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NUCLEAR ENERGY & ENERGY TRANSITIONS: PROSPECTS, CHALLENGES AND SAFEGUARDS IN SUB-SAHARAN AFRICA

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ABSTRACT

In the pursuit of decarbonisation, states in Sub-Saharan Africa (SSA), like their developed counterparts, must ensure the realisation of climate change objectives. The obligations relate to limiting greenhouse gas emissions and overall temperature increase as stipulated by the international climate change regime. Besides, the States have to ensure access to affordable and clean energy for all people as per the 2015 Sustainable Development Goal (SDG) Number 7. In SSA, South Africa has embraced the use of nuclear energy with many others like Uganda, Kenya, Tanzania, Ghana, Nigeria, Zambia and Ethiopia considering atomic power programmes. Although it does not fall within the ambits of renewable energy per se, nuclear energy is a two-sided sword tackling both the climate change concerns while addressing the access to energy challenges. This is crucial for sub-Saharan Africa, where a significant portion of the population lacks access to modern and cleaner forms of energy.

Effective regulation of the nuclear industry is vital in achieving the broader objectives of the climate change regime and meeting SSA energy needs. However, following the Chernobyl and Fukushima Daichi nuclear power accident disasters, populations are sceptical in embracing nuclear energy. Further, the utilisation of nuclear energy poses questions relating to safety, environmental issues, and regulatory inadequacies, among other things. This chapter thus examines the major prospects and challenges of developing nuclear energy in the region while paying specific attention to environmental, safety and nuclear accident liability regulation under international law. Countries should incorporate these in the national legislation for achieving a productive nuclear energy industry. By comparing the SSA regime to that of the European Union (EU) with particular reference to France, ultimately, the chapter finds that for the region to reap the benefits of nuclear energy, it must put in place robust policies and regulatory measures to address the potential and resulting challenges.

Key Words: Nuclear Energy, Nuclear Safety, Nuclear Accident Liability, Social and Environmental Protection, Non-proliferation and Security

1. INTRODUCTION

The 2030 Agenda for Sustainable Development[1] under goal seven calls for concerted efforts in ensuring access to modern and cleaner forms of energy while goal 13 provides for taking action to combat climate change. Moreover, the 2015 Paris Agreement[2] puts in place measures and conditions for all member states to mitigate climate change by reducing emissions to '*hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognising that this would significantly reduce the risks and impacts of climate change*'[3], with access to clean energy being key in the cause. The world is, therefore, looking for cleaner forms of energy as compared to the traditional fossil fuels which are considered detrimental to the environment for their far-reaching consequences on the climate.

In the fight against climate change, therefore, all measures which alleviate the problem must be explored. Although nuclear energy was widely shunned and a significant part of the population remains sceptical about its use, it stands as one of the cleanest forms of energy with little emissions as compared to the widely used fossil-based fuels. It thus offers a bigger platform for mitigating climate change and meeting electricity demands of the world,[4] especially in the least developed countries like those in the SSA region. Nuclear energy is a form of energy produced by an atomic reaction, capable of producing a cleaner alternative source of electrical power to that produced by traditional fossil fuels.

However, the use of nuclear power energy is not immune to criticism. Following the Chernobyl nuclear accident of 1986 and the Fukushima Daiichi accident of 2011 in Japan, many countries

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[1] The concept of sustainable development and sustainability as it appears today was first established by the Brundtland Commission in 1987. It is currently recognised as the standard definition, and it espouses that sustainable development is "a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." See 'Transforming our world: the 2030 Agenda for Sustainable Development, 2015' <http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E> See also the 2000 Millennium Development Goals <http://www.un.org/en/mdg/summit2010/pdf/List%20of%20MDGs%20English.pdf>

[2] See the Paris Agreement, 2015, United Nations <https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf>

[3] *Ibid*., Article 2

[4] OECD, '*Risks and Benefits of Nuclear Energy*,' 2007, Nuclear Agency, Organisation for Economic Cooperation and Development pp.19,20

