical institutions, and the local economy. The sensitive point in most cases here is the way of the involvement of the representatives of the local communities who may be affected. With involvement of foreign developers there is of course the risk that they may demand control over project implementation to safeguard their economic interests which may sometimes take priority over the overall interests of the host country and affected populations. The next chapter will look at the how exactly local populations can be made part of the decision not just to embark on a nuclear power program, but also in the decision of how and what form a country's nuclear power program might take.

4 CHAPTER IV– NEGOTIATING NUCLEAR POWER PROJECT AGREEMENTS TO SAFEGUARD LOCAL COMMUNITY INTERESTS

Chernobyl and Fukushima both had severe impacts on the growth of nuclear energy and raised several concerns about nuclear safety and liability. Both of these accidents while evident of the catastrophic nature of the potentiality of a nuclear accident also exposed the inadequacy of our legal system to address them as discussed in Chapter II. Victims of Chernobyl were left with the burden of establishing their claim through complicated and cumbersome procedures, and the litigation with regard to claims settlement for Fukushima is still ongoing. Development of nuclear energy projects in the shadows of Chernobyl and Fukushima has understandably been fraught with negative public perception, government reluctance, and just overall fear of nuclear energy. Some of this fear of nuclear energy comes from the lack of understanding of the very complex technology. Since the 1940s nuclear physicists and engineers have been perceived as an elite group of intellectuals who do not see the importance of trying to explain the details of their work. This was reflected in the lack of awareness amongst victims at Chernobyl. According to Svetlana Alexeivich's book titled "Voices from Chernobyl", the residents of neighboring villages in and around the town of Pripyat were reportedly so grossly unaware of the effects of radiation that when the highly radioactive debris from the explosion at Chernobyl landed near their homes, they collected them as souvenirs hoping to sell them later on for a quick profit. Not just residents, but apparently even the firefighters that arrived first at Chernobyl to respond to the fires were so unaware that in order to clear paths, they picked up and tossed the radioactive debris with their bare hands. All of these people would suffer the horrible effects of radiation poisoning, and almost none of them would survive. Similarly, in other parts of the world nuclear energy is a subject that is treated with relative secrecy and the public concern about it has been treated with a condescending or dismissive attitude by nuclear scientists and policymakers. This culture of opacity seems very counter-productive when one thinks of the risks associated with operating a nuclear power. However, as nuclear energy becomes commercialized globally, this culture of secrecy and opacity around it is slowly fading.

The first Chapter of this dissertation stressed the relevance of nuclear energy in decarbonization while the second chapter touched upon some of the risks of nuclear energy as well as how law can help mitigate/manage them, and the third chapter talked about some of the commercial considerations that go into planning a nuclear power project. This Chapter has a slightly different focus. This Chapter will talk about the specific risks that local populations face during the implementation and operation of a nuclear power plant and how important it is for them to have strong voices in the decision to not just embark on a nuclear power project, but also in every decision that might affect them during the lifetime of a nuclear power plant. Most importantly, this Chapter will discuss how nuclear power projects can be negotiated and implemented in a way that adds value to host economies and their populations.

4.1 Negotiation Circumstances in Southeast Asia and sub-Saharan Africa

First, it is important to address the disadvantaged negotiating position of the countries within the scope of this thesis. As addressed in Chapter II and III, nuclear power projects today have shifted from the traditional state-owned model and become more complex with the involvement of foreign entities for e.g. majority nuclear reactors both proposed and under-construction in sub-Saharan Africa are to be supplied by a Chinese Corporation and these projects will be structured on a build-own-operate model. Furthermore, these projects are also being financed through the China-Africa development fund, which puts these nations in a position where they have little to no control over the course of these transactions and how they will impact their own citizens. Thus, these countries are significantly dependent on foreign suppliers for their nuclear power programs and often take a less powerful position in negotiating agreements for these projects. As a result, the interests of local communities are often ignored. Therefore, it is pertinent to address the reality of dangers of such skewed negotiations that several emerging economies end up in given their dependence on foreign expertise and growing need for electricity. For this purpose, this Chapter includes case-studies of what partnership between developed and developing nations on nuclear power projects has looked like in other countries and discusses some industry best-practices as well as IAEA recommendations.

The discussion below will first look at what a fair negotiation looks like and what that would mean specifically in the context of nuclear power projects in the selected regions.

4.2 Basic principles of fair negotiation

In its most basic sense negotiation is a discussion that is aimed at reaching an agreement. Business negotiations usually involve corporate entities that are trying to agree upon various details of a transaction. There are three major norms that help ensure a fair negotiation – *equality* (an equal split of the resources), *equity* (a split in proportion to input), and *need* (a split that favors the negotiator who could most benefit from the resources under consideration).[349]

In the context of nuclear power projects, a fair negotiation would translate to the following:

- Equality – both the host state and investor come up to an agreeable level of involvement that is not detrimental to any of the stakeholders. This includes several factors like:
    - The host state does not agree to put it more money than it can without impacting its domestic development
    - The host government does not commit any resources that may be unfairly taken away from citizens including land and water.
- Equity – the host state is able to receive benefits that are in proportion to investment meaning that the electricity prices negotiated under the PPAs are not too high, and the foreign investors should not gain unlimited control.

[349] What are Business Negotiations? Program on Negotiation, Harvard Law School https://www.pon.harvard.edu/tag/business-negotiations/

- Need – the nuclear power plant actually helps supply low carbon energy into the grid of the country.

The reason behind picking these factors is a result of two major assumptions. The first one is that host countries are most in need of energy here and then secondly the presence of these factors will ensure a fair negotiation. The first assumption comes from the discussion of the growing energy demand (see Chapter I) in Southeast Asia and sub-Saharan Africa. The second assumption comes from a review of how different nuclear power projects were negotiated in other embarking countries. A limiting factor to point out here though is that there is not an extensive history of operating nuclear power plants in collaboration with a foreign vendor in the selected countries and therefore the discussion in this chapter will rely on drawing examples from other embarking countries that have implemented nuclear power projects of similar nature (Turkey's Akkuyu Nuclear Power Project and India's Kudankulam Nuclear Power Project).

4.2.1 What is stopping nuclear power projects from being negotiated fairly?

4.2.1.1 Geopolitics

The above scenario is ideal and at the same time also far from reality. Nuclear power projects are multi-billion-dollar projects that do not just involve the business interests of multiple stakeholders but also involve balancing of several political motivations. The Akkuyu Nuclear Power Plant for example, was motivated by Turkey's aim to further relations with Russia. Additionally, the Akkuyu power plant may have helped pave the way for other forms of cooperation between Russia and Turkey like the Moscow-Ankara agreement in 2017 for the sale of Russia's S-400[350] surface-to-air-missile batteries.[351]

Beyond the strategic consideration of host states to enter nuclear power project agreements, vendors from countries exporting nuclear technology have their own set of political objectives. Western economies with advanced nuclear power programs and especially the US were initially perceived leaders in nuclear technology however, they now face tough competition from Russia and China. Russia and China are the major players making nuclear energy investment in Southeast Asia and sub-Saharan Africa, as a means to expand their global influence. In 2003, Russia recognized that its involvement in global energy markets determines its geopolitical influence[352] and that the same is a significant factor in Rosatom's external strategy.[353] The 2015 draft of the Energy Strategy of Russia up to 2035 (not yet adopted) also identifies the growth of nuclear

[350] The United States views these missile batteries as a major security threat to its F-35 stealth fighter jets, which are being rolled out among the NATO allies. Nakano, Jane. Report. Center for Strategic and International Studies (CSIS), 2020. Accessed August 30, 2021.

[351] Nakano, Jane. Report. Center for Strategic and International Studies (CSIS), 2020. Accessed August 30, 2021. http://www.jstor.org/stable/resrep24239.public/publication/200416_Nakano_NuclearEnergy_UPDATED%20FINAL.pdf?heOTjmYgA_5HxCUbVIZ2PGedzzQNg24v

[352] Minin and Vlček, "Determinants and considerations of Rosatom's external strategy," 37.

[353] Névine Schepers, "Russia's Nuclear Energy Exports: Status, Prospects and Implications," Stockholm International Peace Research Institute, Non-Proliferation and Disarmament Paper, no. 61, February 2019, 2, https://www.sipri.org/ sites/default/files/2019-02/eunpdc_no_61_final.pdf

technology and services exports a primary objective for development of Russia's nuclear industry.[354] This gives Rosatom significant freedom to pursue transnational nuclear investment as the representative for the Russian nuclear industry and it is also is exempt from seeking approval from Russian government agencies before initiating a nuclear power project abroad and signing agreements with foreign governments.[355] This political authority has however been curtailed now due to financial challenges of implementing nuclear power projects. In addition, Rosatom also has access to place its employees at Russian embassies[356] to facilitate deals for nuclear power projects.[357] Similarly, China too is competitively pursuing nuclear investment in Argentina, Brazil, the Czech Republic, Kenya, Malaysia, Thailand, Turkey, South Africa, and Saudi Arabia.

These geopolitics of the global nuclear energy market in addition to each country player's economic and strategic interests could endanger the safe implementation of nuclear projects in embarking countries and these interests will need to be balanced by the interests of host country and its population that may be affected by the project. Beyond this, politically motivated supplies of nuclear technology are also likely to overlook some of the technological as well as financial barriers to safe implementation in host countries. This includes the lack of a sturdy nuclear regulatory and governance regime which is a common issue in the selected regions.[358]

An example of geopolitical considerations influencing nuclear power project implementation can be found in India. After the Bhopal Gas Leak Case and the ensuing challenges in holding Union Carbide liable for damages, the popular consensus in India was that there must be mechanisms in place to hold foreign vendors supplying hazardous materials or technologies accountable for damage arising out of their fault. Driven by this narrative, India enacted its law on civil nuclear liability that provided for holding suppliers of nuclear technology liable for an accident occurring due to a patent or latent defect in equipment supplied by them. This was met with strong opposition from nuclear suppliers globally, including from Rosatom. India had been working with Rosatom to implement the Kudankulam Nuclear Power Project and amidst strong opposition from its Russian counterparts, the Indian government decided to allow two of the units of this project to be grandfathered accepting Rosatom's argument that since the construction for those two units had been under construction before the nuclear liability law came into effect, Rosatom could not be held liable as a supplier retroactively under the Act. In this context, it is fair

[354] Nikita Minin and Tomáš Vlček, "Determinants and considerations of Rosatom's external strategy," Energy Strategy Reviews 17 (September 2017): 37-44, doi:10.1016/j.esr.2017.07.001
[355] "Russian law increases Rosatom's political authority," World Nuclear News, December 28, 2017, https://www.world-nuclear-news.org/NP-Russian-law-increases-Rosatoms-political-authority-28121701.html.
[356] Russian embassies in Bangladesh, Belarus, China, India, Iran, Japan, Kazakhstan, and Turkey and trade missions in Argentina, the Czech Republic, France, Germany, Hungary, Vietnam, and the United Kingdom.
[357] Jian Liu and Ye Feng, "Analysis of the Competitiveness of Russia's Nuclear Energy Overseas Development, Industry Insights," China Nuclear Industry, 2018, original in Chinese. http://www.cnki.com.cn/Article/CJFDTotal-ZHGY201605016. htm
[358] Nakano, Jane. Report. Center for Strategic and International Studies (CSIS), 2020. Accessed August 30, 2021. http://www.jstor.org/stable/resrep24239.public/publication/200416_Nakano_NuclearEnergy_UPDATED%20FINAL.pdf?heOTjmYgA_5HxCUbVIZ2PGedzzQNg24v

to ask whether countries in Southeast Asia and sub-Saharan Africa may be faced with similar situation when negotiating with foreign vendors.

4.2.1.2 Power Imbalance and Knowledge Asymmetries

Negotiation is a process to facilitating reach an outcome agreeable to all parties participating in the negotiation. However, several factors affect how a negotiation will pan out. One of the most important factors that influences the direction of a negotiation is the power dynamic between negotiating parties. When we speak of negotiating international business transactions involving multiple jurisdictions, nature of relations between different regions hugely affects how the negotiations will go.

As also discussed earlier, nuclear power projects proposed in the developing economies of Southeast Asia and sub-Saharan Africa involve investment from China, and Russia. This already creates a bit of a power imbalance in negotiations with them because countries in the selected regions are heavily dependent on foreign suppliers not just for technology but also for financing these nuclear power projects. Beyond just construction of the power plants, this dependency extends to construction of grid infrastructure as well. This is because most large nuclear power plants require a certain level of grid infrastructure that is not yet present in many of these countries.[359] So, a foreign supplier holds the key to construction of the nuclear power plant as well as the requisite grid infrastructure and for financing these multi-billion-dollar projects. From the perspective of a foreign vendor, it may seem that a host country is in a desperate situation as most of the economies in Southeast Asia and sub-Saharan Africa are developing economies with fast growing populations and an even faster growing energy demand for energy. In such a situation a natural assumption may be that nuclear energy is a key for developing countries to not just ensure reduce for their growing carbon emissions but also maintain energy security which is vital for any country's development. This creates a power imbalance between the foreign investors and the host country that are heavily reliant on a foreign vendor for their nuclear power programs. This leads to knowledge asymmetries and dissimilar negotiating situations that are impediments to an effective and fair negotiation and this can only be resolved if the power is balanced between the different negotiating countries. which makes developing countries less effective in international negotiations. [360] However, a historical review of General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO) negotiations shows that over time developing countries have been able to become more effective in negotiations with the help of more experience and regional alliances. This, however, is not true in the case of negotiations related to climate change in which developing countries have still been relatively ineffective.[361]

When it comes to negotiating nuclear power projects the countries in Southeast Asia and sub-Saharan Africa still need to develop internal capabilities to reduce their level of dependence on a foreign vendor. In the meantime, however, it is important to consider how

[359] Conventional nuclear reactors which are usually 1000 require minimum grid capacity of 10,000 MW that several emerging economies especially in sub-Saharan Africa do not yet have.
[360] Jawara, F. and Kwa, A., 2003, Behind the Scenes at the WTO: the Real World of International Trade Negotiations, London and New York: Zed Books
[361] Developing Countries in International Negotiations: How they Influence Trade and Climate Change Negotiations, Journal: IDS Bulletin, : 2004, ISSN: 1759-5436

this existing power imbalance and knowledge asymmetries will affect the implementation of proposed nuclear power projects in these regions. While negotiating a nuclear power project with a vendor from a developed country, countries in Southeast Asia and sub-Saharan Africa find themselves concerned about the impact of such a transaction on their economy. They want to maintain power and control over their economy, recognition in the international community and improved wages and promotion of sustainable development. This leaves them in a vulnerable position of having to worry about a potential monopoly that the transnational corporation might establish, the catastrophic environmental impact from a nuclear accident, and labor exploitation.

This fear in the context of nuclear power projects is further amplified by the fact that beyond construction and financing, most of the nuclear power projects in the selected regions are on BOO format (discussed in Chapter III) under which the foreign supplier will continue to maintain control of the nuclear facility and sell electricity under a PPA which may not be as fairly negotiated. In some cases, even the grid infrastructure required for a nuclear power project to supply electricity is built by the foreign vendor.

4.2.1.3 Why developing nations worry? Exploitation and Reputational Issues.

As stated earlier, export of raw materials as well as manufactured goods forms a big part of developing countries' economies and at the same time, they seek to attract foreign investment for infrastructural development.[362] They often find themselves in a predicament of attracting more foreign income and investment while trying to also maintain power over their economies and safeguarding the interests of their labor and local communities. For this reason, developing countries have supported international codes dealing with business conduct and technology transfer to enhance their leverage over multinational corporations.[363] In the context of nuclear power projects, developing nations have done this by actively participating in IAEA programs and complying with its guidelines hope to safeguard their place in the nuclear industry.

Transnational Corporations have been accused of political interference in the countries in which they operate, corrupt and restrictive business practices, thwarting the goals and policies of governments, as well as endangering interests of local communities. For example, recently an agreement between Russia and South Africa for adding 9600 MW capacity with 10 nuclear reactors was ruled unlawful for lack of transparency and unfair tax incentives to Russia.[364] There have also been trends of foreign labor exploitation and of the environment and the abandonment of native labor needs as multinational corporations from developed countries transport business to countries with cheaper labor pools and relatively little economic or political clout.[365] The nuclear industry has not steered clear of this either as there were instances of labor exploitation even during the clean-up in the aftermath of Fukushima.[366]

---

[362] United Nations Development Program (UNDP), Towards Human Resilience: Sustaining MDG Progress in an Age of Economic Uncertainty, pp. 22 (2011)

[363] M. Wolf, Differential and More Favorable Treatment of Developing Countries and the International Trading System, The World Bank Economic Review, Vol. 1, No. 4, Symposium (Sep., 1987), pp. 647- 668

[364] W. Roelf, South African court declares nuclear plan with Russia unlawful (April 26, 2017)

[365] Samuel Paul, Transnational Corporations and Developing Countries: Some Issues in Industrial Policy, Economic and Political Weekly, Vol. 14, No. 30/32, Special Number (August 1979), pp. 1315-1330

[366] UN experts cite 'possible exploitation' of workers hired to clean up toxic Japanese nuclear plant, United Nations News August 16, 2018 (Accessed 06/5/2021)

This does make entities in developing countries form pre-judgments of foreign suppliers of nuclear technology even before the negotiations begin, and this information might be lost on their counterparts. This can lead to potential friction during negotiations because the developing countries may sometimes see the lack of understanding from a developed country entity as an insult or challenge to their sovereignty. In addition, financing a nuclear power project requires several billion dollars which many of the embarking countries cannot afford to spend on one project and international banks are vary of providing loans for nuclear power projects because of the high-risk magnitude. This leaves host states with extremely limited options. In addition, among the states that are involved in supplying civilian nuclear technology, US and France who are amongst the biggest suppliers are reticent to get involved in the nuclear power programs in Southeast Asia and sub-Saharan Africa. This gives transnational corporations from Russia and China unfair bargaining power, leaving developing countries compelled to accept arrangements that they would reject if power were distributed more equitably.[367]

4.3 Role of International Organizations in NPP Negotiations – IAEA Guidelines

Mindful of the complicated dynamics of negotiating and implementing nuclear power projects, the IAEA has provided its own set of guidelines on planning and implementation of nuclear power projects. It is however pertinent to note that these recommendations do not touch upon the specifics of good practices in the case of international nuclear power projects which involve foreign entities.[368] There recommendations include:

i. Exhibiting accountability
ii. Recognizing the purpose of stakeholder involvement
iii. Understanding stakeholder issues and concerns from the beginning
iv. Building trust
v. Practicing openness and transparency
vi. Identifying affected stakeholders

The IAEA guidelines[369] emphasize that one of the ways of ensuring fair negotiation and implementation of nuclear programs is to create accountability for each party to the concerned stakeholders which includes the affected local communities. These guidelines note the importance of maintaining transparency while finalizing project site and other details.[370] The IAEA recommends that this responsibility should ultimately lie with the operator as the operator is

https://news.un.org/en/story/2018/08/1017232

[367] Supra at 11.

[368] OECD Nuclear Energy Agency, Stakeholder Involvement Techniques: A Short Guide and Annotated Bibliography, NEA/RWM/FSC (2004)7, OECD/NEA, Paris (2004).

[369] International Atomic Energy Agency, The Management System for Facilities and Activities, IAEA Safety Standards Series No. GS-R-3, IAEA, Vienna (2006).

[370] B. Fischhoff, The Nuclear Energy Industry's Communication Problem, Bulletin of the Atomic Scientists, 17 February 2009.
http://www.thebulletin.org/web-edition/features/the-nuclear-energy-industrys-communication-problem

usually solely liable for any damage from a nuclear facility (as discussed under the concept of legal channeling of liability in Chapter II). In addition, the IAEA guidelines say that the responsibility to ensure that the operator discharges their duty of care lies with the regulator of host governments.

The IAEA guidelines also touch upon the importance of crafting stakeholder involvement programs to demonstrate compliance with laws and regulations but does not specify what these programs would look like. Perhaps this is because each country has its own set of regulations about what a stakeholder involvement program would involve. Another thing that the IAEA guidelines point is that the purpose of stakeholder involvement is to make sure that the views of all stakeholders have been heard and the program is implemented through a collaborative process. This does not mean that a consensus has to be reached with all sides.[371]

In addition, the IAEA provides a brief overview of the steps and issues that should be integrated into stakeholder involvement programs: Develop a strategy for stakeholder involvement; Develop plans for implementing this strategy; Ensure that the capacity to effectively implement these plans are available; Implement these plans; Continually monitor the effectiveness of these actions and look for ways to improve. From a reading of these guidelines it is apparent that they are very general in nature and therefore limited in how much they can impact negotiations and implementation of a NPP by a foreign developers. The specifics of how these guidelines are translated into enforceable legislation is dependent on the circumstances in each host state. In addition, the circumstances and the kind of stakeholders involved vary from country to country and the culture around stakeholder involvement is also heavily dependent on the form of government prevailing in the host state. Therefore, each stakeholder plan will have to be calibrated to best suit a nuclear facility and the host state.

4.4 Stages of Stakeholder Involvement

The biggest issue concern for communities around a nuclear power plant is that of safety. Three Mile Island[372], Chernobyl[373], and Fukushima Daiichi[374] have confirmed the fears of the impact of nuclear accidents. While conventional safety issues applicable to any technology are equally applicable to nuclear energy one aspect of it – ionizing radiation makes the risks associated with it particularly perplexing to the public. This is because human senses do not detect the presence of radiation.[375] Even with natural background radiation, one cannot see, hear, smell, taste or feel it. This

[371] International Nuclear Safety Group, Stakeholder Involvement in Nuclear Issues, INSAG-20, IAEA, Vienna (2006)
[372] P. Sandman, Three Mile Island — 25 Years Later, Safety at Work, April 24, 7–11. Int. At. Energy Agency Bull., March (2006) 9–13.
[373] A. V. Lowe, Colin Warbrick, and John Woodliffe, "Chernobyl: Four Years On," International and Comparative Law Quarterly 39 (2) (1990): 461–471, and L. A. Malone, "The Chernobyl Accident: A Case Study in International Law Regulating State Responsibility for Transboundary Nuclear Pollution" (1987), Faculty Publications, Paper 590, http://scholarship.law.wm.edu/facpubs/590

[374] T. Weiss, The Campaign for Nuclear Power in Japan before and after 2011, Civil Society and the State in Democratic East Asia. Amsterdam University Press 2020 p. 85
[375] J.M. Havenaar, et al., Perception of risk and subjective health among victims of the Chernobyl disaster, Soc. Sci. Med. 56 (2003) 569–572.

contrasts with almost every other human activity, where we can make a reasonable judgment based on common sense and without much of external advice as to how safe that activity may be.[376] With ionizing radiation, one can only measure it, which does not tell a layman anything meaningful about what he or she is experiencing. Understandably, this is also the reason why the public has several misconceptions and fears about radiation though many technologists may scoff at the fears of the laymen who do not understand technology and dismiss the importance of stakeholder involvement.

Chapter I of this dissertation emphasized the rapidly deteriorating environmental conditions and discussed the role of nuclear energy in clean energy transition. However, while beneficial for carbon emission reduction efforts, nuclear energy at the same time carries considerable risks and therefore the decision to embark on a nuclear power project should only be made in collaboration with all the stakeholders that may be affected by them. This would not only help with ensuring safety of local populations and give them a voice in important decisions like siting and operation but also ensure that the proposed NPP enjoys the support from local communities instead of facing political opposition and litigation. Public outreach and awareness programs as well as mechanisms for providing community benefits have an important role here.

These programs should begin from the very inception of a nuclear power project and different roles have to be played by the government, the domestic enterprise, and the foreign vendor in its implementation. The success of the whole process depends upon the attitudes displayed by each one of these in understanding their roles, responsibilities, as well as their obligations to the other parties and most importantly towards the local communities. The IAEA[377] and OECD-NEA recommend the implementation of public outreach programs in the following steps:

4.4.1 New nuclear power programs and Siting

Siting tends to be one of the most contentious steps in a nuclear power project. So, a first step while finalizing siting should include establishing early-stage communication with the relevant decision-making authorities, public, media, as well as neighboring countries.[378] In addition, plans for disposal of the radioactive waste from the proposed project should also be communicated at this point. Doing this helps dispel dome of the initial fears around a new nuclear project and is essential for building trust amongst all the stakeholders involved throughout the lifecycle of a nuclear power plant beyond siting. Siting will be discussed in more detail in the next section.

At this stage it is also important to communicate the plans for the electricity generated from a proposed project and any possible changes to the price of electricity.

4.4.2 Operational phase of nuclear facilities

After overcoming the challenges of public acceptance during siting it is likely that a foreign project developer may take little interest in stakeholder involvement. However, it is vital to maintain transparency with all stakeholders even during operation of a nuclear power plant because the risk of

[376] V.T. Covello, The perception of technological risks: a literature review, Technol. Forecast. Soc. 23 (1983) 285–297.
[377] International Atomic Energy Agency, An Overview of Stakeholder Involvement in Decommissioning, IAEA Nuclear Energy Series No. NW-T-2.5, IAEA, Vienna (2009).
[378] International Atomic Energy Agency, International Status and Prospects of Nuclear Power, Information Booklet, IAEA, Vienna (2008).

harm from a nuclear accident continues throughout the lifecycle of a nuclear power plant. Therefore, it is important to continue to share with stakeholders any updates on safety levels and another performance related issues such as power output level or refueling power outage schedules. This can usually be done through representative groups and responsible authorities.

4.4.3 Expansion or extension of nuclear facility operations

Whether it is extending operation of adding reactors to a nuclear power plant, involvement of stakeholders remains of significant importance. The full range of impact including economic benefits, justifications, and risks of expansion of the project need to be communicated to the local community. In addition, this information should not be presented in a misleading or oversimplified manner as that can affect the operator's credibility.

4.4.4 Decommissioning of nuclear facilities

While decisions regarding decommissioning of nuclear power plants are generally not made by regulatory authorities without significant involvement of local communities, it is still vital to maintain open communication with them throughout the process. This is because closure of a nuclear facility warrants important decisions to be made about waste management that may affect local stakeholders. Radioactive waste management in particular tends to be the most challenging part of successful decommissioning. Decommissioning plans are usually made at the time of planning a nuclear power project but in most cases, these are not concrete.[379] In fact, in some cases the site of a nuclear power plant itself may be turned into an interim waste storage facility which may be a cause for concern by the local population.[380] This is why, it is pertinent to maintain communication with the local communities throughout the decommissioning process so that they can be part of the decision regarding waste disposal[381] which has in the past been beyond their influence especially in embarking countries.[382] Stakeholder consultation and oversight[383] over decommissioning is also recognized by the IAEA as an integral feature of stakeholder involvement. Throughout the world stakeholder groups have in fact become more organized into national as well as, international bodies that specifically represent communities affected by decommissioning of nuclear facilities like the Nuclear Legacy Advisory Forum (NuLeAF, UK) [384], Associación de Municipios en Áreas con Centrales Nucleares (AMAC, Spain), Energy Communities Alliance (ECA, USA) and Group of European Municipalities with Nuclear

[379] IAEA, Communications on Nuclear, Radiation, Transport and Waste Safety: A Practical Handbook, IAEA-TECDOC-1076, IAEA, Vienna (1999).
[380] IAEA, Socioeconomic and Other Non-radiological Impacts of the Near Surface Disposal of Radioactive Waste, IAEA-TECDOC-1308, IAEA, Vienna (2002).
[381] OECD Nuclear Energy Agency, Stakeholder Involvement in Decommissioning Nuclear Facilities, NEA No. 6320, OECD, Paris (2007).
[382] K. SHIMOMURA, Disposal of Long-lived Waste - An International Perspective. In: Proceedings of DiSTec 2004, an International Conference on Radioactive Waste Disposal, Berlin, Germany, 26–28 April 2004
[383] L. Robinson, Pro-active Public Participation for Waste Management in Western Australia, Part 1: Strategic Rationale, Prepared for the Western Australian Local Government Association & the Waste Education Strategy Integration Group, July 2002.
[384] UK Nuclear Decommissioning Authority, Consultation on a Public and Stakeholder Engagement and Communications Framework for Geological Disposal (2008).

Facilities (GMF, Europe).[385]

4.5 Safeguarding interests of local communities

Nuclear power projects tend to cause much debate around them when they are proposed. Given the nature of nature of nuclear technology and its potential for transboundary damage, these debates are likely to be at local, national, as well as international levels with neighboring countries once the site has been identified.[386] Specifically, for the local communities the biggest fears tend to be losing their land if they are located around the site of the proposed project, health concerns from radiation, and just a general lack of trust towards a foreign vendor .

One of the ways of recognizing and safeguarding these concerns of the communities local to or hosting a nuclear project, is to establish a program for community benefits. Community benefit comprises the mitigation or compensation measures offered by a developer to offset potential impacts of a proposed development on a local community and its environment. The aim of providing community benefits is to not only offset risks for the affected community as a result of the proposed project and to also garner public acceptance for it. Development of long-term projects such as improved roads, hospitals or emergency response facilities are some of the common ways of providing community benefits and their purpose is to ensure safe operation of nuclear facilities while also benefiting the local community.[387] These measures are seen as social responsibility measures by foreign operators and can also involve supporting local businesses, sports, and education. The Diablo Canyon Plant in California is a good example for this.[388] Distribution of local taxes or community support grants can effectively be delegated to community groups or special committees. A number of different approaches are in place in a number of (mainly energy or energy-related) sectors, including: for example for on-shore wind farm developments in the UK and other renewable projects, nuclear power projects, interim storage facilities for nuclear materials in Belgium, and the ITER (International Thermonuclear Experimental Reactor) in Cadarache, France. Community benefit is now in fact recognized internationally as an appropriate response from a developer of a large infrastructure project to a local community in recognition of the potential impacts of such a development on behalf of wider regional and national interests. For example, in 2008 in a White Paper on radioactive waste the UK Government recognized the concept of volunteer communities being central to the success of the project.

---

[385] IAEA, Stakeholder Involvement Throughout the Life Cycle of Nuclear Facilities, IAEA Nuclear Energy Series No. NG-T-1.4 (2011) at p. 12

[386] I. Hore-Lacy, Reclaiming Some Moral High Ground — Ethical Aspects in Nuclear Communications, 12th International Workshop on Nuclear Public Information in Practice, Ljubljana, Slovenia, 13–16 Feb 2000.

[387] Korea Hydro & Nuclear Power Co., Ltd., KHNP Sustainability Report (2018)

[388] Nuclear Energy Institute, Economic Benefits of Diablo Canyon Power Plant, An Economic Impact Study by the Nuclear Energy Institute in cooperation with Pacific Gas & Electric Company, NEI, February 2004.

4.5.1 Form of benefits

Community benefit is a general term applying to a number of different forms of benefit offered to the local community in which an energy project is to be located. These can include cash benefits in the form of a lump sum, staged payments made contingent upon the various regulatory and approval milestones of the development or in the form of investing in infrastructure for education and healthcare for the benefit of future generations. However, it is becoming more common for packages to offer other benefits, rather than purely financial ones. These could include social benefits such as enhanced employment opportunities; improvement of or creation of roads, transport links or other infrastructure; addressing environmental concerns (i.e., by relocating and re-establishing a natural habitat under threat by the development); property value and price protection to compensate homeowners for demonstrable decreases in value; creation of facilities and services, such as a hospital or social facilities for the inhabitants; reduction in utility fees for the communities affected by the development, or even profit sharing. China for example, has been providing educational opportunities to host countries by hosting Master's and Doctoral level students from emerging nuclear power countries under the Atomic Energy Scholarship, whose selection process is facilitated by the International Atomic Energy Agency.[389] Similarly, Russia has also been training Turkish scientists in order to not only allow them to eventually become self-reliant for their nuclear power program but also to help create more educational and employment opportunities for local personnel.

Further forms of benefit, referred to as community empowerment measures create a role for the local community such that a partnership may be established between the developer and local community representatives or local government body, in the decision-making and oversight of the project. Financial support is often provided to support these activities like establishing and maintaining a local office; undertaking socio-economic studies, or even assisting in the design considerations. The Sullum Voe Oil terminal[390] in Scotland, UK, is an example of the progress of a project that was placed under local management including the establishment of a jointly owned consortium of the local council and the companies wishing to pipe North Sea oil ashore.

4.5.2 Structure

While most states will provide some form of community benefit mechanism or framework within which the benefit applies, the way in which such benefits operate on a legal basis differs between countries. In jurisdictions such as France, Slovenia, Canada and South Korea, the community benefit and associated social and empowerment measures are laid down in

[389] "China Trains Nuclear Engineers from Nuclear Newcomer Countries – IAEA Facilitates Selection Process," International Atomic Energy Agency, May 2019, https://www.iaea.org/newscenter/news/china-trains-nuclear-engineers-from-nuclear-newcomer-countries-iaea-facilitates-selection-process.

[390] Ritchie, W. Monitoring long-term environmental change: Some lessons from Sullom Voe, Shetland Islands. WMU J Marit Affairs 3, 193–204 (2004). https://doi.org/10.1007/BF03195059

legislation. However, the specific amounts and benefits differ in that some may be determined by established principles, such as the distance of a community from the facility, whilst other systems rely upon negotiation on a case-by-case basis. Such negotiation, while subject to a number of other factors, permits flexibility and allows the participating community to become closely involved in the development and focus of the relevant benefit package. Other jurisdictions establish contracts between developers and local communities or established partnerships. The funds may also differ from the way in which they are managed, varying from direct transfer of funds to the relevant local body with no further oversight of their use to complex management boards governing funds or other measures put in place. Such boards can consist of representations of all parties to the benefit agreements tasked with fund allocation and expenditure, determined on a case-by-case basis.

In the UK for example, planning law allows applicants to enter into binding agreements with local communities to provide benefits in recognition of the impact of a proposed project.[391] These agreements are negotiated between the planning authorities and the developer that can include a commitment on the part of the developer to make payments to the authority for certain purposes. However, in comparison to some nuclear-specific community benefits awarded outside of the planning law, such section 106 agreement payments are often seen as only "goodwill" payments and too low to address the impact of the project.

Enshrining community benefit into legislation, creating firm limitations for when community benefit should and should not be used could be seen to reduce community benefit to a "box ticking" exercise. This could be particularly apparent where such benefit is codified in the planning laws of a particular state, potentially becoming a precondition for the grant of a planning permission. However, the legislative basis of such community benefit differs widely between states – many areas of planning practice know nothing of community benefit and indeed may never implement such measures.

4.6 Siting

There are many approaches for identifying suitable sites for nuclear installations. Environmental aspects are not the only criteria; others are, for example, the geological characteristics of the site, the availability of cooling water or the position in the electricity grid. However, they should play an important role when choosing a site.[392] In some states a government programme is established to systematically identify suitable sites for nuclear power development in the country. In this case, environmental aspects (together with other relevant aspects) should from the start inform the progressive categorization, evaluation and short-listing of sites and the process for reaching a final selection. As the IAEA Milestones set forth, formal environmental studies and reports should be conducted early, beginning with site categorization and selection.[393] In a second step, the selected site will have to undergo a detailed assessment by the competent authorities, including a review of compliance with all applicable environmental legislation and

[391] Section 106, The Town and Country Planning Act 1990
[392] P.J. Richardson, A Review of Benefits Offered to Volunteer Communities for Siting Nuclear Waste Facilities. Swedish National Co-ordinator for Nuclear Waste Disposal (M 1996:C), Stockholm, (1998).
[393] IAEA Milestones document (see previous footnote), para. 3.13.1.

regulations.

In many embarking countries, a specific site is pre-determined by the government or by the project developer based on non-environmental considerations such as geographical location, grid necessities, infrastructure or economic advantages. In advanced nuclear countries, new build sites tend to be selected adjacent to existing facilities to minimise the impact on the environment and to make use of existing information and assessment regarding the local environment. This option is obviously not available to embarking countries, requiring them to go through the several steps of land-use planning, environmental assessment, each of which cannot be complete without participation of local communities.

4.6.1 Land Use Planning for New Nuclear

As discussed in the previous section, although the particular methods adopted will vary considerably between jurisdictions, the decision to build a nuclear power plant will invariably involve a consideration of the anticipated environmental impacts, and whether they can be mitigated, or even tolerated, to a level whereby the benefits of the development will sufficiently outweigh them. There are a variety of different stakeholders involved that can influence the decision-making process in favour of the environment such as concerned local residents, non-governmental organisations and the environmental and planning authorities. All of these interested groups have the potential to ensure that the environmental impacts of a proposed development, taking into account the information available, including that generated from environmental assessments, is factored into the decision on whether or not to proceed. These considerations will also have an effect on the resulting nuclear site licensing conditions (focussing on safety and security primarily) if the authorities ultimately do provide a land use consent for a proposed installation.

In most civil nuclear jurisdictions, a land use planning system is employed to manage the process and help ensure that there has been adequate scrutiny of environmental impacts in a site-specific context. Environmental considerations play a pervasive role in the planning debate and there is therefore a need to understand the processes and the key authorities involved. Although there are common features which unite the legal processes of individual States, this is an area where they have retained considerable autonomy. There are, therefore, a number of permutations.

IAEA documentation such as the Fundamental Safety Principles (IAEA, No. SF-1), Milestones in the Development of a National Infrastructure for Nuclear Power (IAEA, No. NG-G-3.1) and Stakeholder Involvement in Nuclear Issues (IAEA, INSAG-20) are all important starting points from which most civil nuclear States have developed their domestic legal systems. The following stakeholders however tend to remain common:

4.6.1.1 Land use/Planning authorities

All decisions to build new plant will require review by a competent authority in the affected jurisdiction. This body may be a local authority local to the area in which the proposed NPP is situated or may be a central government body with arrangements to consult at a local level. Land use planning authorisations are a key. This is recognised by the IAEA as a fundamental feature of nuclear law and commonly referred to as the permission principle. This principle holds that, unless specifically exempted, any activity related to the use of nuclear material and technology should be

permitted only after competent authorities have determined that it can be conducted in a manner that does not pose an unacceptable risk to public health, safety and the environment. The national legal infrastructure in each State determines the conditions and procedures applicable to such authorizations and notifications, including any limits on the regulatory body's power to impose additional requirements.[394]

The concept anticipates any number of regulators in the same jurisdiction provided the relationship between them is understood. So, for instance regulators dealing with safety and security may be different to those dealing with land use planning and those managing the environment but they should operate effectively together.

4.6.1.2 Regulators dealing with issues associated to land use planning

Regulators apart from land-use authorities will also have a key ancillary role to play in shaping the land use planning debate. The authority tasked with overall responsibility for the regulation of nuclear installations will generally be involved as a key consultee in key planning decisions since they will bear most of the regulatory responsibility for the plant during its lifetime. For instance, in the UK the land use planning decision will be taken by a government minister supported by inquiry from the Infrastructure planning commission (IPC). The local governmental authority for the area has a vital role and will be involved in closely scrutinising the decision as well as in associated issues such as compulsory purchase. This function is performed by the Office of Nuclear Regulation (ONR), responsible for setting, monitoring and enforcing safety and security requirements on nuclear sites. There are a number of other regulators that will have an interest in the land use planning debate such as the Environment Agency (EA), the Department for Transport and the coastal authorities.

It is imperative for project developers to engage with all the regulators from the outset because the land use planning decision maker will expect the applicant to have involved the relevant regulators at the pre-application stage so that the applicant can incorporate those regulators' requirements in proposals.

4.6.1.3 Stakeholder engagement and public participation

As discussed in the previous section, this will be an extremely important feature of most land use planning systems and provides interested parties with the opportunity to influence the outcome of planning decisions. Generally, it is hoped that early consultation will enable problems, including local environmental impacts, to be identified at an earlier stage in the process.[395] Project developers are usually required to take account of the responses to consultation when deciding whether to proceed with a given project and the decision maker will have regard to those responses when making their decisions.[396]

---

[394] Stoiber et al., Handbook on Nuclear Law (2003) at p.3

[395] International Atomic Energy Agency, Nuclear Communicator's Toolbox, http://www.iaea.org/nuccomtoolbox/index.html

[396] US Department of Energy, Communications and Stakeholder Participation, Project Management Practices Rev E., June 2003.

4.6.2 Environmental Concerns

Once the basic decision on the site, design and operating entity are taken, the authorisation process starts. At this stage, the impact of the planned facility on its environment must be assessed in a comprehensive manner. International environmental law and international instruments on nuclear energy provide some of the basis for how nations treat environmental concerns for nuclear power projects.[397]

The IAEA Fundamental Safety Principles[398], which constitute the keystone of the Agency's safety standards[399], establish that the fundamental safety objective with regards to nuclear energy is to protect people and environment from present and future effects of ionizing radiation. This is also reflected in the Convention on Nuclear Safety, Convention on Physical Protection of Nuclear materials (CPPNM), and the IAEA Code of Conduct on the Safety and Security of Radioactive Sources. When the formulation of a nuclear power programme actually starts, the IAEA Milestones Document clearly states that the unique environmental issues associated with nuclear power should be analysed by the IAEA's Nuclear Energy Programme Implementing Organisation (NEPIO).[400] The potential environmental impacts and improvements should be considered as part of the overall nuclear development programme.[401]

The 1992 Rio Declaration on Environment and Development emphasizes the importance of public participation for nuclear power projects and states that at the national level, states should ensure that each stakeholder should not only have access to information but also be participate in the decision-making process about hazardous materials and activities (which includes nuclear energy) in their communities.[402]

A key principle in this regard is the precautionary principle enshrined in the 1992 Rio Declaration on Environment and Development.[403] The precautionary principle in International Environmental Law states that where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. The precautionary principle is an integral part of the principle of nuclear safety[404] and also nuclear law. [405]Very similar to the precautionary principle is the preventive principle, which holds that the primary objective of nuclear law is to promote the

[397] OECD-NEA Environmental Radiological Protection in the Law, A Baseline Survey (2007)

[398] Fundamental Safety Principles, Safety Fundamentals, Safety Standards Series No. SF-1 (2006)

[399] Governmental, Legal and Regulatory Framework for Safety, Safety Standards Series No. GSR Part 1 (2010); Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, Interim Edition, Safety Standards Series No. GSR Part 3 (Interim) (2011); Safety Assessment for Facilities and Activities, Safety Standards Series No. GSR Part 4 (2009); and Milestones in the Development of a National Infrastructure for Nuclear Power, Nuclear Energy Series No. NG-G-3.1 (2007)

[400] Milestones in the Development of a National Infrastructure for Nuclear Power, Nuclear Energy Series No. NG-G-3.1 (2007)

[401] IAEA NG-G-3.1, Milestones in the Development of a National Infrastructure for Nuclear Power, para. 3.13.1.

[402] Principle 10, The 1992 Rio Declaration on Environment and Development

[403] Principle 15, 1992 Rio Declaration on Environment and Development

[404] Handbook on Nuclear Law Vol. I, p. 5 and 6

[405] Principle 15, The 1992 Rio Declaration on Environment and Development

exercise of caution and foresight so as to prevent damage that might be caused by the use of the technology and to minimize any adverse effects resulting from misuse or from accidents.
A third principle common to both nuclear and general environmental law is the polluter-pays principle which, in its broadest definition, states that manufacturers or operators should assume responsibility for the environmental impacts of their products or activities. In nuclear law, this principle is the basis for the requirement that nuclear operators are liable (at least in financial terms) for management and disposal of the waste generated in their facilities.

In addition to the Rio Declaration, the 1998 Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters concluded in Aarhus, Denmark (Aarhus Convention) stipulates that the right to health and clean environment includes the right to access information and participate in decision-making in environmental matters. One notable feature about the Aarhus Convention is also its recognition of the important role that non-governmental organizations (NGOs) promoting environmental protection play in public participation. Under the Aarhus Convention, they are given certain rights. Several countries for example, they are deemed to fulfil the criteria for access to review procedures.

These principles have been incorporated into the national legislation of most IAEA member states which also includes the nations within the scope of this research. Specific institutional arrangements country to country but most procedures for public participation and addressing environmental concerns through assessments are based on general administrative law which requires public participation for the authorization of complex infrastructure projects or potentially hazardous facilities. Often these procedures form part of the nuclear licensing process itself. This is the case, for example, in the US and in Germany. In such a system, either the nuclear regulator additionally fulfils, with appropriate staff and expertise, the functions of the environmental regulator, or the nuclear regulator involves the competent environmental authorities and issues its license only after having received their comments or having obtained their approval. Even in the US and Germany, the competencies of the nuclear authorities in the environmental field are not comprehensive; some separate environmental permits (e.g. for water use) must be obtained from the competent authorities.