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and people are cynical about the use and production of nuclear energy.[5] This is because it has many adverse related consequences if things go wrong, including environmental degradation, social and economic loss and damage, *inter alia*. These hazards have raised the global action, especially with an increased focus on nuclear safety, environmental protection and comprehensive liability regimes in determining how nuclear victims are to be compensated or who bears the burden of compensation.[6]

Moreover, there exists an active nuclear science and technology sector in Africa, and this includes several research reactors, and with many governments expressing interest in starting commercial nuclear programs.[7] Several States in SSA are currently exploring or investing in the use of nuclear energy to meet the enormous demands of power for their populations. Such countries include Uganda, Ethiopia, Tanzania, Namibia, Rwanda and Zambia, among others, with South Africa being the only country in the region which already has a commercial nuclear power plant. Globally, there are some countries like France which are heavily reliant on nuclear energy, and these are used as benchmarks by the rest of the world in determining how they can manage the nuclear industry successfully.

The author acknowledges that the development of nuclear power energy requires several safeguards like proper technology, sound financing sources, skilled workforce, and goodwill of the people, among others. However, this chapter is majorly limited to legal and policy safeguards on nuclear safety, social and environmental protection. It tackles one major question: - What are the critical legal and regulatory issues to be addressed for the active development and management of the nuclear energy power industry in SSA? This chapter thus argues that aligning Africa's policies with the global nuclear legal regimes is crucial in determining the region's energy future. Further, that effective policy choices can guide the continent to a more inclusive and sustainable energy future and accelerate its economic and industrial development[8] while meeting the objectives of the climate change regime.

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[5] Patricia Birnie, Alan Boyle and Catherine Redgwell, '*International Law and the Environment*,' 2009, Third Edition, Oxford University Press p.488

[6] See Abigail Sah, Jessica Lovering, Omaro Maseli, and Aishwarya Saxena. 2018. "*Atoms for Africa: Is There a Future for Civil Nuclear Energy in Sub-Saharan Africa?*" CGD Policy Paper. Washington, DC: Center for Global Development. <https://www.cgdev.org/publication/atoms-africa-there-future-civilnuclear-energy-sub-saharan-africa>

[7] *Ibid*., at p.5 >

[8] International Energy Agency, 'Africa Energy Outlook 2019,' 2019, World Energy Outlook Special Report, p.18.

It tackles the significant challenges posed by the use of nuclear energy ranging from social, economic and environmental aspects. Section 2 examines the relationship between nuclear power, access to electricity and climate change. It also examines the major social, economic, ecological and regulatory concerns around nuclear use and reflects on the nuclear power accidents of Chernobyl and Fukushima Daichi. Section 3 discusses the international nuclear legal regime on matters of safety, nuclear accident liability, environmental and social protection, *inter alia*. Through a comparative analysis, Section 4 analyses the status of the nuclear sector in the European Union (EU) with a focus on France and draws success lessons for guiding policy in SSA for the emerging industry. It also examines the energy challenges of SSA and the status of nuclear activity and its regulation. Chapter 6 makes recommendations and conclusions.[9]

2. NUCLEAR ENERGY: ACCESS TO ENERGY AND CLIMATE CHANGE

This section discusses the nexus between nuclear energy, access to electricity and climate change. It also highlights both the pros and cons of the use of nuclear power and why public perception has remained low.

2.1 Nuclear Energy and access to energy

Energy is key to the achievement of economic growth and development. As such, under Goal 7 of the Sustainable Development Goals (SDGs), there are global commitments to '*Ensure access to affordable, reliable, sustainable and modern energy for all.*' This also includes increasing the use of renewable energy worldwide.[10] SSA countries are still struggling with energy access and energy poverty challenges. Moreover, Sub-Saharan Africa experiences energy insecurity due to some crucial changes such as population growth, fast-tracked

[9] For a full discussion on nuclear energy, watch the video featuring the author and other experts. Nuclear Energy Developments in Africa. Link, https://www.youtube.com/watch?v=bt3n-ssgpjI&t=136s

[10] See SDG 7.2; Many NDCs currently feature renewable energy which shows its role in addressing climate change. Out of the 194 parties to the UNFCCC which adhered to the Nationally Determined Contributions (NDCs) under the 2015 Paris Agreement, for instance, 145 referred to renewable energy as being key in the mitigation of climate change. In addition, 109 parties have incorporated some form of quantified targets for renewables. Several sub-Saharan African States have either ratified, accepted, approved or accented to the Paris Agreement. The Agreement is in force in the countries including Botswana, Cameroon, Burundi, Democratic Republic of Congo, Ethiopia, Ghana, Nigeria, Kenya, Uganda, Malawi, South Africa, Rwanda, and Zimbabwe *inter alia*. They are thus enjoined to meet their own NDCs as well as adhering to objectives and targets of the Agreement. See IRENA (2017), '*Untapped Potential for Climate Action: Renewable Energy in Nationally Determined Contributions*,' p.7, International Renewable Energy Agency, Abu Dhabi. http://irena.org/-/media/Files/IRENA/Agency/Publication/2017/Nov/IRENA_Untapped_potential_NDCs_2017.pdf; See Also the UN Report of the Secretary-General, 'Special edition: progress towards the Sustainable Development Goals,' 2019, Economic and Social Council.

urbanisation, economic development and relative price changes of other energy options. These make the region more susceptible to the effects of climate change.[11] The people therefore mainly depend on wood-based biomass for their energy needs, with approximately 81% of households relying on it.[12] Most energy in sub-Saharan Africa, with South Africa being the exception, is used for cooking, which accounts for around 70% of the total final consumption as compared to less than 10% globally.[13] Therefore, taking into account the energy access challenges in SSA, there is potential for nuclear energy to contribute in tackling these challenges.

2.2 Nuclear Energy and Climate change

Nuclear energy can play a significant role in not only tackling energy access challenges in SSA but also the fight against climate change. There is also a global movement to transition to a low carbon economy and fight climate change by reducing reliance on fossil fuels. This presents an opportunity for the development and utilisation of Nuclear energy. Nuclear energy is a form of energy produced by an atomic reaction. A nuclear reactor produces energy through a chain reaction that splits a uranium nucleus, releasing energy in the form of heat. The collision of one neutron with one nucleus of uranium leads to the production of electricity, among others. Many SSA countries such as South Africa, Zimbabwe, Namibia, Botswana, Malawi, and Zambia have got large uranium deposits, and this makes the region a fertile ground for the growth of the nuclear industry.[14] Namibia alone has got the potential of providing 10 per cent of the world's mining output due to its substantial uranium deposits and mines.[15]

Nuclear energy is capable of producing an alternative source of electrical power to that supplied by the traditional sources - coal, gas, or oil which are considered unclean.[16] This is especially important in a world where the focus is shifting from the conventional energy sources to other

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[11] World Bank. 2011. *'Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches, at p.8,* Energy Sector Management Assistance Program (ESMAP); World Bank, Washington, DC. © World Bank. <*https://openknowledge.worldbank.org/handle/10986/26149*> *License: CC BY 3.0 IGO.*

[12]—World Bank, 2011, *ibid*., at *p.v.*

[13] IEA, 'Africa Energy Outlook 2019,' *supra*, at p.86

[14] Further information at <https://www.world-nuclear.org/information-library/country-profiles/others/uranium-in-africa.aspx>; See also 'OECD Nuclear Energy Agency and International Atomic Energy Agency, *Uranium 2018: Resources, Production and Demand ('Red Book')'*- A Joint Report by the Nuclear Energy Agency and the International Atomic Energy Agency <https://www.oecd-nea.org/ndd/pubs/2018/7413-uranium-2018.pdf>

[15] See World Nuclear Association, 'Nuclear in Namibia,' <https://www.world-nuclear.org/information-library/country-profiles/countries-g-n/namibia.aspx>.

[16] See OECD, '*Risks and Benefits of Nuclear Energy*,' 2007, *supra*.

forms with a less carbon footprint in a bid to mitigate climate change – the 'energy transition'.[17] Nuclear energy, although not renewable per se, is a clean source of power considering its tiny carbon footprint.