4.7 Foreign Vendor's Role in Fairer Negotiation

The world's major suppliers have adopted a common set of principles – the Nuclear Power Plant Exporters' Principles of Conduct[406] to guide them in their decisions and practices in negotiating export contracts, designing facilities and engaging customer states. The said guidelines seem to articulate and consolidate a set of principles reflecting recommended best practices in the areas of safety, security, environmental protection and spent fuel management, non-proliferation, business ethics and internationally recognized systems for compensation in the unlikely event of nuclear related damage, that may influence, national and international governance and oversight. They, however, are at best an industrial initiative to develop norms of corporate self-management in the export of nuclear power plants and have the status of legally non-binding common industrial

[406] Nuclear Power Plant Exporters' Principles of Conduct
https://carnegieendowment.org/publications/special/misc/nppe/principles-of-conduct.pdf

standards to establish shared norms of self-regulation. Though not obligatory, they may be relevant for the suppliers and the recipients in considering transfers of technology.

4.8 Utility of Recommendatory Guidelines

All the IAEA Guidelines and treaties discussed in the previous sections are of recommendatory nature and are not enforceable. It is ultimately up to each country to create their own stakeholder involvement plans. As discussed in Section I, in negotiations for nuclear power projects with foreign developers, embarking countries tend to take a disadvantaged position because of their dependence on foreign technology and expertise. From the perspective of a foreign developer, it is most important to keep the costs of the project low and that all authorizations are obtained without delays. As discussed in Section VI, part of the process of obtaining site, permits, and environmental clearances also involves communicating with concerned communities. In reality though, many times stakeholder involvement is treated as a formality while other aspects like business and political considerations are prioritized. From the perspective of embarking countries in Southeast Asia and sub-Saharan Africa who are already heavily dependent on a foreign supplier, the situation is made worse by the fact that most of the advanced nuclear economies in the West are not open to investing in their nuclear power programs as they consider them to be too risky. So, with limited options in China and Russia, these countries find themselves in an even more desperate situation and all the above considerations tend to not be prioritized.

4.9 India as a Case Study

India is a relevant case study to this topic because it is a developing economy with a fast-growing population and a high demand for electricity. Much like the Southeast Asian and sub-Saharan African countries within the scope of this research, India has been pursuing nuclear energy as a means to maintaining energy security and reducing carbon emissions. Another factor that makes India relevant to the discussion here is that the nuclear power plants recently constructed in India were also build by foreign suppliers from Russia and France specifically.

Currently, nuclear energy provides only about 3% of the India's total energy and the government has planned to construct many additional nuclear power plants. The Nuclear Power Corporation of India (NPCIL) alone wishes to construct 36 imported reactors by 2032. Four 700 MW Pressurized Heavy Water Reactors, two at Rawatbhata in Rajasthan and two at Kakrapar in Gujarat are under construction. Almost all these new projects have faced pushback from the local populations. But the two reactors in Kudankulam district of Tamil Nadu in Southern India that became operational in 2013 in particular have attracted strong resistance ever since the Kudankulam nuclear power project (KKNPP) was announced. Most of the resistance has been due to concerns over nuclear safety and a lack of trust towards the developer as well as concerned nuclear regulatory authority. These fears have been further amplified by the fact that previously the public hearings regarding siting of nuclear power plants in India have not been very effective or transparent given that several nuclear projects have been exempted from public hearings in the past. Apart from safety concerns, residents around KKNPP have also protested the diversion of water for the reactors from a nearby dam which has also caused apprehensions amongst the

surrounding fishing community regarding the impact of the project on their livelihood.

To provide more context, it is important to look into the politically charged backdrop in which he KKNPP was conceptualized. Nuclear energy is generally treated with relative opacity in India and before KKNPP there was lack of public participation in decisionmaking around it. KKNPP was originally planned to be established in technical cooperation with the USSR in 1988 and post its breakup, a supplementary agreement was signed with Russia in 1998. Following this, although conditional environmental site clearances from the Indian nuclear regulatory authority in November 1989, the project remained stalled until 2004. In 2004 however, plans for KKNPP were renewed and the local Pollution Control Board approved the project subsequent to an Environmental Impact Assessment (EIA). Even after approval, plans for KKNPP remained dormant for a while, but it in 2008 it was decided to expand the capacity of the plant and in 2011 KKNPP was close to second stage of commissioning, the Fukushima Daichi nuclear disaster occurred in March 2011. The Fukushima accident caused widespread fear and skepticism towards new nuclear power projects globally and a task force was set up to make recommendation for safety of KKNPP in light of the nuclear safety reforms in the aftermath of Fukushima. This task force made seventeen recommendations, but they were only partially complied with.

After Fukushima, the public opposition towards KKNPP became stronger and the first legal challenge to the KKNPP was filed as a public interest litigation in the Madras High Court (MHC). [407] There were primarily three grounds involved in this legal challenge. First that a fresh and transparent review of the KKNPP should be undertaken, since following the first environmental clearance there was an expansion in the capacity and modernization of the plant. Second, a public hearing should also be held as part of the EIA process and the review process should be undertaken by an independent group of experts. Third, full compliance with the task force's recommendations was yet to be undertaken.

This legal challenge would ultimately reach the Supreme Court of India who upheld the Madras High Court's decision to dismiss it initially. The Supreme Court accepted the economic argument in favor of nuclear energy and found the KKNPP to be in compliance with all safety requirements. However, as a remedy to petitioners, the Supreme Court agreed to direct operator of KKNPP to provide compensation in the form of certain benefits (similar to community benefits discussed in section V) to the groups that were most vulnerable to the impact of KKNPP as part of its Corporate Social Responsibility. The Supreme Court however did not provide any specifics about what this compensation might look like.

The experience at Kudankulam shows how nuclear power projects can become political issues especially when a foreign supplier is involved. The KKNPP was not just about power generation but also represented a step towards enhancing Indo-Russia relations and there was a lot of pressure involved in implementation of the project. The countries in Southeast Asia and sub-Saharan Africa will likely experience something similar when collaborating with an advanced nuclear economy to implement their nuclear power program. Just like in India, it is common for an embarking country's nuclear power program to be heavily controlled by the government with

[407] Writ Petition No. 24770 of 2011 and Writ Petition No. 8262 of 2012 of the Madras High Court.

little public participation. During implementation of the KKNPP this was a major issue. The India administration had to do a difficult balancing act of implementing a very expensive nuclear power project while also trying to maintain good relations with Russia. Amongst all this the concerns of local communities were not sufficiently addressed. This of course led to protests and the ensuing litigation which in turn further delayed KKNPP. All of this could have been avoided with maintaining transparency and making efforts to involve concerned communities in the decisionmaking process from the first day and throughout the process of implementation.

4.10 Conclusion

Given the risks associated with nuclear energy, it is vital to maintain transparency with local populations to ensure that they are kept fully informed about any impact they might face during the lifetime of a nuclear power plant from planning to its decommissioning. Beyond maintaining transparency and communication with local communities, it is also important to ensure that a nuclear power project is negotiated in a manner that ultimately benefits the local communities. Negotiating nuclear power projects is a complex process in which viewpoints from different nations, and stakeholder groups come together to implement a large infrastructural project between multi-jurisdictional entities. The purpose of the analysis in this chapter was to talk about the factors that affect the interests of communities in the vicinity of nuclear power projects. In addition, this chapter also talked about some of the ways that these interests can be safeguarded. One of the biggest hurdles to protecting the interests of local communities is the fact that they are not prioritized in the first place due to other considerations. This chapter talked about the existence of a power imbalance during negotiations between economies in Southeast Asia and sub-Saharan Africa and developed economies with advanced nuclear industries. The countries within the scope of this thesis are largely dependent on foreign vendors to not only supply equipment, but also to construct, operate, and finance nuclear power plants. As a result, countries in Southeast Asia and sub-Saharan Africa find themselves in a disadvantaged position while negotiating with nuclear technology vendors. This is because firstly, these nuclear vendors are from advanced nuclear countries and secondly because most of the vendors in the West are vary of investing in nuclear power projects in embarking countries which leaves these countries with limited options. This creates a power imbalance in the way that nuclear power projects are negotiated, and amongst all the myriad considerations the interests of local communities are often ignored.

A review of IAEA guidelines and international instruments pertaining to project implementation shows that stakeholder involvement and ensuring community benefits is an integral part of fair decision-making with regards to nuclear energy. All of these guidelines are of recommendatory nature and need to be incorporated in national legislation to become enforceable. However, even when incorporated into domestic legislation, public participation in decision-making seems to be treated as a box-checking exercise. This is again, because of the fact that economic and political considerations are often prioritized over interests of affected communities.

India is a good case study in this regard. The Kudankulam nuclear power plant in Southern India was supplied by Russia's Rosatom which is also involved in the nuclear programs in Southeast Asia, and sub-Saharan Africa. Despite the presence of laws in India mandating

comprehensive environmental assessments and public consultation, the implementation of KKNPP lacked transparency and effective stakeholder involvement. As a result, the proposed power plants at Kudankulam were met with strong opposition from the local communities and faced several legal challenges which also delayed its implementation. Similar challenges are likely to arise in implementing nuclear power projects in Southeast Asia and sub-Saharan Africa as well. This chapter emphasizes the importance of foreign developers of nuclear power projects as well as the governments in these regions maintaining complete transparency with all stakeholders while planning and implementing a nuclear power project. Some of the other measures discussed in this chapter that help safeguard the interests of affected communities include in addition to keeping informed, also allowing these communities to become part of decisionmaking at every crucial stage of implementation like siting, construction, expansion, and decommissioning. A big part of being involved in decisionmaking is also to provide these communities an opportunity to negotiate any potential benefits that may be offered to them to offset any impact of the proposed project.

So far, the discussion in this thesis has revolved around the willingness and opportunity for nuclear energy investment in Southeast Asia and sub-Saharan Africa and the different legal issues that affect it. The last chapter discussed additional issues that affect nuclear energy investment from the perspective of foreign developers of nuclear power projects and this chapter looked into the perspective of local communities that may be impacted by these projects, as well as, how their interests can be protected. The next chapter will tie all of these together and make policy recommendations for how exactly the existing international and domestic legal frameworks need to evolve with the changing nature of nuclear power projects.

5 CHAPTER V – BRIDGING THE GAP – OPENING DOORS TO NUCLEAR ENERGY INVESTMENT

5.1 Gaps in law and perspectives between nuclear power project (NPP) stakeholders

Nuclear power projects are capital intensive ventures involving several stakeholders and for their successful implementation it is important to align the perspectives of each of these stakeholders. The preceding four chapters showed the different obstacles and as well as the interests particular to each stakeholder while also pointing out the lack of coordination between them. Chapter I emphasized that though nations in Southeast Asia and sub-Saharan Africa have shown inclination to embark on their nuclear power programs to support growing energy demand and reduce emissions, progress on their nuclear power programs remains slow. Chapter II then pointed out that while these nations have continued to show strong interest in nuclear energy, there are several barriers to incorporation of nuclear energy into their grids. Amongst these barriers are legal issues that affect implementation of nuclear power projects. These barriers pertain to regulation of nuclear facilities, management of liability emerging from nuclear accidents (including spent fuel management), and nuclear non-proliferation.[408]

These barriers also create several uncertainties for private entities from different countries that are becoming significantly involved in nuclear power programs of the embarking nations of Southeast Asia and sub-Saharan Africa as also mentioned in Chapter III. As nuclear power projects are extremely expensive ventures new arrangements in the form of public-private partnerships to incentivize technology development through risk-sharing between the vendors and host governments.[409] Foreign vendors care about their level of involvement in the nuclear power program and the different risks which include economic considerations (recovery of costs, sale of electricity, nuclear liability, financial incentives provided by the host government, and disputes settlement), reputational concerns which revolve primarily around ensuring surety and non-proliferation of nuclear materials. However, beyond economic considerations, a state's nuclear program should be focused on achieving the maximum benefit to the State in which these facilities are to be constructed and operated. With involvement of foreign developers there is of course the risk that they may demand control over project implementation to safeguard their economic interests which may sometimes take priority over the overall interests of the host country and affected populations. Chapter IV talked about how important it is for local communities to have strong voices in the decision to not just embark on a nuclear power project, but also in every decision that might affect them during the lifetime of a nuclear power plant. The most important theme covered in Chapter IV was how the existing mechanisms for stakeholder involvement are inadequate and how nuclear power projects can be negotiated and implemented in a way that adds value to host economies and their populations. One of the recommendations from Chapter IV is to ensure active public participation and coming up with mechanisms for not just ensuring public

[408] Newcomer countries face common challenges in nuclear infrastructure development, IAEA Bulletin April, 2016 Pp. 28-32

[409] Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)

safety, but also smooth implementation by ensuring that surrounding communities are able to derive some benefits out of a nuclear power plant that is being implemented in their vicinity. Chapter IV also talked about the existence of a power imbalance during negotiations between economies in Southeast Asia and sub-Saharan Africa and developed economies with advanced nuclear industries and the importance of foreign developers of nuclear power projects as well as the governments in these regions maintaining complete transparency with all stakeholders while planning and implementing a nuclear power project.

The purpose of this thesis is to explore areas where common ground exists for all stakeholders involved in a nuclear power program to pave the way for fairer negotiation and safe implementation of nuclear power projects. This chapter will first analyze the commonality of interests as well as the obstacles faced by the different stakeholders in a nuclear power project. Secondly, this chapter will look at how the lack of coordination between the international nuclear legal framework and different domestic regimes leaves many stakeholder concerns either unanswered or inadequately addressed. Lastly, this chapter will analyze how stakeholder perspectives can be bridged together to ensure that nuclear power projects are implemented in a way that protects the interests of the host countries, their populations, as well as the interests of foreign developers/vendors of nuclear technology. This chapter will also include recommendations for changes to the existing international nuclear legal framework to create more uniformity and encourage international collaboration on nuclear power projects.

5.2 Finding Common Ground – Takeaways from Previous Chapters

There is a great deal of similarities between the interests as well as the obstacles faced by different stakeholders involved in a nuclear power project. For the purposes of this thesis, the stakeholders covered are embarking states, foreign vendors, and local communities. Some of the common interests include the financial issues, certainty in implementation, and safety.

One of the major themes discussed in this thesis is that of the disconnect that exists not just between the different legal instruments that constitute nuclear law, but also the lack of coordination between the different stakeholders involved in a nuclear power project. Host governments want projects to be implemented safely and expeditiously but often find themselves constrained by the financial limitations and even more limited options for vendors who may be interested in investing in their nuclear power program. From the perspective of vendors, the uncertainties of implementing a nuclear power project in an embarking state may be a major deterrent factor for them to take up implementing the project. Lastly, communities that are close to nuclear power projects are apprehensive of the impact of such a project on them and may therefore be strongly opposed to its implementation which can result in unexpected delays and cost overruns. Previous chapters demonstrated that despite the difference in their respective interests, there are several commonalities between the obstacles faced by all three stakeholders like difficulties in financing a nuclear power plant, the complicated nature of the existing nuclear liability which add to uncertainties of implementation and create the risk of scenarios where inadequate attention is paid to the voices of the local communities who may be vulnerable to the impact of a potential nuclear accident and more immediately loss of land and environmental degradation. However, while there are common obstacles faced by each stakeholder in implementing a nuclear power project, currently there is a lack of cooperation between them due to the fact that each of them experience

these obstacles differently.[410] The purpose of the discussion in this section is to find areas where each of these stakeholders can find some common ground.

5.2.1 Common Interests and Obstacles

5.2.1.1 Financing a nuclear power project

Given the large financial and institutional commitment required to support all activities, governments of countries within the scope of this dissertation tend to incline towards minimizing the amount of equity that they wish to commit to the NPPs and opt for vendor financing. But this is a large undertaking for vendors as well because nuclear power plants on average cost between USD 4-10 billion and are also prone to cost overruns during implementation which makes them even more expensive.[411] The Philippines[412] and South Africa[413] for example have faced the issue of massive cost overruns in pursuing their nuclear power plans.[414] It is important to also point out that in addition to costs, the risk of potential nuclear accidents and the background of Three Mile Island, Chernobyl, and more recently Fukushima have also affected embarking countries' willingness to continue with their nuclear power programs resulting in project cancellation and delays that add on to the existing high costs. One of the mechanisms however that has been popular are public private partnerships in the form of build-own-operate model which provides some risk-sharing between a foreign vendor and host governments. The China National Nuclear Corporation (CNNC) and Rosatom for example have signed agreements with the countries in Southeast Asia and sub-Saharan Africa under which they will finance the construction and operation of nuclear facilities, as well as own them for sale of electricity to local power companies at an agreed price. Arrangements like these, however, are capable of putting these nations in a position where they have little to no control over the course of these transactions and how they will impact their own citizens. In this context, as emphasized in Chapter IV, financial considerations may take precedence over effective public engagement and environmental protection measures. However, this creates an opportunity to find common ground because the above also impedes the credibility of the vendor and undermines the ability of the state to safely implement a nuclear power project

---

[410] See Sections 3.1 and 3.2 of Chapters 3 and Section 4.2.1 of Chapter 4.

[411] Nuclear Power Economics, World Nuclear Association 2020
https://world-nuclear.org/information-library/economic-aspects/economics-of-nuclear-power.aspx#:~:text=Its%20November%202016%20report%2C%20Capital,%2FkW%20(overnight%20cost).

[412] S. Hoffman, Phillipines: Asia Pacific Energy Series Country Report, Energy Program Resource Systems Institute, November 1988
https://www.osti.gov/servlets/purl/6368191

[413] Sub-Saharan Africa and nuclear energy, World Nuclear Association, April 2018
https://www.world-nuclear-news.org/V-Sub-Saharan-Africa-and-nuclear-energy-23041802.html

[414] Ryan Collyer, acting CEO of Rosatom Central and Southern Africa, correspondence with *POWER Magazine*, Darrell Proctor, Philippines Taking New Look at Nuclear Power, Power Magazine October 1, 2020
https://www.powermag.com/russia-china-drive-africas-plan-for-nuclear-expansion/

leading to project delays and litigation which can be extremely expensive. For any large scale project that has the potential to impact surrounding communities and a country's economy in general, credibility of the government embarking on such a project and that of the vendor chosen by it are critical. There have been examples of nuclear power projects in the US that remained stalled for a long period of time causing major cost overruns like for the VC Summer nuclear power project which ended up costing USD 9 billion partially due to cost overruns as a result of lack of public acceptance and regulatory/permitting delays and the level of consumer engagement in planning the project and in allocating the cost of the plant.[415]

As there is a lack of data of negotiations and the construction of nuclear power projects in Southeast Asia and sub-Saharan Africa, some insights can be gained from negotiations of other large scale projects. In Vietnam for example, owing to lack of public engagement in siting led to locals protesting the construction of a wind power project in the Thanh Hai Commune citing concerns related to damage to their homes and farmland.[416] These protests caused project delays resulting in added costs of USD 4.37 million. Apart from renewable power projects, coal projects have also met with strong opposition in Vietnam due to lack of public involvement in siting and the impact of the plant's operation on surrounding air quality, it is however unclear if these protests and general opposition to the construction of these plants led to cost overruns.[417] There are however reports that Samsung's Construction and Trading Security Arm who is also involved in Vietnam's coal power plants have decided to withdraw from involvement in construction of any new coal power plants amid opposition and reputational concerns.[418]

5.2.1.2 Fear and opposition towards a proposed NPP

Given the risks associated with nuclear energy, it is vital to maintain transparency with local populations to ensure that they are kept fully informed about any impact they might face during the lifetime of a nuclear power plant from planning to its decommissioning. However, in the past a more technocratic approach has been taken towards public engagement[419] in nuclear

---

[415] Robert Walton, SCE&G customers could grab $146M in VC Summer settlement, largest in state history, utility Dive June 14, 2019 https://www.utilitydive.com/news/sceg-customers-could-grab-146m-in-vc-summer-settlement-largest-in-state/556877/

[416] Farmers in Vietnam's commune protest wind power project over alleged house, crop damage, Tuoi Tre News, December 21, 2021 (Accessed February 4, 2023) https://tuoitrenews.vn/news/society/20211221/farmers-in-vietnams-commune-protest-wind-power-project-over-alleged-damage/64838.html

[417] Le Quynh, Vietnamese provinces say 'no' to coal power as central government, industries build more, Earth journalism Network 11 March 2019 (Accessed January 18, 2023) https://earthjournalism.net/stories/vietnamese-provinces-say-no-to-coal-power-as-central-government-industries-build-more

[418] Samsung C&T announces coal exit, November 27, 2020 (Accessed January 25, 2023) https://trading.samsungcnt.com/EN/trading/ne/501000/articleRead.do?board_id=6&article_id=4904&page_index=4

[419] Reuben Holmes et. al, Public Engagement in the Nuclear Sector: A UK and EU Perspective EU08051/06/10/01 Issue 3 (October 2016) https://www.nnl.co.uk/wp-content/uploads/2019/12/EU08051-06-10-01-Issue-3-Public-Engagement-in-the-Nuclear-Sector-A-UK-and-EU-Perspective.pdf

power projects which has not helped build public confidence towards nuclear energy especially with the background of Chernobyl and Fukushima accidents. The possibilities of local communities and stakeholders opposing the project creates big uncertainties for vendors in implementing nuclear projects. For example, the Kudankulam nuclear power plant in Southern India which was supplied by Russia's Rosatom was met with strong opposition from the local communities and faced several legal challenges which also delayed its implementation. This delay caused in part by opposition to the project and technical hurdles led to major cost overruns of up to USD 2.7 billion.[420] As also discussed above this scenario creates incentives for all stakeholders to initiate public engagement earlier in order to ensure smooth implementation with greater certainty around costs and project completion. In Thailand for example, the level of public acceptance for nuclear energy is quite low and before initiating plans to build its nuclear power plant as part of its power development by 2036[421], signed an MoU with Russia to begin with technical cooperation and public education to pave the way for integrating nuclear into its energy mix.[422] This is why there is an incentive for vendors as well governments to prioritize public engagement to establish public trust towards the entities involved in implementing the program. As part of their Memorandum of Understanding with Rosatom, countries in Southeast Asia have also made agreements for long-term cooperation in public education and awareness. The effectiveness of these measures however remains to be seen as the first reactors in Southeast Asia are planned to begin operation by 2030.