With respect to the nexus between nuclear energy and climate change, it is worth briefly exploring what climate change means. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as those changes in the state of the climate which persist for an extended period whether due to natural causes or because of human activity.[18] The adoption of the Paris Agreement in 2015 which focuses a lot on reducing greenhouse gas (GHG) emissions has seen a surge in the efforts for a global transition to a low carbon economy by advocating for a shift from fossil fuels to cleaner sources. However, much focus has always been on renewable energy.[19]

Besides, one of the significant ways through which climate change can be mitigated is by reducing the amounts of carbon emitted through the use of clean energy.[20] This is because a lot of pollution is proven to occur from the use of traditional fossil fuels and from the use of wood-based fuels in many developing countries where there is limited access to modern fuel means.[21] About 78% of the total global GHG emissions between 1970 and 2010 resulted from CO2 emissions from fossil fuel combustion and industrial processes, with the trend continuing for proceeding years.[22]

There is no universally agreed definition of the term 'clean energy'. However, it is usually defined descriptively by referring to energy sources by the level at which they emit pollutant substances to the environment. The Environmental Protection Agency (EPA) for instance defines clean energy as those resources which meet energy demand needs with less pollution

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[17] Nalule, V.R., 2020. Transitioning to a Low Carbon Economy: Is Africa Ready to Bid Farewell to Fossil Fuels?. In *The Palgrave Handbook of Managing Fossil Fuels and Energy Transitions* (pp. 261-286). Palgrave Macmillan, Cham.

[18] IPCC, 'Fourth Assessment Report: Climate Change 2007' (2007) <https://www.ipcc.ch/publications_and_data/ar4/syr/en/mains1.html>

[19] *Ibid*, p.261

[20] See Mark Maslin, 'Climate: A Very Short Introduction,' Oxford University Press (2013) at p.120.

[21] In fact, about half of the world's population and 80% of Africans rely on wood-based fuels for their energy needs. *See* World Bank. 2011. *'Wood-Based Biomass Energy Development for Sub-Saharan Africa: Issues and Approaches,' at p.8,* Energy Sector Management Assistance Program (ESMAP); World Bank, Washington, DC. © World Bank. <*https://openknowledge.worldbank.org/handle/10986/26149*> *License: CC BY 3.0 IGO*

[22] IPCC, '*Climate Change 2014: Synthesis Report*,' 2014, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, RK Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp.45-47

compared to the conventional fossil-based sources–in essence; they have a low carbon footprint.[23]

2.3 Nuclear Energy: Merits and Challenges

While nuclear energy is an attractive option in terms of being clean, reliable and cost-effective for the developed world, in Africa, nuclear power could be the answer to the continent's energy deficiency.[24] Other advantages of nuclear energy include the low emission of carbon dioxide and other greenhouse gases and low operating costs.

There is also a direct link between SDG 7 on access to energy and SDG 13, which requires taking action on combating climate change and its impacts. Studies also show that access to modern forms of energy is closely intertwined with and has got a direct bearing on other SDGs. For instance, SDG 7 on affordable and clean energy has a direct impact on the SDG goals on the eradication of poverty[25]; eradication of hunger, food security and sustainable agriculture[26]; healthy lives[27]; and gender equality[28], among others.[29]

However, the nuclear energy industry is a complex one, and it has got potential grave negative impacts on the environment if not properly managed. By their nature, nuclear activities produce solid, liquid and gaseous waste with some being radioactive. Besides, atomic installations have a lifespan, and even when they are no longer in operation, they must stay in a satisfactory safety condition following the proper standards of dismantling installations. Even so, dismantling operations produce radioactive waste which has to be managed to avoid the resulting consequences on both people and the environment.

Furthermore, the risks posed have got the potential to cause transboundary harm or pollution damage to other states. These perils are graver when it comes to the issue of accidents occurring

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[23] US Environmental Protection Agency (EPA), *'Assessing the Multiple Benefits of Clean Energy: A Resource for States*,' 2011, at p.2 https://www.epa.gov/sites/production/files/2017-06/documents/epa_assessing_benefits_ch1.pdf

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

[25] *See* SDG 1

[26] *See* SDG 2

[27] *See* SDG 3

[28] *See* SGG 5

[29] See Nalule, V.R., 2018. *Energy Poverty and Access Challenges in Sub-Saharan Africa: The Role of Regionalism*. Springer.

from nuclear operations as can be seen from the Chernobyl and the Fukushima Daiichi incidents. The world first awoke to the gruesome menaces of the nuclear power accidents following the explosion at the Chernobyl nuclear power plant on April 26, 1986, in Ukraine (formerly the Soviet Union).[30] This caused adverse effects such as damage to the atmosphere environment, urban environment, agriculture, forestry, and the aquatic environment, the contamination of the environment with radioactive substances, evacuation and relocation of more than 300,000 people as well as transboundary impacts.[31]

The Fukushima Daiichi nuclear power accident of 2011 in Japan presents yet another shocking face of the nuclear energy industry.[32] The accident resulted from a 9.0 magnitude earthquake which triggered a 15-meter tsunami, causing damage at the Fukushima Daiichi Nuclear power plants operated by the Tokyo Electric Power Company (TEPCO). The plant experienced hydrogen explosions and a meltdown, leading to the releasing of radiation into the environment. This led to contamination of soil and groundwater, and today, there is still evidence of contamination of the Pacific Ocean. Although no deaths or cases of radiation were recorded, over 85,000 people were evacuated from their homes following the accident.[33]

In conclusion, the use of nuclear energy presents many opportunities for SSA's energy access and security challenges as well as fostering the mitigation of climate change. As such, the region can meet its sustainable development targets under Goals 7 and 13. This is because nuclear is a more reliable and a cleaner form of energy compared to traditional energy sources. However, the associated risks to human health, society and environment and the disastrous magnitude of the accidents, for instance, Chernobyl and Daiichi make many people opposed to the development of the industry. These perils necessitate the setting up of a robust regulatory

[30] See Nuclear Monitor, 'Chernobyl: Chronology of a Disaster,' A publication of the Wise Information Service on Energy (WISE) and the Nuclear Information and Resource Service (NIRS), March 2011 issue No. 724 pp.2-4 <https://www.nirs.org/wp-content/uploads/mononline/nm724.pdf> (accessed on 10/4/2020)

[31] See, IAEA, '*Environmental consequences of the Chernobyl accident and their remediation: twenty years of experience/ report of the Chernobyl,'* Forum Expert Group 'Environment'. — Vienna: International Atomic Energy Agency, 2006. p.; 29 cm. — (Radiological assessment reports series, ISSN 1020-6566) STI/PUB/1239 ISBN 92–0–114705–8 <https://www-pub.iaea.org/MTCD/publications/PDF/Pub1239_web.pdf> (accessed on 10/4/2020)

[32] Stephen L. Kass, 'International Law Lessons from the Fukushima Nuclear Disaster,' New York Law Journal April 29, 2011, <www.clm.com/publication.cfm?ID=324>; World Nuclear Association <www.world-nuclear.org/information-library/safety-and-security/safety-ofplants/fukushima-accident.aspx>; World Nuclear Association <www.world-nuclear.org/focus/fukushima/fukushima-accident.aspx> (all accessed on 10/4/2020)

[33] Eri Osaka, *Corporate Liability, Government Liability, and the Fukushima Nuclear Disaster*, 21 PAC. RIM L & POL'Y J. 433 (2012) pp.433-459. Available at: <https://digitalcommons.law.uw.edu/wilj/vol21/iss3/3> (Accessed on 10/4/2020)

regime on global, regional and national scales to establish common legal and regulatory standards.[34] In so doing, a generally accepted minimum level of social and environmental protection is set.[35]

3. THE INTERNATIONAL LEGAL ORDER ON NUCLEAR ENERGY

There are currently four broad areas where global and regional regulation of nuclear energy is focused, and these include liability and compensation for nuclear damage, environmental protection, nuclear safety and emergency response, and Non-proliferation and nuclear security. International and regional institutions on nuclear use include the International Atomic Energy Agency (IAEA)[36]; International Commission on Radiological Protection (ICRP)[37]; Euratom Treaty; [38] the OECD Nuclear Energy Agency; and the Inter-American Nuclear Energy Commission (IANEC).