5.2.1.3 Lack of infrastructure

Developing states face unique challenges and often lack the finances, institutional capacity, and physical infrastructure to support a large-scale, multibillion-dollar nuclear power plant project, even if the costs are spread out over several years. From the perspective of host governments it is not only the actual project construction and maintenance costs but also the cost of establishing the appropriate institutional framework around its nuclear power program. Also, large traditional nuclear facilities are generally extremely capital-intensive and expensive to build and maintain and require minimum grid capacity of 10,000 MW.[423] From the perspective of vendors, it can be hard from them to make a decision to invest in the nuclear power program of a country that does not have the technical and the institutional infrastructure to successfully implement its nuclear power program. Therefore, it may make sense for countries negotiating nuclear power projects with a foreign vendor to enter into technical cooperation for infrastructure development which will ultimately benefit the host country's economy and provide the infrastructure needed by the vendors

[420] CAG faults NPCIL for cost overruns on Kudankulam Nuclear Power Plant, Nuclear Asia, December 28, 2017 (Accessed January 25, 2023)
https://www.nuclearasia.com/feature/cag-faults-npcil-cost-overruns-kudankulam-nuclear-power-plant/1743/#:~:text=The%20national%20auditor%20noted%20that,22%2C462%20crore%20in%202014.

[421] T. Energy Policy and Planning Office, Thailand Power Development Plan (2015-2036), in, Ministry of Energy, Thailand, Bangkok, Thailand, 2015, pp. 78.
[422] Nur Azha Putra, The dynamics of nuclear energy among ASEAN member states, Energy Procedia, Volume 143, 2017, Pages 585-590
https://doi.org/10.1016/j.egypro.2017.12.731.
[423] International Atomic Energy Agency (IAEA), Financing Nuclear Power in Evolving Electricity Markets April, 2018 at p.6

to implement the project.[424]

5.2.1.4 Lack of interest among most advanced nuclear economies to invest in NPPs in Southeast Asia and sub-Saharan Africa

Beyond the strategic consideration of host states to enter nuclear power project agreements, vendors from countries exporting nuclear technology have their own set of political objectives. Western economies with advanced nuclear power programs and especially the US were initially perceived as leaders in nuclear technology however, they now face tough competition from Russia and China. Russia and China are the major players making nuclear energy investment in Southeast Asia and sub-Saharan Africa as a means to expand their global influence. In addition, Rosatom also has access to place its employees at Russian embassies to facilitate deals for nuclear power projects. Similarly, China too is competitively pursuing nuclear investment in Argentina, Brazil, the Czech Republic, Kenya, Malaysia, Thailand, Turkey, South Africa, and Saudi Arabia.

From the perspective of host governments, there is a lack of choices because they are already heavily dependent on foreign suppliers, and most of the advanced nuclear economies in the West are not open to investing in their nuclear power programs as they consider them to be too risky. So, with limited options in China and Russia, these countries find with little negotiating leverage in order to prioritize foreign investment in their nuclear power program over the interests of local communities potentially impacted by the NPP. With higher competition, embarking states would have more options to choose and a better position to negotiate the terms of investment in their nuclear power program.

5.2.1.5 Lack of uniformity in regulatory structure

Although he IAEA safety standards establish fundamental safety principles, requirements and measures for the safety of radioactive material to mitigate the consequences of a nuclear accident, they are not binding upon states and are issued in the form of guidelines. Given their recommendatory nature, states can choose to incorporate into their domestic framework to facilitate trade. This creates uncertainties for vendors as from their perspective a strong regulatory structure helps them have certainty in implementation as a good regulator will enjoy public confidence. From the perspective of vendors and host states it would therefore make sense enter into early cooperation to help build an optimal safety and regulatory framework. There is also a role for the IAEA here because the IAEA has in the past sent INIR and OSART missions to embarking countries to ensure that there is infrastructural and legal framework readiness for implementation of a nuclear power project in a country. As mentioned earlier, there are such agreements signed with Southeast Asian countries between their vendors and the IAEA to do the early work on ensuring that these frameworks are in place before a vendor invests heavily in a program.

5.2.1.6 Lack of uniformity in legislation on nuclear liability management

Review of various Nuclear Liability Regimes in force in different parts of the world and the ones which are yet to come into force and national approaches in different states reveals that a

[424] See section 4.7 of Chapter 4.

consensus on an ultimate Nuclear Liability Regime is yet to go through a long process of metamorphosis. The Chernobyl accident was an eye-opener to the need for a viable and more effective international nuclear liability and compensation regime. Efforts have been made nationally, regionally and internationally as evident in the amendments and creation of newer nuclear liability regimes. Notwithstanding these efforts, there are still big lacunae in the nuclear liability regime. This leaves several advanced as well as embarking states uncovered by any uniform globally recognized instrument on managing nuclear liability. In Asia alone, China, South Korea, Taiwan, Iran, and Pakistan are all not party any nuclear liability convention. This is quite problematic if one factors in the possibility of transboundary damage. Absence of reciprocity or cooperation regarding claims settlement etc. between these states especially endangers the victims and industry stakeholders. Embarking on a nuclear power project would therefore require the host governments to work with international organizations and have dialogues with vendors while making its decision to become signatory to the apt international instrument concerning nuclear liability (see Chapter II Section III). For example, India was initially not a party to any conventions on nuclear liability. However, in order to invite more investment in its nuclear power program and to address concerns related to availability of compensation to victims of a nuclear accident, India join the Convention on Supplementary Compensation in 2016. This was a significant step in the growth of India's commercial nuclear power program as it allowed foreign vendors more certainty about the limits on their exposure from a potential nuclear accident.

5.2.1.7 Nuclear Energy and National Development

Investments in a state's nuclear industry can be an important driver of its economic development. The impact on the national economy is mainly economical and financial, but the achievements are not limited to safe and reliable operation and management of nuclear power plants. Construction and upgrade of nuclear power plants, waste treatment and storage facilities, production of devices utilizing radioactive materials can increase a state's technical capabilities, enhance the industrial status of the country and stimulate the industrial activity in localities – resulting in the development and progress of the embarking state's overall economy. In addition, there are ways in which nuclear power projects can also create benefits for local communities. For example, although not from an embarking state, the Hinkley Point C project in the UK will create about 25,000 employment opportunities, and 900 permanent jobs during its 60-year lifecycle with its overall contribution to the local economy being GBP 1.5 billion during construction, and about GBP 40 million a year during operation.[425]

As the scope of the supply is broad and significant, the desire of the engagement by the suppliers of the local industry brings additional benefit to the country. Cooperation may result in new technical solutions. This way, relations may be assisting to the development of new industrial areas and/or contributing to the global increase of the local economy. Nuclear investments intensify the technical communication between the scientific institutions of the suppliers and the institutional background of the recipient country. The control of the installation process, the review of the completion, the inspection of the supplied equipment and techniques at the site require measures and quality control of wide range. Developed on

[425] Creating high-value jobs in the post-COVID-19 recovery with nuclear energy projects, OECD-NEA Policy Brief June 2020
https://www.oecd-nea.org/news/2020/covid-19/post-covid-19-recovery/policy-brief-2-jobs-in-nuclear.pdf

nuclear basis of new techniques and technologies can be used for the benefit of the other sectors of the economy. Even in the case of BOO projects where there is little or no request in participation from the local personnel and industry in construction and installation works. Nuclear projects involve a range of non-delegable technical, safety, environmental and other tasks that will increase the overall domestic technical capabilities. A crucial aspect of a nuclear investment program, particularly for new entrants, is a thorough study of the technology during the installation stage. The installation process provides the opportunity to the future operator to examine equipment and systems in their clean and open status before any radioactive contamination may occur. This experience is one of the most important in order for being fully aware of the technology and being prepared to conduct operation and maintenance works. Maintenance experts even may participate in the installation works under the control and management of the supplier.

5.3 What should nuclear power projects in Southeast Asia and sub-Saharan Africa look like in the future?

The discussion in this thesis began with outlining the driving factors and opportunities present in Southeast Asia and sub-Saharan Africa for investing in their nuclear power program. Since then, this thesis has mainly talked about all the obstacles that exist in actually implementing these nuclear power projects while also emphasizing the alarming risks that exist to local communities if these projects are not implemented in a safe and transparent manner. Ultimately, this thesis does not make a recommendation as to whether these nations should or should not pursue nuclear energy but the purpose for the discussion below is to help gather knowledge from other industries and countries that may be relevant for the stakeholders in a nuclear power project. Although there are no strict rules or procedures for implementation activities, the following recommendations touch upon some of the factors that need to be present if the economies in Southeast Asia and sub-Saharan Africa choose to embark on their nuclear power programs:

5.3.1 Local communities as allies – open and collaborative decision-making

5.3.1.1 Community involvement in Siting and Operation

It is really important that local communities are seen as allies rather than an obstacle while planning and implementing a nuclear power project to create a win-win solution where the vendor can successfully implement the project without delays and the local communities can also benefit from the project. It is however important to note that public engagement may in itself lead to project delays as will be discussed later in this section. Chapter IV discussed how local communities can be affected in the implementation process for a nuclear power project. The overall human and environmental impact of oil exploration and drilling in the Niger Delta is a relevant example to get learnings about how large-scale projects in the energy sector can turn exploitative and have negative impact on a country and its population. Nigeria is one of largest petroleum producers and oil exploration began there in 1956 with a joint venture between the

Royal Dutch Shell and the British Government.[426] Since then, there have been approximately more than 7000 oil spill incidents and severe environmental impact like pollution of soil and farmlands due to gas flaring (resulting from drilling) which has caused destruction of the livelihoods of the local communities – the Ogoni people.[427] An important thing to note here is that although Shell has operations worldwide, its operations in Nigeria alone account for 40% of its oil spills worldwide which is very different from the experience of its operations in the US and Europe.[428] Apart from oil spills, the process of oil extraction leads to release of large amounts of natural gas which needs to either be conserved or disposed. Capturing, transporting, and processing this gas is a much more expensive process to oil companies who have resorted instead to a very polluting method – burning or flaring.[429] Regardless of environmental protection laws, gas flaring has been the most common method of disposing of the natural gas released in the process of oil extraction.[430]

In the face of corrupt government practices which were leveraged by Shell in undermining local community rights, the Ogoni people became organized as the Movement for Supporting the Ogoni People (MOSOP) which asked for involvement of the Ogoni people in decisionmaking and share of the proceeds of oil extraction, and remediation of environmental damage.[431] Unfortunately however all the main leaders of this movement were executed sparking international outrage. In addition, the opposition from locals also caused several issues for Shell including pipeline sabotage causing major losses to Shell, kidnapping of employees, oil theft, and gang violence[432] made the Niger Delta an extremely complex operating environment for Shell.[433] This also led to Shell having to close oil pipelines earlier than expected.[434]

The alarming example from Nigeria is extremely relevant because it shows how a large project driven by economic factors, can turn into a large exploitative process for locals. One of the lessons from Nigeria is how important it is to have an open dialogue with the local communities at the outset and not see them as an obstacle but rather treat them as allies.

5.3.1.2 Community involvement and Operational Safety and Preparedness

Community engagement is also an important factor with regard to emergency preparedness and safety. After Chernobyl and Fukushima, the need for public engagement for nuclear new build

[426] Steve Kretzmann, "'Nigeria's Drilling Fields': Shell Oil's Role in Repression," Multinational Monitor 26, no. 1-2 (January/February 1995).
[427] Steven Cayford, Africa Today , Apr. - Jun., 1996, Vol. 43, No. 2, Conflict and Conflict Resolution in Africa (Apr. - Jun., 1996), pp. 183-197
[428] Kretzmann, "'Nigeria's Drilling Fields"
[429] R.A. Olu Sule, The Environmental Pollution Consequences of Nigerian Oil Boom: The Socio-Economic Calamity of Oil Spillage in the Delta Region, GeoJournal , 1982, Vol. 6, No. 5, Miscellanies in Economic Geography (1982), pp. 443-452
[430] Okonkwo, C.N.P., Kumar, L., Taylor, S. (2015), The Niger Delta wetland ecosystem: What threatens it and why should we protect it? African Journal of Environmental Science and Technology, 9(5), 451-463.
[431] Human Rights Watch, *The Ogoni Crisis: A Case-Study of Military Repression in Southeastern Nigeria*, 1 July 1995, available at: https://www.refworld.org/docid/3ae6a7d8c.html [accessed 5 May 2022]
[432] Ghazvinian John. "The Curse of Oil: Niger Delta, Nigeria, 2005." *The Virginia Quarterly Review*, vol. 83, no. 1, 2007, pp. 4–27. *JSTOR*, http://www.jstor.org/stable/26444733. Accessed 6 Feb. 2023.
[433] Hennchen, Esther. "Royal Dutch Shell in Nigeria: Where Do Responsibilities End?" *Journal of Business Ethics*, vol. 129, no. 1, 2015, pp. 1–25. *JSTOR*, http://www.jstor.org/stable/24702884. Accessed 6 Feb. 2023.
[434] Shell shuts 25,000 bpd oil pipeline in Nigeria due to theft damage, Reuters NOVEMBER 11, 2012 (Accessed February 5, 2023)
https://www.reuters.com/article/cbusiness-us-shell-nigeria-idCABRE8AA09Z20121111

has become even more important and the two major factors of public perception include – fear towards nuclear energy and distrust towards the governmental institutional framework around nuclear energy. [435] In the Niger Delta for example, lack of public engagement first caused the violation of the rights of Ogoni people and then led to mass public opposition which also involved sabotage of pipelines leading to further oil spills than were already occurring due to Shell's negligence. Lastly, lack of any form of disaster preparedness and negligence of Shell and the government in clean up led to further environmental damage.[436] Similarly, during Chernobyl the lack of emergency preparedness led to further damage to human life as even the firefighters on scene were not aware of the methods to handle radioactive debris and the locals were unable to evacuate immediately[437], and there was also an epidemic of thyroid cancer in neighboring areas due to inadvertent consumption of contaminated food.[438]

In the case of Fukushima an independent investigation by the Diet[439] revealed that Japan was not prepared for the simultaneous earthquake, tsunami, and the nuclear accident and more importantly, Japan was unprepared for the nuclear accident even if the earthquake and tsunami had not occurred. This was partially because the possibility of a critical nuclear accident was considered so unlikely[440] that planning for such an event was not treated seriously.[441] Although none of the workers or surrounding population received a dangerous level of radiation the level of unpreparedness was an alarming find and emphasized the need for reconsidering how the risks of nuclear energy are both evaluated and informed. The above examples show the level of risks that local communities are exposed to as a result of a nuclear accident. This is why it is important to ensure that all stakeholders involved in a nuclear power project prioritize educating local communities about the risks involved in the implementation and operation of a nuclear power project in order to prepare plans for safe evacuation and remediation in the case of a nuclear accident. Given the potential risk exposure to the local communities, it is also fair for them to be involved any decisionmaking process especially for a large project involving hazardous substances.

---

[435] Adrian Bull et. al., NUGENIA: Developing an 'EU Nuclear Public Engagement Toolkit' EU08051/06/10/02 Issue 3 (2016) https://www.nnl.co.uk/wp-content/uploads/2019/12/EU08051-06-10-02-Issue-3-NUGENIA-Developing-an-EU-Nuclear-Public-Engagement-Toolkit.pdf

[436] Omenyi Tonia, Oil Resource Management: Lessons from Canada and Nigeria at p. 74 DOI10.13140/RG.2.2.15815.52649

[437] Svetlana Alexeivich, Voices from Chernobyl

[438] Cardis E, Krewski D, Boniol M, Drozdovitch V, Darby SC, Gilbert ES, Akiba S, Benichou J, Ferlay J, Gandini S, Hill C, Howe G, Kesminiene A, Moser M, Sanchez M, Storm H, Voisin L, Boyle P. Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident. International Journal of Cancer. 2006;119(6):1224–1235.

[439] NAIIC (Nuclear Accident Independent Investigation Commission). The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission. Tokyo: National Diet of Japan; 2012.

[440] Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants, Chapter 4

[441] NSC (Nuclear Safety Commission). Emergency Preparedness for Nuclear Facilities (May 2007), Chapter 2: Sections 2.1, 2.2, 2.6; Chapter 3: Sections 3.1, 3.2; Chapter 5; and Appendixes D, F, J, L, and N (Technical Language Service, Trans.). Tokyo: Government of Japan; 2013. www.nsr.go.jp/archive/nsc/anzen/sonota/houkoku/bousai220823.pdf

5.3.1.3 Approaches to Public Engagement

The UK is a relevant case study to see how early communication and efforts toward building public trust and confidence can also help host governments and other stakeholders involved in implementing a nuclear power project. As was common globally as well, initially the approach taken by the nuclear industry towards the public was very focused on technical risk assessments rather than the opinions and fears of the public. This is also known as the "Decide-Announce-Defend" (DAD) approach where decisions are made by the scientific community without meaningful dialogue with the public and later a defensive approach is taken rather than a collaborative one in communicating the decision where the public was only informed of facts that were perceived by technical experts as relevant.[442] This of course led to a lack of trust between the nuclear industry and public,[443] as was also evident in 1997 from the failure of UK's deep repository program for radioactive waste disposal due to lack of public support resulting in an inability to plan for long-term disposal of nuclear waste in the UK.[444] This however also led to a realization that the approach towards public engagement needs to shift to a more collaborative and transparent one where now UK's nuclear energy has worked with government and non-government or non-profit organizations as well as public stakeholders to over time build public trust and confidence through open and informed dialogue.[445] Parallel to this can also be drawn between the experience in UK to that of the failure of the Nuclear Waste Policy Act of 1982 in the US that involved the US Congress beginning with a centralized technocratic-meritocratic approach nuclear waste management. This process however became derailed in between political maneuvers which resulted in Yucca Mountain being chosen as the site of the repository in a manner that was not transparent or involved meaningful participation from relevant stakeholders. This resulted in further delays and ultimately failure to implement the repository at Yucca Mountain in the face of strong opposition from the State of Nevada.[446] In addition, the opposition from the State of Nevada was due in part from the lack of trust in the Nuclear Regulatory Commission's licensing process and whether it would be unbiased and transparent given the frequent interaction between the Department of Energy and the NRC. This led the state to oppose the project hoping that it would ultimately be abandoned.[447]

The examples from the UK and Yucca Mountain show the importance of effective and meaningful engagement from stakeholders in key stages of decisionmaking with regard to nuclear facilities. On the contrary however, Sweden where environmental legislation mandating public consultation has gone a step ahead and given the local municipality consisting of elected municipality

---

[442] Whitton, J. (2010) 'Participant Perceptions on the Nature of Stakeholder Dialogue Carried Out by the UK Nuclear Decommissioning Authority (NDA)', PhD Thesis submitted to the University Of Manchester.
[443] Reuben Holmes et. al., Public Engagement in the Nuclear Sector: A UK and EU Perspective EU08051/06/10/01 Issue 3, October 2016 at p. 24
[444] Elam, M. and Sundqvist, G. (2007) 'Six Domains of Decision for Stakeholder Involvement in Nuclear Waste Management', CARL Thematic Report No. 4; Bergmans, A. (2008) 'Stakeholders in Radioactive Waste Management and their Networks', CARL Thematic Report No. 3; Elam, M. and Sundqvist, G. (2007) 'Fission or Fusion? Reconciling Technical and Social Aspects of Radioactive Waste Management', CARL Thematic Report No. 5.
[445] Leslie-Anne Duvic-Paoli and Priska Lueger, A democratic nuclear energy transition? Public participation in nuclear activities, February 2022
[446] Stewart, Jane Bloom, and Richard Burleson Stewart. *Fuel Cycle to Nowhere: U.S. Law and Policy on Nuclear Waste.* Nashville: Vanderbilt University Press, 2011. muse.jhu.edu/book/10361 Pp. 207-209.
[447] Marta Adams, Yucca Mountain - Nevada's Perspective, Idaho Law Review Vol. 46 1-26 https://ag.nv.gov/uploadedFiles/agnvgov/Content/Hot_Topics/Issue/nvag100412perspective.pdf

officials the power to veto implementation of a new project sheds light on another aspect to consider.[448] Although a powerful mechanism for preventing public consultation becoming a box-ticking aspect, SKB which is the Swedish Nuclear Fuel and Waste Management Company held a consistent consultation process[449] with the public lasting about 10 years. By the end of this long consultation public support for the nuclear waste repository rose to 80%.[450] Yet, an important question to ask is whether such extensive public consultation is conducive to quick implementation of nuclear power projects. Unlike Sweden, a 10-year consultation period may not be a viable option for embarking states in Southeast Asia and sub-Saharan Africa and may also make the process of implementing a project for vendors too time-consuming and uncertain. There are however other approaches that can be taken to ensure that enough time has been set aside for public engagement and consultation for nuclear new build in these regions. So far, the first few reactors are expected to come online in Southeast Asia by 2030 and some of these states have already invited the IAEA to conduct initial reviews of their infrastructure and are also receiving assistance from the IAEA in drafting the requisite legislative framework required for operation of commercial nuclear facilities. One of the vital elements to these early steps needs to be efforts to open public dialogue and education about the project. With IAEA involvement comes a greater deal of credibility as it is an independent organization represented by all nations. The IAEA is also sufficiently removed from influence of national governments and industry stakeholders such that it can be ensured that their primary goal would be ensuring that the NPP is implemented safely. Given the fact that there is still a considerable amount of time left until we see the first few nuclear power projects coming up in southeast Asia and sub-Saharan Africa, it would be a sensible approach to initiate IAEA's involvement in key decision stages. Since there is likely to be a considerable knowledge gap between the host government and foreign vendor, involvement of independent expertise can help ensure that safety considerations are not ignored. It is however pertinent to note that the involvement of IAEA experts may not necessarily help create a substantial open dialogue with local community stakeholders, since highly technical experts may be seen as unapproachable. On the other hand however, it is also not realistic to hold a long public consultation process similar to that of the UK and Sweden. As noted in Chapter I, countries in Asia and Africa account for about two-thirds of the global electrification deficit and four-fifths of the global deficit in access to non-solid fuels, and account for nearly 80% of people across the world living without access to energy.[451] These nations are classified as high-impact countries[452] by the International Energy Agency, and represent countries with the highest gaps in access to electricity and clean cooking.

---

[448] Thegerstrom, C. and Engstrom, S.L. (2012) 'Deep Geological Disposal of Nuclear Waste in the Swedish Crystalline Bedrock', International Journal for Nuclear Power, vol. 59, no. 6

[449] Thegerstrom, C. and Engstrom, S.L. (2012) 'Deep Geological Disposal of Nuclear Waste in the Swedish Crystalline Bedrock', International Journal for Nuclear Power, vol. 59, no. 6

[450] Ahagen, H. (1999), The Oskarshamn Model for Public Involvement in the Siting of Nuclear Facilities, IAEA NCL Collection Store, SE0000124.

[451] Sustainable Energy for All (SEforALL) and the Climate Policy Initiative (CPI). 2018. Energizing Finance: Understanding the Landscape, 2018: Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries." SEforALL and CPI, Washington, DC p.10

[452] Afghanistan, Angola, Bangladesh, Burkina Faso, Congo (DR), Ethiopia, India, Kenya, Korea (DPR), Madagascar, Malawi, Mozambique, Myanmar, Niger, Nigeria, Philippines, Sudan, Tanzania, Uganda, and Yemen for electricity. Bangladesh, China, Congo (DR), Ethiopia, India, Indonesia, Kenya, Korea (DPR), Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Philippines, Sudan, Tanzania, Uganda, and Vietnam for access to clean cooking.

In this scenario, embarking countries in Southeast Asia and sub-Saharan Africa will likely need to consider their trade offs and decide whether a long consultation process is worthwhile to delay implementation of nuclear power projects that will supply much needed carbon-free electricity.

5.3.1.4 Communicating benefits of nuclear energy

Implementation of a nuclear project can also have positive impact on many sectors of the social life as well and this positive impact if communicated to and understood by local communities can really help improve the acceptance level for the NPP. As was also seen in the case of the Bataan Nuclear Power Plant in the Philippines, the level of acceptance for renewing its operations was higher when people understood the various benefits to be derived from the plant including, environmental benefits.[453] Use of nuclear technology initiates and helps in adaptation of new medical service requirements, and also triggers regular monitoring of the environment and in strong control of releases. Other important positive consequence is establishment of education programs in relevant nuclear disciplines for the preparation of future generations of nuclear experts, both as a precondition for conducting nuclear projects and to ensure the successful operation of nuclear facilities over their very lengthy lifetimes. Beyond just generating electricity, there are also opportunities for host governments to leverage nuclear technology for other areas to promote its growth. In 2021, nuclear energy industry members also published a report highlighting how nuclear energy can contribute to the UN Sustainable Development Goals by helping eliminate hunger (through food irradiation technology and nuclear techniques to develop new plant seeds), improve health (radiotherapy and nuclear medicine), providing access to affordable and clean energy, generating decent work and economic growth, and mobilizing climate action.[454]

All of the above however is only possible depending on the nature of technical cooperation with the supplier which usually forms part of the contract for a project. Ultimately, transparency, benefit of the local communities, and safety of the nuclear power plant help eliminate the risk of opposition and resulting delays in implementation of a project as well as ensure safe and profitable operation of the power plant. Therefore, at the time of negotiating project cooperation agreements, both the vendors and host governments need to be mindful of the above in ensuring their shared interest in the safe, reliable and economic operation of the nuclear project.[455]

5.3.2 Holding vendors accountable

The nuclear industry had for a long time enjoyed special privileges since the 1950s and the Atoms for Peace movement. As explained in Chapter II, the principle of Exclusive liability applies in the case of nuclear accidents which means that in the case of an accident, all claims are to be brought against the entity operating the nuclear power plant – nuclear operator. This is known as legal channeling of liability and it applies regardless of the accident's cause. By this legal mechanism, suppliers or builders of the plant not involved in its day-to-day operations are protected from public litigation in the case of an accident. Another purpose of legal channeling of liability is that it simplifies the process because claimants do not have to

figure out who is responsible as under law it will be the nuclear operator. Under the ordinary rules of civil liability, should an incident occur due to a defect in services, material or equipment supplied, the persons suffering damage may well have a right of action against any person who has supplied or manufactured such services, material or equipment in connection with the planning, construction or operation of a nuclear installation.[456] For example, such a right may derive from rules relating to so-called "product liability".[457] As noted earlier, one of the purposes behind this legal channeling of liability to the operator was to support the growth of nuclear industry. It is a fair question to ask if it is in the best interest of the countries within this thesis to not have any way of holding the vendor of nuclear technology liable. From the perspective of embarking nations, the concept of protecting nuclear suppliers in order to foster the nuclear industry may not be of prime importance. Rosatom (Russia), CNNC (China), KEPCO (South Korea), and EDF (France) who are the primary nuclear suppliers have existed since 1950s. For countries that are just beginning their nuclear power programs find themselves dependent on these suppliers for technical and financial aspects of implementing a nuclear power project and the concept of protecting the suppliers from liability may not be an appealing prospect for them given also the financial incentives for foreign suppliers to participate in the nuclear power programs of the countries in Southeast Asia and sub-Saharan Africa. It is of course worth noting that this may deter suppliers of nuclear technology. As seen in the case of India, Section 17 of its Civil Liability for Nuclear Damage Act, 2011 extends the liability to the suppliers of nuclear equipment. After this law was passed in 2011, suppliers globally including Russia's Rosatom, France's Areva, and GE Hitachi which is an alliance between US' General Electric and Japan's Toshiba raised severe concerns over supplying nuclear technology to India. This ultimately caused all proposed projects to remain halted until 2015 when India created an insurance pool that would allow suppliers to be indemnified for their share of the liability. Such an insurance product was created because the customary way of managing civil nuclear liability since the 1950s has been to legally channel liability for all accidents occurring at a nuclear installation to the operator of such nuclear installations. In order to provide indemnification for the operator civil nuclear insurance products were created. However, no such insurance product existed to protect the suppliers. Since they had so far not been held liable for damage resulting from a nuclear accident. Therefore, one of the concerns raised by GE Hitachi with regard to the civil liability for nuclear damage act, 2011, was that not only did this law deviate from the normative principle of strict liability of operator, but also that a supplier held liable under section 17 of the act would have no insurance products available to indemnify themselves. Thus, in order to resume implementation of proposed nuclear projects which would supply much needed electricity the Indian government began the process of helping create an insurance product for suppliers within its domestic insurance industry. This was seen as the middle path for India to hold suppliers of nuclear technology liable without impeding

[456] Liability for Nuclear Damage - An International Overview, OECD-NEA 1994 at p. 16 *https://www.oecd-nea.org/law/pubs/1994/liability-compensation-nuclear-damage.pdf*

[457] Most legal systems legal systems rely on the concept of product liability with regards to manufactured. Under the product liability concept, the manufacturer would be liable without fault. Under this rule, liability does not depend upon the behavior of the actor and is rather termed strict or objective. All that is required for the victim to obtain compensation is establishing of causality that is, a causal link between the injury suffered and action of the defendant.

implementation of nuclear new build in the country. Most nuclear power projects even on a Build Own Operate model are implemented through a special purpose vehicle created with joint stock owned by the vendor and the government. For example, in the case of the Akkuyu nuclear power plant in Turkey which was based on a Build, Own, operate model with Rosatom and the operator as well as the license holder for the power plant is the Akkuyu Nuclear Joint Stock Company with a wide majority of the stocks owned by Rosatom. [458] It is very important to ask that given the considerable knowledge and technological gaps how equitable is it for an embarking country to accept a share of the liability (through the nuclear operator entity) in case of a nuclear accident. India for example does not strictly adhere to legal channeling as Section 17 of its Civil Liability for Nuclear Damage Act, 2011 extends the liability to the suppliers of nuclear equipment. The main impetus behind such a law in India came with the background of the Bhopal Gas tragedy from 1984 in which a gas plant operated by a US company Union Carbide Corporations (UCC) which is now known as Dow Chemicals, had an accident leading to release of toxic gas killing three thousand people instantly and leading to long-term health impact for many. The litigation resulting from the disaster was complicated, long, and ultimately confusing for the victims. The Indian government passed the Bhopal Gas Leak Disaster (processing of Claims) Act, 1985[459] under which it gave itself the exclusive right as the Union of India to represent and act on behalf of every person (both within or outside India) entitled to make a claim concerning the gas disaster. Following this, the Indian government pursued a claim against UCC which was the parent company of Union Carbide Corporation of India Ltd. (UCIL) who was operating the plant where the gas leak occurred. This claim was brought by the Indian government before the District Court of New York but was dismissed on the ground of *forum non conveniens* on the condition that UCC shall submit itself to the jurisdiction of Indian courts. The US Court of Appeals later affirmed this dismissal. Ultimately, the litigation for claims in India went on for about 36 years until 2020 during which a settlement fund was created in UCC executives failed to appear before the Indian courts regarding the criminal charges against them, settlement amounts were challenged numerous times due to inadequacy, and UCC ended up selling all its stake in its Indian subsidiary UCIL to another Indian company.[460] The Bhopal case is a clear example of how difficult it can be to hold foreign entities involved in operation of hazardous facilities accountable. This case also showed how ultimately the victims were left litigating for years without any appropriate remedy while most of the liability for the accident was transferred onto the host state stakeholders. It also emphasized the need for mechanisms to hold the responsible entities accountable so that victims are not left in a disadvantaged position when it comes to seeking redress for potential injuries. In the event of a nuclear accident, having a system in place to facilitate claims settlement between the affected nations is of utmost importance. Having a uniform nuclear liability regime provides the necessary treaty relations between the affected states to clarify the applicable law, define jurisdiction, enforcement of

[458] Akkuyu NPP Construction Project (Accessed May 7, 2022) http://www.akkunpp.com/

[459] Act No.21 of 1985. See The Gazette of India, Extraordinary, Part 11, Section 1, No.24 (March 1985)

[460] Bharat Desai, The Bhopal Gas Leak Disaster Litigation: An Overview, Asian Yearbook of International Law, Volume 3 (Ko Swan Sik et al., eds.; 0-7923-2708-X; 1994 Kluwer Academic Publishers; printed in Great Britain), pp. 163-179.

awards, and ensuring availability of funds to compensate victims.

Another example of a long and cumbersome litigation process where a foreign corporation attempted to evade liability for damage resulting from their negligence again comes from oil drilling and exploration in the Niger Delta. In 1970, one of Shell's biggest oil spills in Nigeria occurred. Shell argued these spills were caused due to sabotage and bunkering by locals during the 1967-1970 Civil War.[461] While it is true that vandalization and sabotage of oil pipelines was occurring in Nigeria during 1970 and 2006, the primary cause for the 1970 spill as noted as corrosion and operational[462] failure which had also resulted in about 50% of the oil spills in the region during that period.[463] In addition to the environmental impact of the spillage, Shell also adopted negligent methods of cleanup as a cost-saving method in which instead of clearing the crude oil from the farmlands, the spillage was burned creating a fifteen feet thick crust.[464] Then finally in 2021, Shell agreed to pay a compensation of approximately USD 110 million to the farmers after more than fifty years long dispute[465], before which two of the Nigerian farmers had already passed away.

The examples from the Niger Delta and Bhopal show the impact that the implementation of a large facility can have on a country. In both cases, it was ultimately the local communities that were left high and dry. In the Niger Delta, Shell ultimately paid a heavy fine however it was delayed to a point where it could not be seen as justice. These examples, however, also point to areas where vendors, host states, and local communities can find common ground.to work together in safe implementation in order to avoid delays due to opposition while also giving each stakeholder a meaningful opportunity to safeguard their interests. In cases where an embarking country may decide to have supplier's liability built into its domestic law on civil nuclear liability, there would need to be a dialogue as well as collaboration between foreign vendors and host governments in order to create solutions wherein the proposed projects do not end up suffering from long halts and a host governments interest in holding the foreign vendor accountable can also be upheld. This would however need to be done in a way that also addresses the concerns related to financial exposure for the vendor as was done in the case of India, in creating a suppliers liability insurance product.

5.3.3 Managing Nuclear Liability

As discussed in Chapter II, the way that nuclear liability is handled globally is not satisfactory.

---

[461] Tom Bawden, Shell 'uses sabotage claims to avoid blame, The Independent me for Nigeria oil spills' 19 June 2013 (Accessed May 7, 2022) https://www.independent.co.uk/news/business/news/shell-uses-sabotage-claims-to-avoid-blame-for-nigeria-oil-spills-8664202.html

[462] Aroh, Kenneth & Ubong, Ini & Chibuogwu, Eze & Harry, I.M. & Umo-Otong, J.C. & A.E., Gobo. (2010). Oil spill incidents and pipeline vandalization in Nigeria: Impact on public health and negation to attainment of Millennium development goal: The Ishiagu example. Disaster Prevention and Management. 19. 70-87. 10.1108/09653561011022153.

[463] Ntukekpo, D.S. (1996), Spillage: Bane of Petroleum, Ultimate Water Technology and Environment, Ota

[464] Steven Cayford, The Ogoni Uprising: Oil, Human Rights, and a Democratic Alternative in Nigeria, Africa Today, Apr. - Jun., 1996, Vol. 43, No. 2, Conflict and Conflict Resolution in Africa (Apr. - Jun., 1996), pp. 183-197

[465] Shell to pay $110 million to Nigerian community over 1970 oil spill, The Washington Post August 11, 2021 (Accessed May 8, 2022)

Nuclear accidents can have wide-reaching transboundary impact and therefore it is imperative that countries adopting nuclear energy establish robust mechanisms both at the domestic and international level to protect the rights of victims of a nuclear accident and allow for speedy claims settlement. However, there is currently no uniform nuclear liability regime in Southeast Asia and sub-Saharan Africa. Out of the nine countries[466] within the scope of this thesis, only Nigeria, Ghana, and the Philippines are parties to international instruments on nuclear liability that cover liability for transboundary damage.[467] However, since each of them subscribe to a different international instrument on nuclear liability, there are no treaty relations between most nations pursuing their nuclear power programs in these two regions. Absence of reciprocity or cooperation regarding claims settlement etc. between these states especially endangers the victims and industry stakeholders. It is crucial that before beginning operations of their nuclear facilities treaty relations are established to cover ensuring that all the stakeholders are covered by identical liability rules and that victims' rights to make claims are safeguarded. As discussed in greater detail in Chapter II, these treaty relations can be established under the auspices of the IAEA by joining the Convention on Supplementary Compensation, 1997, an instrument that can cover all States regardless of whether they are parties to any existing nuclear liability convention or have nuclear installations within their territories. Currently, there is no uniform nuclear liability regime in Southeast Asia and sub-Saharan Africa. Out of the nine countries[468] within the scope of this thesis, only Nigeria, Ghana, and the Philippines are parties to international instruments on nuclear liability. This is because globally (as discussed in Chapter II) there is a lack of consensus among nations about the ideal nuclear liability regime and efforts to establish a global regime have so far been unsuccessful.

5.3.4 Role of international organizations

As discussed at several points in this thesis, the role of international organizations although limited is essential in maintaining accountability of all stakeholders and to help narrow down the knowledge, technical and infrastructural gaps that exist between embarking states and vendors of nuclear technology. The IAEA and the European Atomic Energy Community (Euratom) for example has funded initiatives to improve nuclear safety overseas[469], notably through the Instrument for Nuclear Safety Cooperation (INSC) which was created in 2007 through which the EU led projects in Eastern Europe, Central Asia, South America, and East and South East Asia.[470] Additionally, the IAEA has also been actively involved with helping embarking countries build the knowledge base and domestic technical capabilities required for making informed decisions about their nuclear power program.

Beyond just technical capacity building, the IAEA also helps create knowledge sharing platforms to help policymakers from embarking states gain learnings from the experiences in

[466] Nigeria, Ghana, South Africa, Kenya, Indonesia, Malaysia, Philippines, Viet Nam, and Thailand.
[467] Nigeria (Vienna Convention), Ghana (CSC), and the Philippines (Vienna Convention)
[468] Nigeria, Ghana, South Africa, Kenya, Indonesia, Malaysia, Philippines, Viet Nam, and Thailand.
[469] European Commission, Joint Research Centre, 'Enhancing nuclear security: training and international collaboration', News release, 19 Feb. 2011, http://ec.europa.eu/dgs/jrc/downloads/jrc_20110219_newsrelease_nuclear_en.pdf.
[470] European Union co-funded projects https://www.iaea.org/about/partnerships/european-union/european-commission-funded-projects

advanced nuclear economies.[471] In 2019, the IAEA organized training for experts and decisionmakers from 9 countries – Ghana, Jordan, Kazakhstan, Kenya, Nigeria, Poland, Sri Lanka, Tunisia and Zambia to provide a broad overview of the fundamentals of nuclear power and nuclear policy for countries planning or already launching a nuclear power program, including the fundamentals of processes to ensure safe and sustainable use of nuclear power, but also the roles of national institutions, as well as the technical studies needed for informed decisionmaking.[472] Besides training nuclear experts, international organizations also have a significant role in educating the next generation to ensure that embarking countries can become self-reliant for technical expertise in the long-run. The IAEA has recently announced partnership with universities in six countries – Argentina, Brazil, Egypt, Jamaica, South Africa and the United Arab Emirates through partnership agreements to support education and training for students and professionals in international and nuclear law.[473] It is however important to remember that guidelines and support from international organizations is largely recommendatory in nature as each nation is a sovereign and therefore in the authority to implement them ultimately falls upon the national and infrastructural framework of the host state. That said, the involvement of internationally recognized and unbiased experts that are well-versed in the globally accepted standards can be very effective.

5.3.5 Role of Experts

Apart from early public engagement and setting up adequate legislative framework, another important factor in the nuclear power program of countries in Southeast Asia and sub-Saharan Africa must be the involvement of experts. The role of experts in the nuclear power projects of embarking countries is essential in ensuring transparency in the planning as well as management of the project. The most important initial task is to define clearly and precisely the objectives of the project and to specify in necessary detail the scope of the supplied technology, equipment, and materials. In advanced nuclear countries these are routine tasks but for embarking countries having no nuclear facilities and no nuclear experience this represents the first challenge in the way forward to implementing a program. The establishment of a nuclear team needs nuclear experts and experts from all other professions from the conventional energy production sector. Alongside the obvious need of all technical disciplines, the team also needs financial, legal and procurement experts from the outset. The example of the UAE is very relevant here as the UAE had limited experience in drafting and processing a legal regime pertaining to nuclear energy.[474] In order to help in establish

[471] INT2018, 'Supporting Knowledgeable Decision-making and Building Capacities to Start and Implement Nuclear Power Programmes'

[472] Gashaw Gebeyehu Wolde, Experts from Nine Countries Considering Nuclear Power Participate in Scientific Visit to Explore Possibilities, IAEA Department of Technical Cooperation, November 20, 2019 [Accessed May 2, 2022] https://www.iaea.org/newscenter/news/experts-from-nine-countries-considering-nuclear-power-participate-in-scientific-visit-to-explore-possibilities

[473] Inna Pletukhina, IAEA to Support Nuclear Law Education at Six Universities, May 4 2022 [Accessed May 5, 2022] https://www.iaea.org/newscenter/news/iaea-to-support-nuclear-law-education-at-six-universities

[474] Nuclear Law: The Global Debate, International Atomic Energy Agency (2019) ISBN 978-94-6265-494-5 https://doi.org/10.1007/978-94-6265-495-2

their nuclear liability and regulatory framework,[475] the UAE established the International Advisory Board (IAB) consisting of international experts.[476] Another reason behind the establishment of IAB was to ensure operational transparency with the participation of internationally recognized experts in the fields of nuclear safety and security, non-proliferation and the development of human resources.[477] Thus, involvement of experts is not only necessary from a technical perspective or the operational aspects of a nuclear power project, but a widely represented and unbiased team of experts (several of whom have previously worked with nuclear regulatory authorities in other countries, as well as, the IAEA) can also help maintain transparency at every stage. While it is true that these experts will have limited to no interaction with local communities, their involvement is still a strong mechanism to ensure the accountability of both the government and foreign vendors.

The role of experts is not just restricted to planning and implementation of the project, but their involvement remains important during the entire project lifecycle, and it is beyond participation from international experts, it is also important to help cultivate domestic expertise. Once the selection procedure for the supply of the nuclear project is completed and the contract for the supply is signed, the next step is to expand the team and to educate and train both the international as well as domestic experts for the operation of the nuclear facility. The manner of identifying, hiring and training needed experts depends on the purpose and nature of the project:

a. Build, Own, Operate – If an embarking state adopts the build, own, operate model in which all functions (operation, maintenance, waste treatment, radiochemistry, and others) to be covered by a foreign vendor, in order to maintain necessary control and oversight it is still important to over time help develop internal resources, with extensive training and development of all relevant disciplines.
b. Build, Own, Transfer – If the embarking state adopts a model in which it is expected only to conduct operations, with all other supplementary tasks and functions to be covered by external service contracts, necessary training and development would be much less extensive, involving only operation and related disciplines while other technical functions are outsourced.

Although these approaches have significant differences, the management of nuclear facilities in either case must provide the most thorough and up to date training program on nuclear technology for relevant employees. For embarking states, the education of experts and the training on the basics of the nuclear technology are usually part of the contract of the main supply. On the basis of the agreement between the suppliers and the management of the nuclear object, experts are educated and trained either in different sites of reference or in training centers of the type of technology of the supply, or both. This is why, it is critical to negotiate to establish mechanisms for simultaneously train domestic personnel to ensure that there are no knowledge and expertise gaps in the long run for them. It is pertinent to note that involvement of experts can create added costs for embarking states however, the IAEA offers significant assistance to embarking states in accessing relevant expertise to guide their nuclear power program. This includes Integrated Nuclear Infrastructure Review Missions (INIR), the Integrated Regulatory Review Service (IRRS), and the Operational Safety Review Team (OSART). All these programs provided by the IAEA are aimed at assessing the general (technical, legal, financial, and infrastructural) readiness

[475] Hamad AlKaabi, Nuclear Newcomer Countries—The Path of the United Arab Emirates
[476] http://www.uaeiab.ae/ar/members.html
[477] *Ibid.*

of a country to embark on a nuclear power project through a series of inspections and studies. These programs also help boost investor confidence in the host country. The INIR missions are aimed at assisting states in evaluating the status of their overall national infrastructure for the introduction of a nuclear power program which includes grid capacity, technical facilities required for safe operation of nuclear power plants, and the institutional and legislative framework pertaining to nuclear energy.[478] The IRRS is also a similar program but mostly focuses on providing states assistance in enhancing their regulatory framework on radiation safety, transport, and waste management.[479] Finally, the OSART constitutes a team of international experts who conducts in-depth reviews of operational safety performance at a nuclear power plant including personnel and management of safety.[480] Multiple INIR missions have been conducted by the IAEA in both Southeast Asia[481] and sub-Saharan Africa.[482] Countries in both Southeast Asia and sub-Saharan Africa have consulted the IAEA in the technical aspects nuclear energy, as well as, in establishing a legal framework for the same. However, as discussed in Section 3(iii) of this chapter the engagement of experts itself is not an effective solution to community engagement. Nevertheless, it helps add more transparency in project implementation especially when the experts are recruited from an independent organization like the IAEA.