3.1 Liability and compensation for nuclear damage

In any accident arising from nuclear operations, the pressing issue is guaranteeing that there are proper measures for compensating the resulting damage.[39] The compensation relates to loss of life or personal property and any resultant economic loss, costs for repairing the environment and the financial loss resulting from use of the environment thereof and the cost of preventative measures, among other things. The Paris Convention on Nuclear Third-Party Liability (The Paris Convention)[40] establishes a liability regime for the compensation of victims arising out of nuclear accidents. It relies on principles like the exclusive liability – 'strict liability' – of the operator of a nuclear installation.[41] There exists the Brussels Supplementary Convention on Third Party Liability in the Field of Nuclear Energy (Brussels Supplementary Convention) which covers incidents arising out of nuclear activities of the contracting States, including those

[34] *Ibid* at p.493
[35] *Ibid*
[36] The IAEA is a creation of the Statute of the IAEA which was approved on October 23, 1956, by the Conference on the Statute of the International Atomic Energy Agency.
[37] Created in 1928, the ICRP is a non-governmental organisation responsible for assessing the knowledge of States on the effects of radiation and advising on the most appropriate radiological protection rules to adopt.
[38] See Article 2 of the 1957 Eurotam Treaty
[39] Raphael J. Heffron, Stephen F. Ashley, and William J. Nuttall, '*The global nuclear liability regime post-Fukushima Daiichi*,' Progress in Nuclear Energy 90 (2016) 1-10 at pp.6-8
[40] Convention on Third Party Liability in the Field of Nuclear Energy, 1960, as amended by the Additional Protocol of January 28, 1964, and by the Protocol of November 16 1982. Available at <https://www.oecd-nea.org/law/nlparis_conv.html>
[41] *See* Article 3 of the Paris Convention. *See* Heffron *et al*., (2016) *supra*., at pp.3-4 on the channelling principle.

causing transboundary harm.[42] Others include the Vienna Convention on Civil Liability for Nuclear Damage – (The Vienna Convention)[43]; Convention on Supplementary Compensation for Nuclear Damage (CSC)[44]and several Protocols.[45]

3.2 Environmental protection

Nuclear activities raise severe social and environmental concerns, mainly due to the ever-looming threat of radiation from atomic substances and waste throughout the entire project lifecycle. The areas covered include the transboundary ecological harm, protection of the marine environment, and environmental justice, among others, in line with the principles of sustainable development.[46] Firstly, the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)[47]obligates the contracting States to ensure the environmental impact assessment of nuclear activities during the early stages of planning. Secondly, under the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention)[48], the EU and other 15 governments undertake to cooperate in the prevention and elimination of pollution as well as the protection of the maritime area against the adverse effects of human activities to preserve human health. Others include the

[42] Brussels Supplementary Convention, Convention of January 31, 1963, Supplementary to the Paris Convention, 1960, as amended by the additional Protocol of 1964 and by the Protocol of 1982 ("Brussels Supplementary Convention"), Available at <https://www.oecd-nea.org/law/nlbrussels.html>. See also Philippe Sands and Paolo Galizzi, '*The 1968 Brussels Convention and Liability for Nuclear Damage*,' (1999) Nuclear Law Bulletin, NEA, OECD, No. 64, Dec 1999 at pp.7-27 *See also* Novotná Marianna and Varga Peter, '*The Relation of the EU Law and the Nuclear Liability Legislation: Possibilities, Limits and Mutual Interaction*,' (2014), Societas et Iurisprudentia, Vol.2. pp.96-123; Shirley S. Ho,Jiemin Looi, Agnes S.F. Chuah, Alisius D. Leong, Natalie Pang, "*I can live with nuclear energy if…": Exploring public perceptions of nuclear energy in Singapore*', 2018, Energy Policy, Elsevier Publishers.