5.4 Conclusion

In the face of climate change, the urgent need to reduce emissions, and the need to enhance economic growth, governments in Southeast Asia and sub-Saharan Africa are beginning to consider nuclear energy. While there are obvious benefits to incorporating nuclear energy into the grid there are also several obstacles to implementing nuclear power projects as well as risks associated with the same. Financing nuclear power projects is one of the biggest initial obstacles to implement a nuclear power project and it also leads to embarking states becoming dependent on vendor financing to kickstart their nuclear power program. Given the wide knowledge and technical gaps that exist between the embarking states and vendors of nuclear technology, it is important to be cognizant of the risk of unfair negotiations of supply agreements that do not take into consideration the concerns of local communities and the overall national development interests of a nuclear power program. It is however also important to remember that discussions

[478] Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years IAEA-TECDOC-1779(, International Atomic Energy Agency (2015)
https://www-pub.iaea.org/MTCD/Publications/PDF/TE-1779_web.pdf
[479] Integrated Regulatory Review Service Guidelines, IAEA Service Series 37, International Atomic Energy Agency (2018)
https://www-pub.iaea.org/MTCD/Publications/PDF/SVS-37web.pdf

[480] Guideline Independent Oversight, International Atomic Energy Agency, and World Association of Nuclear Operators (2018)
https://www.iaea.org/sites/default/files/20/09/wano-guideline-independent-oversight.pdf
[481] Alex Nitzsche, IAEA and ASEAN Strengthen Cooperation in Nuclear Science, Technology and Applications, and Nuclear Safety, Security and Safeguards, IAEA Office of Public Information and Communication (September 16, 2019)
https://www.iaea.org/newscenter/news/iaea-and-asean-strengthen-cooperation-in-nuclear-science-technology-and-applications-and-nuclear-safety-security-and-safeguards
[482] Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)

on successfully implementing a nuclear power project cannot be in isolation to how these projects can support communities in their vicinity and contribute to the overall development of a country. This is because although differing in their interests, all stakeholders including host governments, vendors, and local communities can find common ground in the risks they face due to nuclear energy, as well as the benefits that can be derived from their successful implementation.

When incorporated into the grid, nuclear power can not only provide clean energy but also contribute to the domestic economy of a host state by creating employment opportunities, enhancing domestic industry, and other technological advances as discussed in the previous section. This goal can be achieved when nuclear supply contracts are negotiated while keeping in mind the importance of transparent decisionmaking and effective public engagement in ensuring the financial viability of a nuclear power project by preventing significant delays and other uncertainties. Apart from this, international organizations have a pivotal role to play in helping narrow the knowledge gaps and empower embarking states to be self-reliant and make informed decisions regarding their nuclear power program. Suppliers or vendors of nuclear technology also have a major role to play in empowering embarking states by helping them establish domestic expertise in the technical aspects of operating and maintaining nuclear facilities.

6 REFERENCES

Books

1. Carlton Stoiber et. al., (2003) Handbook on Nuclear Law, International Atomic Energy Agency
2. Vagts, Dodge, Buxbaum, and Koh, (2019) Transnational Business Problem Sixth Edition, ISBN: 9781683286523
3. Carlton Stoiber et. al., (2010) Handbook on Nuclear Law: Implementing Legislation, International Atomic Energy Agency.
4. Jawara, Fatoumata. & Kwa, Aileen. (2003). Behind the scenes at the WTO : the real world of international trade negotiations. London : Bangkok :bFocus on the Global South : Zed Books
5. Alexievich, S. (2006). Voices from Chernobyl (K. Gessen, Trans.). St Martin's Press.

Treaties

1. Convention on Nuclear Safety, 1994, International Atomic Energy Agency
2. Convention on Physical Protection of Nuclear Materials (CPPNM), 1980
3. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, 1997
4. Vienna Convention on the Law of Treaties 1980
5. Vienna Convention on Civil Liability for Nuclear Damage, 1963
6. Paris Convention on Third Party Liability in the Field of Nuclear Energy, 1960
7. Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention, 1988
8. Convention on Supplementary Compensation, 1997
9. Nuclear Non-Proliferation Treaty, 1968
10. United Nations Convention on the Law of the Sea, 1982
11. Declaration of the United Nations Conference on the Human Environment (Stockholm Declaration, 1972)
12. Vienna Convention on Civil Liability for Nuclear Damage, 1997
13. Paris Convention on Third Party Liability in the Field of Nuclear Energy, 2004
14. The Rio Declaration on Environment and Development, 1992

Legislation

1. Nigeria Nuclear Safety and Radiation Protection Act, 1995
2. Ghana Nuclear Regulatory Authority Act, 2015
3. South Africa National Nuclear Regulator Act, 1999
4. Kenya Nuclear Regulatory Act, 2019
5. Indonesia National Nuclear Act, 1997
6. Malaysia Atomic Energy Licensing Act, 1984
7. Philippines Atomic Energy Regulatory and Liability Act, 1968

8. Comprehensive Nuclear Regulatory Framework Bill, 2019 (Philippines)
9. Viet Nam's law on Atomic Energy, 2008
10. Thailand Nuclear Energy for Peace Act, 2016
11. Civil Liability for Nuclear Damage Act, 2011(India)
12. U.S. Atomic Energy Act, 1954
13. Thailand Nuclear Energy for Peace Act, 2016.
14. The Town and Country Planning Act, 1990 (United Kingdom)
15. The Bhopal Gas Leak Disaster (Processing of Claims) Act, 1985 (India)

Case Law

1. Case 3:12-cv-03032, Cooper et al. v. Tokyo Electric Power Co. Inc. In June 2017
2. Case 3:2017v01671 Bartel et al. v Tokyo Electric Power Company Inc. et al., 18 August 2017.
3. Trail Smelter Arbitration, 33 A31L (1939) 182; 35 A31L (1941), 684,
4. Gut Dam Arbitration, 8 ILM (1968), 118.
5. Writ Petition No. 24770 of 2011 and Writ Petition No. 8262 of 2012 of the Madras High Court.

Reports

1. United Nations Environment Program (UNEP), Climate Change and Human Rights, December, 2015.
2. Thomas Fuller and Kendra Pierre-Louis, A Forecast for a Warming World: Learn to Live With Fire, New York Times, October 30, 2019.
3. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019 Global Assessment Report on Biodiversity and Ecosystem Services Pp. 66-68
4. Field, C.B et. al., Climate Change 2014 Impacts, Adaptation, and Vulnerability Part A: Global and Sectoral Aspects, Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC 2014)
5. Human Mobility in the Context of climate change - Paris COP - 21: Recommendations from the Advisory Group on Climate Change and Human mobility (UNHCR November 2015).
6. John Campbell and Olivia Warrick, 'Climate Change and Migration Issues in the Pacific' (Report, United Nations Economic and Social Commission for Asia and the Pacific, 2014)
7. World Health Organization (WHO) Discussion Paper (2012), Our Planet, Our Health, Our Future Human health and the Rio Conventions: biological diversity, climate change and desertification
8. Intergovernmental Panel on Climate Change, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.
9. International Energy Agency, Global Energy & CO2 Status Report 2019
10. International Energy Agency, Global Energy & CO2 Status Report The latest trends in energy and emissions in 2018.
11. International Energy Agency, Tracking Transport, IEA, (2019)
12. International Energy Agency, Global CO2 emissions in 2019
13. International Energy Agency (IEA), Global Energy Review 2020
14. IEA, Energy related CO2 emissions, 1990-2019, IEA, Paris
15. IEA, Change in energy related CO2 emissions by region, 2018-2019, IEA, Paris

16. Transforming our world: the 2030 Agenda for Sustainable Development, United Nations General Assembly A/RES/70/1
17. International Energy Agency World Energy Outlook, 2019
18. Sustainable Energy for All (SEforALL) and the Climate Policy Initiative (CPI). 2018. Energizing Finance: Understanding the Landscape, 2018: Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries." SEforALL and CPI, Washington, DC
19. Financing Climate Futures OECD, 2019
20. Sustainable Energy for All, Energizing Finance: Understanding the Landscape, 2019
21. Sustainable Energy for AllEnergy Finance, Report Series, 2019
22. The World Bank, Tracking SDG 7: The Energy Progress Report 2019
23. Tracking SDG 7: The Energy Progress Report, The World Bank, 2019
24. Accelerating SDG 7 Achievement Policy Brief 18: Achieving SDG 7 in Africa, United Nations Economic Commission for Africa (UNECA), 2018
25. International Energy Agency, International Energy Outlook, 2018
26. Southeast Asia Energy Outlook, 2019
27. Africa Energy Outlook, 2019
28. Planning for the Renewable Future: Long-term Modelling and Tools to Expand Variable Renewable Power in Emerging Countries, International Renewable Energy Agency 2017
29. IEA, Levelised cost of electricity LCOE for solar PV and coal-fired power plants in India in the New Policies Scenario, 2020-2040, IEA, Paris
30. IEA (2019), World Energy Model, IEA, Paris
31. IEA (2020), India 2020, IEA, Paris
32. International Energy Agency, Africa Energy Outlook (2019)
33. International Energy Agency, Africa Energy Outlook (2014)
34. Changing Climates, Moving People: Framing Migration, Displacement and Planned Relocation, K. Warner and others, eds. UNU-EHS Policy Brief, No. 8., Farbotko, C., and H. Lazrus (2011).
35. The first climate refugees? Contesting global narratives of climate change in Tuvalu. Global Environmental Change, vol. 22, No. 2, pp. 382-390.; International Panel on Climate Change (IPCC) (2000).
36. "Summary for Policymakers" Emissions Scenarios: A Special Report of IPCC Working group III, IPCC.
37. Asia's Nuclear Energy Growth, World Nuclear Association 2019
38. ASEAN Center for Energy (ACE), Pre-Feasibility Study on the Establishment of Nuclear Power Plant in ASEAN (April 2018)
39. International Energy Agency, Southeast Asia Energy Outlook 2019
40. International Energy Agency, Sustainable Development Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all 2019
41. International Energy Agency, Southeast Asia Energy Outlook, 2017 p.11-14
42. International Energy Agency, Sustainable Development Goal 7 Ensure access to affordable, reliable, sustainable and modern energy for all 2019
43. International Hydropower Association, Hydropower Status Report, 2019 p.57
44. IEA (2019), Tracking Power, IEA, Paris
45. IEA (2019), Nuclear Power in a Clean Energy System, IEA, Paris

46. International Hydropower Association, Hydropower Status Report, 2019
47. International Atomic Energy Agency (IAEA), Financing Nuclear Power in Evolving Electricity Markets April, 2018
48. Organisation for Economic Cooperation and Development (OECD-NEA)
49. Small Modular Reactors: Nuclear Energy Market Potential for Near-term Deployment, Nuclear Development 2019 NEA No. 7213
50. International Status and Prospects for Nuclear Power 2012, IAEA Vienna (2012)
51. IEA (2022), Clean Energy Technology Innovation, IEA, Paris https://www.iea.org/reports/clean-energy-technology-innovation, License: CC BY 4.0
52. Small Modular Reactors: Challenges and Opportunities, OECD-NEA 2021
53. Organisation for Economic Cooperation and Development - Nuclear Energy Agency and International Energy Agency, Technology Roadmap: Nuclear Energy (2010)
54. Department of Energy (DOE) Small Modular Reactor Report, MSA No. DOE0638-1022-11 (2017)
55. Intergovernmental Panel on Climate Change (2013)
56. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press
57. Sources and Effects of Ionizing Radiation, UNSCEAR 2008 Report to the General Assembly with Scientific Annexes, Vol. II Scientific Annexes C, D and E
58. Impacts of the Fukushima Daiichi Accident on Nuclear Development Policies Impacts of the Fukushima Daiichi Accident on Nuclear Development Policies, Organization for Economic Cooperation and Development - Nuclear Energy Agency (OECD-NEA) 2017
59. The concept of regulatory independence will be explained in greater detailed later in this chapter in section II.
60. IAEA Report on Strengthening Nuclear Regulatory Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant (2013)
61. World Bank, Philippines Energy Sector Survey, Vol. 2 Annex 1980
62. Commission on Nuclear Reactor Plants, Inquiry on the Safety to the Public of the Bataan Nuclear Plant, 1979
63. IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1) Milestones in the Development of a National Infrastructure for Nuclear Power (2015)
64. A review of technology and policy deep decarbonization pathway options for making energy-intensive industry production consistent with the Paris Agreement", Journal of Cleaner Production, Vol. 187/20, pp. 960-973
65. African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) 1990, International Atomic Energy Agency (IAEA), April 3 2020 INFCIRC/935
66. Declaration by the IAEA Ministerial Conference on Nuclear Safety in Vienna on 20 June 2011, International Atomic Energy Agency (IAEA), INFCIRC/821
67. IAEA Action Plan on Nuclear Safety at p.6. September 22, 2011
68. Milestones in the Development of a National Infrastructure for Nuclear Power, IAEA Nuclear Energy Series No. NG-G-3.1 (Rev.1), 2015
69. Liability for Nuclear Damage - An International Overview, OECD-NEA 1994

70. Liability and Compensation for Nuclear Damage - An International Overview, OECD-NEA at p.102
71. IAEA Explanatory Texts on The 1997 Vienna Convention on Civil Liability for Nuclear Damage and the 1997 Convention on Supplementary Compensation for Nuclear Damage by the INLEX
72. Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)
73. The Financing of Nuclear Power Plants, NEA No. 6360, OECD 2009 at p.44
74. Nuclear Power in Turkey, World Nuclear Association (Updated March 2021)
75. MIT Energy Initiative, The Future of Nuclear Energy in a Carbon-Constrained World (2018)
76. World Nuclear Association, Nuclear power in the US, May 2021
77. The New Economics of Nuclear Power, World Nuclear Association Report 2005
78. Sector Overview, Grid-Parity Rooftop Solar Project (RRP THA 49087), Asian Development Bank
79. Nuclear Power Economics, World Nuclear Association 2020
80. Sub-Saharan Africa and nuclear energy, World Nuclear Association, April 2018
81. U.S. Department of Energy, Energy Information Administration. The Changing Structure of the Electric Power Industry 2000: An Update. 2002.
82. IAEA, Financing Arrangements for Nuclear Power Projects in Developing Countries, Technical Report Series No. 353 (1993)
83. Economics of Nuclear Power, World Nuclear Association March 2020
84. Economic Assessment of the Long-term Operation of Nuclear Power Plants: Approaches and Experience, IAEA Nuclear Energy Series No. NP-T-3.25.
85. United States Electricity Industry Prime, U.S. Department of Energy DOE/OE-0017, June 2015
86. IEA (2018), Electricity Information 2011, IEA Statistics, International Energy Agency, OECD, Paris, France
87. IAEA, Financing Nuclear Power in Evolving Electricity Markets, April 2018
88. Financing arrangements for nuclear power projects in developing countries: a reference book. — Vienna: International Atomic Energy Agency, 1993. (Technical reports series, ISSN 0074-1914; 353) STI/DOC/10/353 ISBN 92-0-1009933
89. IAEA: Impacts of electricity market reforms on the choice of nuclear and other generation technologies / International Atomic Energy Agency. IAEA TECDOC series, ISSN 1011–4289 ; no. 1789 : IAEAL 16-01039 | ISBN 978–92–0–103916–3
90. Financing Nuclear Power in Evolving Electricity Markets, International Atomic Energy Agency, April 2018
91. Financing Nuclear Power in Evolving Electricity Markets, IAEA April 2018
92. Nuclear Law in the Post-Chernobyl Period OECD-NEA No. 6146 (2006) ISBN 92-64-02293-7
93. Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects, IAEA Nuclear Energy Series No. NG-T-4.6, 2017
94. Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects, IAEA Nuclear Energy Series No. NG-T-4.6 2017
95. Communications Received from Certain Member States Regarding Guidelines for the Export of Nuclear Material, Equipment or Technology, IAEA INFCIRC/254, February 1978
96. Financing Arrangements for Nuclear Power Projects in Developing Countries, IAEA 1993 at p.91
97. Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years IAEA-TECDOC-1779(, International Atomic Energy Agency (2015)

98. Integrated Regulatory Review Service Guidelines, IAEA Service Series 37, International Atomic Energy Agency (2018)
99. Guideline Independent Oversight, International Atomic Energy Agency, and World Association of Nuclear Operators (2018)
100. Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years IAEA-TECDOC-1779(, International Atomic Energy Agency (2015)
101. Integrated Regulatory Review Service Guidelines, IAEA Service Series 37, International Atomic Energy Agency (2018)
102. Guideline Independent Oversight, International Atomic Energy Agency, and World Association of Nuclear Operators (2018)
103. Management of procurement activities in a nuclear installation, IAEA 1996, IAEA-TECDOC-919
104. Steps to Nuclear Power, IAEA Technical Report Series No. 164
105. Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities, IAEA Nuclear Energy Series No. NP-T-3.21 (2016) at p. 34-87
106. Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities, IAEA Nuclear Energy Series No. NP-T-3.21 (2016) at p. 60
107. World Nuclear Supply Chain: Outlook 2040, World Nuclear Association 2021
108. Nakano Jane, The United States views these missile batteries as a major security threat to its F-35 stealth fighter jets, which are being rolled out among the NATO allies. Report. Center for Strategic and International Studies (CSIS), 2020.
109. Developing Countries in International Negotiations: How they Influence Trade and Climate Change Negotiations, Journal: IDS Bulletin, : 2004, ISSN: 1759-5436
110. United Nations Development Program (UNDP), Towards Human Resilience: Sustaining MDG Progress in an Age of Economic Uncertainty, pp. 22 (2011)
111. OECD Nuclear Energy Agency, Stakeholder Involvement Techniques: A Short Guide and Annotated Bibliography, NEA/RWM/FSC (2004)7, OECD/NEA, Paris (2004).
112. International Atomic Energy Agency, The Management System for Facilities and Activities, IAEA Safety Standards Series No. GS-R-3, IAEA, Vienna (2006).
113. International Nuclear Safety Group, Stakeholder Involvement in Nuclear Issues, INSAG-20, IAEA, Vienna (2006)
114. International Atomic Energy Agency, An Overview of Stakeholder Involvement in Decommissioning, IAEA Nuclear Energy Series No. NW-T-2.5, IAEA, Vienna (2009)
115. International Atomic Energy Agency, International Status and Prospects of Nuclear Power, Information Booklet, IAEA, Vienna (2008).
116. IAEA, Communications on Nuclear, Radiation, Transport and Waste Safety: A Practical Handbook, IAEA-TECDOC-1076, IAEA, Vienna (1999)
117. IAEA, Socioeconomic and Other Non-radiological Impacts of the Near Surface Disposal of Radioactive Waste, IAEA-TECDOC-1308, IAEA, Vienna (2002)
118. OECD Nuclear Energy Agency, Stakeholder Involvement in Decommissioning Nuclear Facilities, NEA No. 6320, OECD, Paris (2007).
119. UK Nuclear Decommissioning Authority, Consultation on a Public and Stakeholder Engagement and Communications Framework for Geological Disposal (2008).
120. IAEA, Stakeholder Involvement Throughout the Life Cycle of Nuclear Facilities, IAEA Nuclear

Energy Series No. NG-T-1.4 (2011)
121. International Workshop on Nuclear Public Information in Practice, Ljubljana, Slovenia, 13–16 Feb 2000.
122. Korea Hydro & Nuclear Power Co., Ltd., KHNP Sustainability Report (2018)
123. International Atomic Energy Agency, Nuclear Communicator's Toolbox
124. US Department of Energy, Communications and Stakeholder Participation, Project Management Practices Rev E., June 2003.
125. OECD-NEA Environmental Radiological Protection in the Law, A Baseline Survey (2007)
126. Fundamental Safety Principles, Safety Fundamentals, Safety Standards Series No. SF-1 (2006)
127. Cooperation in Nuclear Power, World Nuclear Association, August 2017
128. World Nuclear Association Annual Report; Working Group on Cooperation in Reactor Design Evaluation and Licensing (CORDEL); 2001-2012
129. Newcomer countries face common challenges in nuclear infrastructure development, IAEA Bulletin April, 2016
130. Governmental, Legal and Regulatory Framework for Safety, Safety Standards Series No. GSR Part 1 (2010)
131. Radiation Protection and Safety of Radiation Sources, International Basic Safety Standards, Interim Edition, Safety Standards Series No. GSR Part 3 (Interim) (2011)
132. Safety Assessment for Facilities and Activities, Safety Standards Series No. GSR Part 4 (2009)
133. Milestones in the Development of a National Infrastructure for Nuclear Power, Nuclear Energy Series No. NG-G-3.1 (2007)
134. Nuclear Power Plant Exporters' Principles of Conduct Sub-Saharan Africa and nuclear energy, Carnegie Endowment for International Peace, Moscow, December 2011
135. Nuclear Energy Institute, Economic Benefits of Diablo Canyon Power Plant, An Economic Impact Study by the Nuclear Energy Institute in cooperation with Pacific Gas & Electric Company, NEI, February 2004.
136. Swedish National Co-ordinator for Nuclear Waste Disposal (M 1996:C), Stockholm, (1998).
137. Carbon Disclosure Project - Global Climate Change Analysis 2018
138. Nuclear Power Economics, World Nuclear Association 2020
139. International Atomic Energy Agency (IAEA), Financing Nuclear Power in Evolving Electricity Markets April, 2018
140. Creating high-value jobs in the post-COVID-19 recovery with nuclear energy projects, OECD-NEA Policy Brief June 2020
141. Human Rights Watch, The Ogoni Crisis: A Case-Study of Military Repression in Southeastern Nigeria, 1 July 1995
142. NAIIC (Nuclear Accident Independent Investigation Commission). The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission. Tokyo: National Diet of Japan; 2012.
143. Energy Policy and Planning Office, Thailand Power Development Plan (2015-2036), in, Ministry of Energy, Thailand, Bangkok, Thailand, 2015, pp. 78.
144. Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants, Chapter 4

145. NSC (Nuclear Safety Commission). Emergency Preparedness for Nuclear Facilities (May 2007), Chapter 2: Sections 2.1, 2.2, 2.6; Chapter 3: Sections 3.1, 3.2; Chapter 5; and Appendixes D, F, J, L, and N (Technical Language Service, Trans.). Tokyo: Government of Japan, 2013
146. The Financing of Nuclear Power Plants, NEA No. 6360, OECD 2009
147. Nuclear Law in the Post-Chernobyl Period OECD-NEA No. 6146 (2006) ISBN 92-64-02293-7 at p. 38
148. Stakeholders in Radioactive Waste Management and their Networks, CARL Thematic Report No. 3; Elam, M. and Sundqvist, G. (2007)
149. Fission or Fusion? Reconciling Technical and Social Aspects of Radioactive Waste Management, CARL Thematic Report No. 5
150. Nuclear Power in a Clean Energy System, IEA, 2019 Paris
151. INT2018, Supporting Knowledgeable Decision-making and Building Capacities to Start and Implement Nuclear Power Programmes
152. Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years IAEA-TECDOC-1779(, International Atomic Energy Agency (2015)
153. Integrated Regulatory Review Service Guidelines, IAEA Service Series 37, International Atomic Energy Agency (2018)
154. Guideline Independent Oversight, International Atomic Energy Agency, and World Association of Nuclear Operators (2018)
155. The Characteristics of an Effective Nuclear Regulator, Nuclear Regulation NEA/CNRA/R(2014)3, OECD-NEA (2014)

News

1. Faith Birol, The coronavirus crisis reminds us that electricity is more indispensable than ever, International Energy Agency 2020
2. Reuters, October 24 2019Russia's Rosatom, Rwanda sign deal to build nuclear science center. https://www.reuters.com/article/us-russia-rwanda-nuclear/russias-rosatom-rwanda-sign-deal-to-build-nuclear-science-center-idUSKBN1X32DV
3. The Moscow Times, Russia Spreads Influence in Africa Using Nuclear Power – Reports, August 29, 2019 https://www.themoscowtimes.com/2019/08/29/russia-spreads-influence-in-africa-using-nuclear-power-reports-a67077
4. Malo, Russia, China back nuclear as a clean-power fix for Africa, Reuters February 6, 2019 https://www.reuters.com/article/us-africa-energy-nuclearpower/russia-china-back-nuclear-as-a-clean-power-fix-for-africa-idUSKCN1PW0KV
5. Nuclear Safety, Security and Safeguards, IAEA Office of Public Information and Communication (September 16, 2019) https://www.iaea.org/newscenter/news/iaea-and-asean-strengthen-cooperation-in-nuclear-science-technology-and-applications-and-nuclear-safety-security-and-safeguards
6. Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)
7. Reuters, Kenya on course to develop nuclear energy, official says (October 5, 2018)
8. A. Gee, Chernobyl Victims Struggle with Consequences of Radiation Exposure U.S. News April 24,

2008
9. Fukushima plaintiffs exhausted after settlements urged but rejected by Tepco, The Japan Times March 7, 2020 https://www.japantimes.co.jp/news/2020/03/07/national/3-11-plaintiffs-exhausted-lawsuits-court-deals-urged-rejected-tepco/
10. Ghana completes first phase of nuclear power programme http://www.ghana.gov.gh/index.php/media-center/news/3356-ghana-completes-first-phase-of-nuclear-power-programme
11. Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)
12. Cooperation in Reactor Design Evaluation and Licensing (CORDEL) Working Group Annual Report 2011-2012
13. European Commission, Joint Research Centre, 'Enhancing nuclear security: training and international collaboration', News release, 19 Feb. 2011
14. IAEA Country Nuclear Profiles: Turkey 2019 https://cnpp.iaea.org/countryprofiles/Turkey/Turkey.htm
IAEA Country Nuclear Profiles: UAE 2019 https://cnpp.iaea.org/countryprofiles/UnitedArabEmirates/UnitedArabEmirates.htm
15. IAEA Report on Strengthening Nuclear Regulatory Effectiveness in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant (2013)
16. Brookhaven National Laboratory Annual Report, 1957
17. IAEA Press Releases: Diplomatic Conference on Nuclear Liability concludes, 12 September, 1997 1997/21
18. Shares in Sino-Thai plunge after anti-graft body corruption allegation, Reuters November 13, 2019 (Accessed September 2, 2021) https://www.reuters.com/article/sinothai-stocks-corruption/shares-in-sino-thai-plunge-after-anti-graft-body-corruption-allegation-idUSL4N27T2LX
19. Error gets firm off NACC bribery hook, Bangkok Post December 17, 2020 (Accessed September 2, 2021) https://www.bangkokpost.com/business/2036559/error-gets-firm-off-nacc-bribery-hook
20. Rosatom: Nigeria's Nuclear Technologies Pact with Russia Comprehensive, Rosatom January 10, 2019. http://www.rusatom-overseas.com/media/mass-media-about-us/rosatom-nuclear-technologies-nigeria-s-pact-with-russia-comprehensive.html
21. New Jersey regulators extend nuclear subsidies for PSEG/Exelon reactors, Reuters April 27, 2021 (Accessed September 4, 2021) https://www.reuters.com/business/energy/new-jersey-regulators-extend-nuclear-subsidies-psegexelon-reactors-2021-04-27/
22. Illinois approves $700 million in subsidies to Exelon, prevents nuclear plant closures, Reuters September 13 2021 (Accessed September 14, 2021) https://www.reuters.com/world/us/illinois-senate-close-providing-lifeline-3-nuclear-power-plants-2021-09-13/
23. GE seeks arbitration over Lungmen payments, World Nuclear News December 14, 2015 (Accessed

September 10, 2021)
https://www.world-nuclear-news.org/C-GE-seeks-arbitration-over-Lungmen-payments-1412154.html
24. King & Spalding, "GE Hitachi Nuclear Energy Wins a US$158 Million Award in ICC Arbitration Against Taiwan", 21 February 2019 (Accessed September 10 2021)
https://www.kslaw.com/news-and-insights/ge-hitachi-nuclear-energy-wins-a-us158-million-award-in-icc-arbitration-against-taiwan
25. Russia wins 'half' of compensation claimed in Belene lawsuit, World Nuclear News, June 16 2016 (Accessed August 28, 2021)
https://www.world-nuclear-news.org/C-Russia-wins-half-of-compensation-claimed-in-Belene-lawsuit-16061601.html
26. The story of Kudankulam: From 1988 to 2016, The Hindu September 20, 2016 (Accessed 20 June 2022)
https://www.thehindu.com/news/national/The-story-of-Kudankulam-From-1988-to-2016/article60528215.ece
27. Tom Bawden, Shell 'uses sabotage claims to avoid blame, The Independent me for Nigeria oil spills' 19 June 2013 (Accessed May 7, 2022)
https://www.independent.co.uk/news/business/news/shell-uses-sabotage-claims-to-avoid-blame-for-nigeria-oil-spills-8664202.html

28. Russia's nuclear power company agrees to consult with neighbors on environmental impacts within framework of UNECE's Espoo Convention, United Nations Economic Commission for Europe (UNECE), May 30, 2011 (Accessed (September 1, 2021)
https://unece.org/environment/press/russias-nuclear-power-company-agrees-consult-neighbours-environmental-impacts
29. Atkins an adviser for UAE reactors, Kevin Brass, The National News Nov 17, 2011 (Accessed 2 July, 2022)
https://www.thenationalnews.com/uae/atkins-an-adviser-for-uae-reactors-1.428357
30. Nuclear Safety, Security and Safeguards, IAEA Office of Public Information and Communication (September 16, 2019)
https://www.iaea.org/newscenter/news/iaea-and-asean-strengthen-cooperation-in-nuclear-science-technology-and-applications-and-nuclear-safety-security-and-safeguards
31. Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)
32. Matt Fisher, UAE's Nuclear Power Journey Has Lessons for Newcomers as IAEA Restarts In-Person Reviews, IAEA May 24, 2021 (September 2, 2021)
https://www.iaea.org/newscenter/news/uaes-nuclear-power-journey-has-lessons-for-newcomers-as-iaea-restarts-in-person-reviews
33. Alex Nitzsche, IAEA and ASEAN Strengthen Cooperation in Nuclear Science, Technology and Applications, and
34. Russia's Rosatom says no 'secret deal' with South Africa, Reuters June 20, 2017 (Accessed September 8 2021)
https://www.reuters.com/article/russia-safrica-rosatom-idAFR4N1JC007

35. Nur Azha Putra and Philip Andrews-Speed, Prospects for Nuclear Power in ASEAN, The Diplomat June 28, 2018 https://thediplomat.com/2018/06/prospects-for-nuclear-power-in-asean/
36. Felix Todd, Analysing the development of nuclear power across Southeast Asia, NS Energy August 5, 2019 (Accessed January 3, 2021) https://www.nsenergybusiness.com/features/development-nuclear-power-southeast-asia/
37. Ryan Collyer, acting CEO of Rosatom Central and Southern Africa, correspondence with *POWER Magazine*, https://www.powermag.com/philippines-taking-new-look-at-nuclear-power/
38. "Russian law increases Rosatom's political authority," World Nuclear News, December 28, 2017, https://www.world-nuclear-news.org/NP-Russian-law-increases-Rosatoms-political-authority-28121701.html.
39. UN experts cite 'possible exploitation' of workers hired to clean up toxic Japanese nuclear plant, United Nations News August 16, 2018 (Accessed 06/5/2021) https://news.un.org/en/story/2018/08/1017232
40. "China Trains Nuclear Engineers from Nuclear Newcomer Countries – IAEA Facilitates Selection Process," International Atomic Energy Agency, May 2019 https://www.iaea.org/newscenter/news/china-trains-nuclear-engineers-from-nuclear-newcomer-countries-iaea-facilitates-selection-process.
41. Policy Statement on U.S. Public-Private Partnerships for Small Modular Reactors, Nuclear Energy Institute (2016)
42. Darrell Proctor, Philippines Taking New Look at Nuclear Power, Power Magazine October 1, 2020 https://www.powermag.com/russia-china-drive-africas-plan-for-nuclear-expansion/
43. Robert Walton, SCE&G customers could grab $146M in VC Summer settlement, largest in state history, utility Dive June 14, 2019 https://www.utilitydive.com/news/sceg-customers-could-grab-146m-in-vc-summer-settlement-largest-in-state/556877/
44. Farmers in Vietnam's commune protest wind power project over alleged house, crop damage, Tuoi Tre News, December 21, 2021 (Accessed February 4, 2023) https://tuoitrenews.vn/news/society/20211221/farmers-in-vietnams-commune-protest-wind-power-project-over-alleged-damage/64838.html
45. Le Quynh, Vietnamese provinces say 'no' to coal power as central government, industries build more, Earth journalism Network 11 March 2019 (Accessed January 18, 2023) https://earthjournalism.net/stories/vietnamese-provinces-say-no-to-coal-power-as-central-government-industries-build-more
46. Samsung C&T announces coal exit, November 27, 2020 (Accessed January 25, 2023) https://trading.samsungcnt.com/EN/trading/ne/501000/articleRead.do?board_id=6&article_id=4904&page_index=4
47. CAG faults NPCIL for cost overruns on Kudankulam Nuclear Power Plant, Nuclear Asia, December 28, 2017 (Accessed January 25, 2023) https://www.nuclearasia.com/feature/cag-faults-npcil-cost-overruns-kudankulam-nuclear-power-plant/1743/#:~:text=The%20national%20auditor%20noted%20that,22%2C462%20crore%20in%202014.

48. I. Nechepurenko and A. Higgins, Coming to a Country Near You: A Russian Nuclear Power Plant, New York Times March 21 2020 https://www.nytimes.com/2020/03/21/world/europe/belarus-russia-nuclear.html
49. Shell shuts 25,000 bpd oil pipeline in Nigeria due to theft damage, Reuters November 11, 2012 (Accessed February 5, 2023) https://www.reuters.com/article/cbusiness-us-shell-nigeria-idCABRE8AA09Z20121111
50. Gashaw Gebeyehu Wolde, Experts from Nine Countries Considering Nuclear Power Participate in Scientific Visit to Explore Possibilities, IAEA Department of Technical Cooperation, November 20, 2019 [Accessed May 2, 2022] https://www.iaea.org/newscenter/news/experts-from-nine-countries-considering-nuclear-power-participate-in-scientific-visit-to-explore-possibilities
51. Inna Pletukhina, IAEA to Support Nuclear Law Education at Six Universities, May 4 2022 [Accessed May 5, 2022] https://www.iaea.org/newscenter/news/iaea-to-support-nuclear-law-education-at-six-universities
52. Laura Gil, Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication (September 3, 2018)
53. Laura Gil, Is Africa Ready for Nuclear Energy? – Economic growth puts pressure on countries to go nuclear, but hurdles remain, IAEA Office of Public Information and Communication September 3, 2018 https://www.iaea.org/newscenter/news/is-africa-ready-for-nuclear-energy
54. S. Miglani, Russia signs pact for six nuclear reactors on new site in India, Reuters October 5, 2018 https://www.reuters.com/article/us-india-russia-nuclear/russia-signs-pact-for-six-nuclear-reactors-on-new-site-in-india-idUSKCN1MF217
55. Shell to pay $110 million to Nigerian community over 1970 oil spill, The Washington Post August 11, 2021 (Accessed May 8, 2022)
56. Rosatom sees wider financing options for new build, World Nuclear News September 11, 2020 (Accessed September 8, 2021) https://world-nuclear-news.org/Articles/Rosatom-sees-wider-financing-options-for-new-build

Papers

1. M.P. Blimpo, Electricity Access in Sub-Saharan Africa Uptake, Reliability, and Complementary Factors for Economic Impact, Africa Development Fund, World Bank 2019
2. S. Bakker et. al., Transport, Development and Climate Change Mitigation: Towards an Integrated Approach Transport Reviews, 2014 Vol. 34, No. 3, 335–355 (2014)
3. J. Corfee-Morlot, P. Parks, J. Ogunleye and F. Ayeni, Achieving Clean Energy Access in Sub-Saharan Africa, 2018
4. Fathima, A.H.; Palanisamy, K. Energy Storage Systems for Energy Management of Renewables in Distributed Generation Systems. In Energy Management of Distributed Generation Systems; InTech: London, UK, 2016
5. Luo, X.; Wang, J.; Dooner, M., Clarke, J. Overview of current development in electrical energy storage technologies and the application potential in power system operation. Appl. Energy 2015.
6. H. Zsiboracs et. al., Intermittent Renewable Energy Sources: The Role of Energy Storage in the European Power System of 2040, Electronics. 8. 729. 10.3390/electronics8070729.

7. Hannah Ritchie and Max Roser (2020) - "Energy". Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/energy'
8. Energy Transitions Commission , Mission Possible: Reaching Net-Zero Carbon Emissions from Harder-to-Abate Sectors by Mid-Century, 2018
9. Evelyne Bertel and Joop Van de Vate, Nuclear energy & the environmental debate: The context of choices. IAEA Bulletin April, 1995
10. McMillan, C., Boardman, R., Mckellar, M., Sabharwall, P., Ruth, M., Bragg-sitton, S., 2016. Generation and Use of Thermal Energy in the U. S. Industrial Sector and Opportunities to Reduce its Carbon Emissions, Bataille, C. et al. (2018)
11. Nur Azha Putra, The dynamics of nuclear energy among ASEAN member states, Energy Procedia, Volume 143, 2017, Pages 585-590
12. M. Åhman, L.,J. Nilsson, F.N. Andersson Industrial development towards net zero emissions – policy conclusions and first steps. (Industrins utveckling mot netto-noll utsläpp- – policyslutsatser och första steg) IMES/DESS report nr 88 Environmental and energy System Studies Lund university (2013)
13. S, Lechtenbohmer et. al., Decarbonising the energy intensive basic materials industry through electrification – Implications for future EU electricity demand, Energy Volume 115, Part 3, 15 November 2016, Pages 1623-1631.
14. Jarvis, S., Deschenes, O., & Jha, A. (2019). The Private and External Costs of Germany's Nuclear Phase-Out (No. 26598). National Bureau of Economic Research.
15. Guivarch, C., and S. Hallegatte. 2013. "2C or Not 2C?" Global Environmental Change 23 (1): 179–192.
16. P.Burkhardt, Russia's State-Owned Nuclear Giant Is Targeting Africa for its Growth, Bloomberg October 30 2019
17. Oppenheimer, M. et. al, Sea Level Rise and Implications for Low-Lying Islands, Coasts and Communities. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate In press. 2019 P. 321
18. John Campbell and Olivia Warrick, Climate Change and Migration Issues in the Pacific, United Nations Economic and Social Commission for Asia and the Pacific August, 2014
19. Locke, J.T. (2009). Climate change-induced migration in the Pacific region: sudden crisis and long-term developments. Geographical Journal, vol. 175, No. 3, pp. 171-180.
20. Kalin W. (2013). Changing climates, moving people: distinguishing voluntary and forced movements of people. In
21. Alex Nitzsche, IAEA and ASEAN Strengthen Cooperation in Nuclear Science, Technology and Applications, and
22. J.E. Aldy, Future-Proof Your Climate Strategy, Harvard Business Review May-June 2019 Issue, pp.86–97
23. Lüthi, D. et al., 2008. High-Resolution Carbon Dioxide Concentration Record 650,000–800,000 Years before Present. Nature Publishing Group, 453(7193), pp.379–82.
24. Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. Science, 360(6392), 987-992
25. Steckel, J.C., Schwerhoff, G., Edenhofer, O. (2017). Enabling Low-Carbon Development in Poor Countries. In: Stark, R., Seliger, G., Bonvoisin, J. (eds) Sustainable Manufacturing. Sustainable

Production, Life Cycle Engineering and Management. Springer, Cham.
26. N, Avila et. al. The energy challenge in sub-Saharan Africa: A guide for advocates and policy makers, Oxfam Research Backgrounder 2017, Part 1 p.20.
27. P.A Trotter, M.C McManus., R. Maconachie, Electricity planning and implementation in sub-Saharan Africa: A systematic review (2017) Renewable and Sustainable Energy Reviews, pp. 1189-1209.
28. Accelerating SDG 7 Achievement Policy Briefs in Support of the First SDG 7 Review at the un high-level political forum 2018, united nations department of economic and social affairs
29. Kumar, A., T. Schei et. al., Hydropower, IPCC Special Report on Renewable Energy Sources and Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, 2011 at p. 449.
30. W. Roelf, South African court declares nuclear plan with Russia unlawful (April 26, 2017)
31. S. Kirshenberg et. al., Purchasing Power Produced by Small Modular Reactors: Federal Agency Options, Matthew Wald, The Next Nuclear Reactor May Arrive Hauled by a Truck, The New York Times, 24 April 2013.
32. M. Ziegler et. al., Storage Requirements and Costs of Shaping Renewable Energy Toward Grid Decarbonization, Joule Vol. 3 Issue 9 2019, A. Blakers, M. Stocks, B. Lu, et. al. (2019) Pathway to 100% Renewable Electricity. IEEE Journal of Photovoltaics, 99:1-6
33. Ren 21, Renewables 2019 Global Status Report (2019)
34. Acemoglu, D., P. Aghion, L. Bursztyn, and D. Hemous. 2012, The Environment and Directed Technical Change. American Economic Review 102: 131–66, International Energy Agency, Coal 2019
35. Edenhofer, Ottmar, Jan Christoph Steckel, Michael Jakob, and Christoph Bertram. 2016. How cheap coal threatens the Paris agreement. MCC Working Paper.
36. Burgherr, P., & Hirschberg, S. (2014). Comparative risk assessment of severe accidents in the energy sector. Energy Policy, 74, S45-S56; McCombie, C., & Jefferson, M. (2016).
37. Renewable and nuclear electricity: Comparison of environmental impacts. Energy Policy, 96, 758-769
38. Hirschberg, S., Bauer, C., Burgherr, P., Cazzoli, E., Heck, T., Spada, M., & Treyer, K. (2016)
39. Health effects of technologies for power generation: Contributions from normal operation, severe accidents and terrorist threat. Reliability Engineering & System Safety, 145, 373-387 Luderer, G., Pehl, M., Arvesen, A., Gibon, T., Bodirsky, B. L., de Boer, H. S., … & Mima, S. (2019).
40. Environmental co-benefits and adverse side-effects of alternative power sector decarbonization strategies. Nature Communications, 10 (1), 1-13
41. Hertwich, E. G., Gibon, T., Bouman, E. A., Arvesen, A., Suh, S., Heath, G. A. and Shi, L. (2015). Integrated life-cycle assessment of electricity-supply scenarios confirms global environmental benefit of low-carbon technologies. Proceedings of the National Academy of Sciences, 112(20), 6277-6282.
42. Paul Slovic, The risk game Journal of Hazardous Materials 86 (2001) 17–24
43. Geoghegan, H., & Brace, C. (2011). On climate change and cultural geography: Farming on the Lizard Peninsula, Cornwall, UK. Climatic Change, 113(1), 55–66. doi:10.1007/s10584-012-0417-5.
44. Amos Tversky & Daniel Kahneman, Judgment Under Uncertainty: Heuristics and Biases, 185 SCI.

1124, 1127 (1974).
45. R.I. Palm, Natural Hazards: An Integrative Framework for Research and Planning, Johns Hopkins, Baltimore, 1995.
46. John Schwartz, How Has Climate Change Affected Hurricane Dorian?, New York Times September 3, 2019
47. Slocum, R. (2004). Polar bears and energy-proficient light bulbs: Strategies to bring climate change home. Environment and Planning D Society and Space, 22, 413–438.
48. Minh Ha-Duong, V. Journ´e. Calculating nuclear accident probabilities from empirical frequencies. Environment Systems and Decisions, 2014, 34 (2), pp.249-258.
49. Alan Buis, A Degree of Concern: Why Global Temperatures Matter, NASA's Global Climate Change Website, June 9, 2019
50. S. Breyer, Breaking the Vicious Circle: Toward Effective Risk Regulation, Harvard University Press, Cambridge, MA.
51. Bea, R., I. Mitroff, D. Farber, H. Foster and K.H. Robert, "A New Approach to Risk: The Implications of E3," Journal of Risk Management, February 2009, Vol. 11, pp. 30-43, doi: 10.1057/rm.2008.12.
52. DOE Standard Human Performance Improvement Handbook, Vol. 1 DOE-HDBK-1028-2009 June 2009 at 1-10
53. Carlton Stoiber et. al., Handbook on Nuclear Law, International Atomic Energy Agency, 2003.
54. Jody Freeman & Daniel A. Farber, Modular Environmental Regulation, 54 Duke L.J. 795, 876 (2005).
55. Daniel Farber, Robert Bea, Karlene Roberts and Kofi Inkabi, Reinventing Flood Control, 81 Tul. L. Rev. 1085 (2006)
56. Stephen Breyer, Breaking the Vicious Circle: Toward Effective Risk Regulation, Harvard University Press, Cambridge, MA.
57. S. Alexievich, Voices from Chernobyl: The Oral History of a Nuclear Disaster, Picador (2006)
58. A. Petryna, Nuclear Payouts: Knowledge and Compensation in the Chernobyl Aftermath, Anthropology Now, November 19, 2009
59. V. Lamm, Reflections on the development of international nuclear law, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1
60. O. Jankowitsch and F. Flakus International convention on nuclear safety: A legal milestone, IAEA Bulletin, 3/1994
61. Effective Nuclear Regulatory Systems: Facing Safety and Security Challenges, Proceedings Series - International Atomic Energy Agency (2006)
62. Wan, Wilfred. "Southeast Asia." In *Regional Pathways to Nuclear Nonproliferation*, 78-94. Athens: University of Georgia Press, 2018. Accessed April 26, 2020.
63. Z. Ilyas, Nuclear Regulatory Policy Concept on Safety, Security, Safeguards and Emergency Preparedness (3S+EP), IAEA-CN-166/19
64. D. Hanks, Managing Safety, Security, and Safeguards (3S) Relationship: A National Regulatory Authority Perspective United States Nuclear Regulatory Commission, Institute of Nuclear Materials Management 54th Annual Meeting (2013)
65. Taniguchi, Establishment and Application of Safety Standards and Security Guidance, Effective Nuclear Regulatory Systems: Proceedings of an International Conference, IAEA 2006 at p. 97

66. C. Stoiber, A. Cherf, W. Tonhauser, M. De Lourdes, Handbook on Nuclear Law, IAEA 2010 at p. 25
67. S. Burns, Reformed and reforming: Adapting the licensing process to meet new challenges, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1
68. F, Paris and N Ghei, The Role of Reciprocity in International Law, Cornell International Law Journal Vol. 6 Issue 1 Spring 2003 Article 4 at p. 100
69. N. Pelzer, Facing the challenge of nuclear mass tort processing, OECD - Nuclear Energy Agency Nuclear Law Bulletin No. 99, Vol. 2017/1
70. Hans Wehberg, The American Journal of International Law , Oct., 1959, Vol. 53, No. 4 (Oct., 1959), pp. 775-786 and Josef L. Kunz, The Meaning and the Range of the Norm Pacta Sunt Servanda, 39 AM. J. INT'l L. 180 (1945).
71. M. Mendez., The Legal Effects of Treaties in Domestic Legal Orders and the Role of Domestic Courts, Oxford University Press 2013 ISBN-13: 9780199606610
72. C. Stoiber, A. Cherf, W. Tonhauser, M. De Lourdes, Handbook on Nuclear Law, IAEA 2010 at p. 20
73. Wolff, K., The Vienna International Conference on Civil Liability for Nuclear Damage, in Weinstein, J. (ed.) Progress in Nuclear Energy, Pergamon Press: Oxford 1966, on p. 7
74. N. Pelzer, Concepts of Nuclear Liability Revisited: A Post-Chernobyl Assessment of the Paris and the Vienna Conventions, in Nuclear Energy Law after Chernobyl 98 (P. Cameron, L. Hancher and W. Kuhn, ed., London: Graham & Trotman Limited, 1988). .
75. Stephen G. Burns, A Global Nuclear Liability Regime: A Journey Or A Destination?, at the 2012 INLA Inter Jura
76. M. J. L. Hardy, Nuclear Liability: The General Principles of Law and Further Proposals, 36 Brit. Y. B. Int'l L. 223 (1960).
77. Adriana Petryna, Knowledge and Compensation in the Chernobyl Aftermath, Anthropology Now, September 2009, Vol. 1, No. 2, Special Atomic Issue (September 2009), pp. 30-39.
78. Julia A. Schwartz, International Nuclear Third Party Liability Law: The Response to Chernobyl, International Nuclear Law in the Post-Chernobyl Period OECD-NEA 2006
79. Gerhard Kegel & Ignaz Seidl-Hohenveldern, On the Territoriality Principle in Public International Law, 5 Hastings Int'l & Comp. L. Rev. 245 (1982).
80. James Hamilton, “Access by Victims to the Compensation Regime of the Vienna Convention on Civil Liability for Nuclear Damage - Question of Geographical Scope” at the Budapest Symposium, 1999
81. James Hamilton - Access by Victims to the Compensation Regime of the Vienna Convention on Civil Liability for Nuclear Damage the Question of “Geographical Scope” at the International Symposium on Reform of Civil Nuclear Liability at Budapest, Hungary,1999
82. N. Pelzer, Concepts of Nuclear Liability Revisited: A Post-Chernobyl Assessment of the Paris and the Vienna Conventions, in Nuclear Energy Law After Chernobyl 98 (P. Cameron, L. Hancher and W. Kuhn, ed., London: Graham & Trotman Limited, 1988).
83. Ben McRae, “The Compensation Convention: Path to a Global Regime for Dealing with Legal Liability and Compensation for Nuclear Damage”, Nuclear Law Bulletin No. 61 (1998)
84. Otto von Busekist, “A Bridge Between Two Conventions on Civil Liability for Nuclear Damage: the Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention

85. Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX).
86. Richard D. McClure, A Review of Nuclear Energy Insurance
87. Civil liability for nuclear damage: Advantages and disadvantages of joining the International Nuclear Liability Regimes – A paper by the International Expert Group on Nuclear Liability (INLEX)" (undated), available at: ola.iaea.org/ola/treaties/documents/liability_regime.pdf
88. OECD-NEA Nuclear Law Bulletin No. 93, 2014 at p. 18
89. Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear
90. Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX). http://ola.iaea.org/ola/treaties/documents/liability_regime.pdf
91. H. Stuart Burness, W. David Montgomery and James P. Quirk Source: Land Economics , May, 1980, Vol. 56, No. 2 (May, 1980), pp. 188-202
92. N. Barkatullah, A. Ahmad, Current status and emerging trends in financing nuclear power projects, Energy Strategy Reviews, Volume 18, 2017, Pages 127-140, ISSN 2211-467X.
93. Economic Assessment of the Long-term Operation of Nuclear Power Plants: Approaches and Experience, IAEA Nuclear Energy Series No. NP-T-3.25 at p.19
94. Dana Nuccitelli, The many ways climate change worsens California wildfires, Yale Climate Connections November 13, 2018.
95. J. Oosten et. al., Impacts of Market Restructuring & Deregulation on Nuclear Safety: Lessons Learned from Rail, Aviation, and the British Experience INIS – FR—727, International Atomic Energy Agency (IAEA)
96. Sinclair A., Palinkas P. (1999) Vertical Integration in the Electricity Supply Industry: Competition and Investment Issues. In: Welfens P.J.J., Yarrow G., Grinberg R., Graack C. (eds) Towards Competition in Network Industries. Springer, Berlin, Heidelberg as p. 27.
97. Sioshansi, Fereidoon P.. (2008). Competitive Electricity Markets - Design, Implementation, Performance - 1.3.1.3 Lessons Learned. Elsevier.
98. Hugh Rudnick and Constantin Velasquez, Learning from Developing Country Power Market Experiences: The Case of the Philippines, Policy Research Working Paper 8721, World Bank January 2019
99. Adiya Belgibayeva and Alexander Plekhanov, Does corruption matter for sources of foreign direct investment?, European Bank of Reconstruction and Development Working Paper No. 176 (February 2015) at P. 23.
100. Pupovic, Elvira (2012) : Corruption's Effect on Foreign Direct Investment - The Case of Montenegro, Economic Review: Journal of Economics and Business, ISSN 1512- , University of Tuzla, Faculty of Economics, Tuzla, Vol. 10, Iss. 2, pp. 13-28
101. Landon Stevens and Mark Pischea, Exposing the utility playbook: Ratepayers are stuck paying the bill for utility corruption, Utility Dive May 27, 2021 (Accessed September 1, 2021) https://www.utilitydive.com/news/exposing-the-utility-playbook-ratepayers-are-stuck-paying-the-bill-for-uti/600784/
102. S. Hoffman, Phillipines: Asia Pacific Energy Series Country Report, Energy Program Resource Systems Institute, November 1988

https://www.osti.gov/servlets/purl/6368191
103. Ryan Collyer, acting CEO of Rosatom Central and Southern Africa, correspondence with *POWER Magazine*,
104. Darrell Proctor, Philippines Taking New Look at Nuclear Power, Power Magazine October 1, 2020 https://www.powermag.com/russia-china-drive-africas-plan-for-nuclear-expansion/
105. Aaron Klein, Here are three ways to pay for new investments in infrastructure and end partisan gridlock, Brookings Institute December 12 2018 https://www.brookings.edu/blog/up-front/2018/12/12/here-are-three-ways-to-pay-for-new-investments-in-infrastructure-and-end-partisan-gridlock/
106. Volpe, Robert C. "The Role of Advanced Cost Recovery in Nuclear Energy Policy." Sustainable Development Law & Policy 15, no. 1 (2015): 28-38, 59-61 at p. 33.
107. Koplow, Doug. "Subsidies to Factors of Production." NUCLEAR POWER: Still Not Viable without Subsidies, Union of Concerned Scientists, 2011, p.37. JSTOR, http://www.jstor.org/stable/resrep00072.9. Accessed 11 Aug. 2022.
108. W.M. Warwick, A Primer on Electric Utilities, Deregulation, and Restructuring of U.S. Electricity Markets, US Department of Energy July 2000 https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-13906.pdf
109. Rothwell, Geoffrey. Electricity Economics: Regulation and Deregulation. New York: Wiley-IEEE, 2002
110. Taylor, Michael (2020), Energy subsidies: Evolution in the global energy transformation to 2050, International Renewable Energy Agency, Abu Dhabi.
111. The deepest cuts, The Economist September 20, 2014 edition https://www.economist.com/briefing/2014/09/20/the-deepest-cuts
112. The Future of Nuclear Energy in a Carbon-Constrained World, MIT Energy Initiative 2018 https://energy.mit.edu/wp-content/uploads/2018/09/The-Future-of-Nuclear-Energy-in-a-Carbon-Constrained-World.pdf
113. N. Bauer, R.. Brecha, and G. Luderer, Economics of nuclear power and climate change mitigation policies, PNAS October 16, 2012 109 (42) 16805-16810; https://doi.org/10.1073/pnas.1201264109
114. Abigail Hing Wen, Suing the Sovereign's Servant: The Implications of Privatization for the Scope of Foreign Sovereign Immunities, Columbia Law Review , Oct., 2003, Vol. 103, No. 6 (Oct., 2003), pp. 1538-1587
115. K. R. Simmonds, Sovereign Immunity, The International and Comparative Law Quarterly, Jan., 1978, Vol. 27, No. 1 (Jan., 1978), pp. 252-254
116. Daniela Páez-Salgado, A Battle on Two Fronts: Vattenfall v. Federal Republic of Germany, Kluwer Arbitration Blog, February 18 2021 (Accessed September 8, 2021) http://arbitrationblog.kluwerarbitration.com/2021/02/18/a-battle-on-two-fronts-vattenfall-v-federal-republic-of-germany/
117. W. H. Upjohn, Choice of Law, The Cambridge Law Journal , 1926, Vol. 2, No. 3 (1926), pp. 321-339
118. Ian Baxter, International Business and Choice of Law, The International and Comparative Law Quarterly, Jan., 1987, Vol. 36, No. 1 (Jan., 1987), pp. 92-115
119. M. Kilejian and C. Edlund, Enforceability of Choice of Forum and Choice of Law Provisions,

Franchise Law Journal, FALL 2012, Vol. 32, No. 2 (Fall 2012), pp. 81-94
120. Julia A. Schwartz, International Nuclear Third Party Liability Law: The Response to Chernobyl, International
121. Ben McRae, "The Compensation Convention: Path to a Global Regime for Dealing with Legal Liability and Compensation for Nuclear Damage", Nuclear Law Bulletin No. 61 (1998)
122. Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX). http://ola.iaea.org/ola/treaties/documents/liability_regime.pdf
123. Duncan E.J. Currie, The Problems and Gaps in The Nuclear Liability Conventions and An Analysis of How An Actual Claim Would be Brought Under The Current Existing Treaty Regime in The Event of a Nuclear Accident, Denv. Journal of International Law Vol. 35:1 Pp.85-127 (2005)
124. Civil Liability for Nuclear Damage: Advantages and Disadvantages of Joining the International Nuclear Liability Regime, A paper by the International Expert Group on Nuclear Liability (INLEX), IAEA 2012 https://www.iaea.org/sites/default/files/17/11/liability-regime.pdf
125. Stephen D. Krasner, Third World Vulnerabilities and Global Negotiations, Review of International Studies, Vol. 9, No. 4 (Oct. 1983), pp. 235-249
126. Minin and Vlček, "Determinants and considerations of Rosatom's external strategy," 37.
127. Névine Schepers, "Russia's Nuclear Energy Exports: Status, Prospects and Implications," Stockholm International Peace Research Institute, Non-Proliferation and Disarmament Paper, no. 61, February 2019, 2.
128. Nikita Minin and Tomáš Vlček, "Determinants and considerations of Rosatom's external strategy," Energy Strategy Reviews 17 (September 2017): 37-44, doi:10.1016/j.esr.2017.07.001
129. Jian Liu and Ye Feng, "Analysis of the Competitiveness of Russia's Nuclear Energy Overseas Development, Industry Insights," China Nuclear Industry, 2018, original in Chinese.
130. M. Wolf, Differential and More Favorable Treatment of Developing Countries and the International Trading System, The World Bank Economic Review, Vol. 1, No. 4, Symposium (Sep., 1987), pp. 647- 668
131. W. Roelf, South African court declares nuclear plan with Russia unlawful (April 26, 2017)
132. Samuel Paul, Transnational Corporations and Developing Countries: Some Issues in Industrial Policy, Economic and Political Weekly, Vol. 14, No. 30/32, Special Number (August 1979), pp. 1315-1330
133. B. Fischhoff, The Nuclear Energy Industry's Communication Problem, Bulletin of the Atomic Scientists, 17 February 2009.
134. P. Sandman, Three Mile Island — 25 Years Later, Safety at Work, April 24, 7–11. Int. At. Energy Agency Bull., March (2006) 9–13.
135. A. V. Lowe, Colin Warbrick, and John Woodliffe, "Chernobyl: Four Years On," International and Comparative Law Quarterly 39 (2) (1990): 461–471, and L. A. Malone, "The Chernobyl Accident: A Case Study in International Law Regulating State Responsibility for Transboundary Nuclear Pollution" (1987), Faculty Publications, Paper 590.
136. T. Weiss, The Campaign for Nuclear Power in Japan before and after 2011, Civil Society and the State in Democratic East Asia. Amsterdam University Press 2020 p. 85

137. J.M. Havenaar, et al., Perception of risk and subjective health among victims of the Chernobyl disaster, Soc. Sci. Med. 56 (2003) 569–572.
138. V.T. Covello, The perception of technological risks: a literature review, Technol. Forecast. Soc. 23 (1983) 285–297.
139. K. Shimomura, Disposal of Long-lived Waste - An International Perspective. In: Proceedings of DiSTec 2004, an International Conference on Radioactive Waste Disposal, Berlin, Germany, 26–28 April 2004
140. L. Robinson, Pro-active Public Participation for Waste Management in Western Australia, Part 1: Strategic Rationale, Prepared for the Western Australian Local Government Association & the Waste Education Strategy Integration Group, July 2002.
141. Ritchie, W. Monitoring long-term environmental change: Some lessons from Sullom Voe, Shetland Islands. WMU J Marit Affairs 3, 193–204 (2004). https://doi.org/10.1007/BF03195059
142. P.J. Richardson, A Review of Benefits Offered to Volunteer Communities for Siting Nuclear Waste Facilities.
143. S. Hoffman, Phillipines: Asia Pacific Energy Series Country Report, Energy Program Resource Systems Institute, November 1988
144. Reuben Holmes et. al, Public Engagement in the Nuclear Sector: A UK and EU Perspective EU08051/06/10/01 Issue 3 (October 2016)
145. Steve Kretzmann, "'Nigeria's Drilling Fields': Shell Oil's Role in Repression," Multinational Monitor 26, no. 1-2 (January/February 1995).
146. Steven Cayford, Africa Today , Apr. - Jun., 1996, Vol. 43, No. 2, Conflict and Conflict Resolution in Africa (Apr. - Jun., 1996), pp. 183-197
147. Steve Kretzmann, 'Nigeria's Drilling Fields': Shell Oil's Role in Repression, Multinational Monitor 26, no. 1-2 (January/February 1995)
148. R.A. Olu Sule, The Environmental Pollution Consequences of Nigerian Oil Boom: The Socio-Economic Calamity of Oil Spillage in the Delta Region, GeoJournal , 1982, Vol. 6, No. 5, Miscellanies in Economic Geography (1982), pp. 443-452
149. Okonkwo, C.N.P., Kumar, L., Taylor, S. (2015), The Niger Delta wetland ecosystem: What threatens it and why should we protect it? African Journal of Environmental Science and Technology, 9(5), 451-463.
150. Ghazvinian, John. "The Curse of Oil: Niger Delta, Nigeria, 2005." *The Virginia Quarterly Review*, vol. 83, no. 1, 2007, pp. 4–27. *JSTOR*, http://www.jstor.org/stable/26444733. Accessed 6 Feb. 2023.
151. Hennchen, Esther. "Royal Dutch Shell in Nigeria: Where Do Responsibilities End?" *Journal of Business Ethics*, vol. 129, no. 1, 2015, pp. 1–25. *JSTOR*, http://www.jstor.org/stable/24702884. Accessed 6 Feb. 2023.
152. Adrian Bull et. al., NUGENIA: Developing an 'EU Nuclear Public Engagement Toolkit' EU08051/06/10/02 Issue 3 (2016) https://www.nnl.co.uk/wp-content/uploads/2019/12/EU08051-06-10-02-Issue-3-NUGENIA-Developing-an-EU-Nuclear-Public-Engagement-Toolkit.pdf
153. Omenyi Tonia, Oil Resource Management: Lessons from Canada and Nigeria at p. 74 DOI10.13140/RG.2.2.15815.52649
154. Cardis E, Krewski D, Boniol M, Drozdovitch V, Darby SC, Gilbert ES, Akiba S, Benichou J, Ferlay J, Gandini S, Hill C, Howe G, Kesminiene A, Moser M, Sanchez M, Storm H, Voisin L,

Boyle P. Estimates of the cancer burden in Europe from radioactive fallout from the Chernobyl accident. International Journal of Cancer. 2006;119(6):1224–1235.

155. Whitton, J. (2010) 'Participant Perceptions on the Nature of Stakeholder Dialogue Carried Out by the UK Nuclear Decommissioning Authority (NDA)', PhD Thesis submitted to the University Of Manchester.
156. Elam, M. and Sundqvist, G. (2007) 'Six Domains of Decision for Stakeholder Involvement in Nuclear Waste Management', CARL Thematic Report No. 4; Bergmans, A. (2008)
157. Leslie-Anne Duvic-Paoli and Priska Lueger, A democratic nuclear energy transition? Public participation in nuclear activities, February 2022
158. Stewart, Jane Bloom, and Richard Burleson Stewart. *Fuel Cycle to Nowhere: U.S. Law and Policy on Nuclear Waste.* Nashville: Vanderbilt University Press, 2011. muse.jhu.edu/book/10361 Pp. 207-209.
159. Marta Adams, Yucca Mountain - Nevada's Perspective, Idaho Law Review Vol. 46 1-26
160. Thegerstrom, C. and Engstrom, S.L. (2012) 'Deep Geological Disposal of Nuclear Waste in the Swedish Crystalline Bedrock', International Journal for Nuclear Power, vol. 59, no. 6
161. Ahagen, H. (1999), The Oskarshamn Model for Public Involvement in the Siting of Nuclear Facilities, IAEA NCL Collection Store, SE0000124.
162. Bharat Desai, The Bhopal Gas Leak Disaster Litigation: An Overview, Asian Yearbook of International Law, Volume 3 (Ko Swan Sik et al., eds.; 0-7923-2708-X; 1994 Kluwer Academic Publishers; printed in
163. Aroh, Kenneth & Ubong, Ini & Chibuogwu, Eze & Harry, I.M. & Umo-Otong, J.C. & A.E., Gobo. (2010).
164. Ntukekpo, D.S. (1996), Spillage: Bane of Petroleum, Ultimate Water Technology and Environment, Ota
165. Steven Cayford, The Ogoni Uprising: Oil, Human Rights, and a Democratic Alternative in Nigeria, Africa Today, Apr. - Jun., 1996, Vol. 43, No. 2, Conflict and Conflict Resolution in Africa (Apr. - Jun., 1996), pp. 183-197
166. Nuclear Law: The Global Debate, International Atomic Energy Agency (2019) ISBN 978-94-6265-494-5
167. Hamad AlKaabi, Nuclear Newcomer Countries—The Path of the United Arab Emirates http://www.uaeiab.ae/ar/members.html

Websites

1. Daily CO2. CO2.Earth. https://www.co2.earth/daily-co2
2. International Monetary Fund, World Economic Outlook Database 2019. https://www.imf.org/en/Publications/WEO/weo-database/2019/October
3. How Climate Is Changing, NASA https://climate.nasa.gov/effects/
4. Akkuyu NPP Construction Project http://www.akkunpp.com/