[43] Vienna Convention on Civil Liability for Nuclear Damage (Vienna Convention), 1963. See also the 1997 Vienna Convention on Civil Liability for Nuclear Damage; 1999 Optional Protocol Concerning the Compulsory Settlement of Disputes to the Vienna Convention on Civil Liability for Nuclear Damage; 2000Vienna Convention on Civil Liability for Nuclear Damage; and Optional Protocol Concerning the Compulsory Settlement of Disputes; 2002 Vienna Convention on Civil Liability for Nuclear Damage; and the Optional Protocol Concerning the Compulsory Settlement of Disputes

[44] Convention on Supplementary Compensation for Nuclear Damage (CSC), 2015. 5

[45] See the Protocol to Amend the Vienna Convention on Civil Liability for Nuclear Damage (1997 Vienna Protocol); the Protocol to Amend the Paris Convention on Nuclear Third Party Liability (2004 Protocol to the PC); Protocol to Amend the Brussels Supplementary Convention on Third Party Liability in the Field of Nuclear Energy (2004)

[46] See Report of the World Commission on Environment and Development: Our Common Future (United Nations General Assembly, ("Brundtland Report"), 1987, p. 43) <http://www.un-documents.net/our-common-future.pdf>; The World Summit on Sustainable Development, *Johannesburg Declaration on Sustainable Development and Plan of Implementation*, 2002 <http://www.un-documents.net/jburgdec.htm>

[47] The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), 1991. See OECD, '*The application of the Espoo Convention on Environmental Impact Assessment in a Transboundary Context to nuclear energy-related activities*,' October 2016, Nuclear Law Bulletin 97, pp.63-69, Semi-annual ISSN: 16097378 <https://doi.org/10.1787/16097378>; See also the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) of 1992

[48] See the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) of 1992

Protocol on Strategic Environmental Assessment to the Espoo Convention (Kiev Protocol)[49]and the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention)[50]

3.3 Nuclear safety and emergency response

The global regime has established mechanisms for addressing safety challenges as well as setting tools to respond to emergencies arising out of nuclear activities. This regime has mainly developed following the nuclear power accidents of Chernobyl and Fukushima- Daichi, which had grave impacts on both the environment and human life. The effect of a nuclear accident can be momentous considering the range and nature of harm and the resources and technology required to deal with the damage. The Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency of 1986[51] provides for cooperation and assistance; while the Convention on Early Notification of a Nuclear Accident of 1986[52] provides for notification in case of a nuclear accident. Other issues include the management of waste and radioactive materials from the activities. The Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (Joint Convention)[53] aims to achieve and maintain, among others a high level of safety in spent fuel and radioactive waste management.

3.4 Non-proliferation and nuclear security

The devastating effects of the use of nuclear weapons such as the USA's atomic bombing of Hiroshima- Japan at the end of World War II on August 6, 1945, awakened the world to the need for non-proliferation and nuclear security safeguards.[54] Scholars have concluded that the nuclear threat is real as long as there still exists stockpiles of atomic weapons, and the only

[49] The Protocol on Strategic Environmental Assessment to the Espoo Convention (Kiev Protocol), 2003.
[50] The Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention), 1998. See also, Emmerechts, Sam. "*Environmental Law and Nuclear Law*." Nuclear Law Bulletin 2008.2 (2009): 91-110 at 91
[51] Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency (1986). It is under the auspices of the Director-General of the International Atomic Energy Agency. <https://www.iaea.org/sites/default/files/infcirc336.pdf > See also the Convention on Nuclear Safety, 1994 <https://www.iaea.org/sites/default/files/infcirc449.pdf>
[52] See Art. 1 of the Convention on Early Notification of a Nuclear Accident (1986). <https://www.iaea.org/sites/default/files/infcirc335.pdf>
[53] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (Joint Convention), 1997. <https://www.iaea.org/sites/default/files/infcirc546.pdf >
[54] See Eiichiro Ochiai, ' Devastation Caused by the Atomic Bombs: Hiroshima and Nagasaki,' in '*Hiroshima to Fukushima*,' August 2014, Chap.5, DOI: 10.1007/978-3-642-38727-2_5 See also Aljazera News- Japan, 'Hiroshima atomic bomb: The US nuclear attack that changed history…*As Japan marks the 74th anniversary of the world's first nuclear bomb attack, we examine the events that shaped history,' January 6, 2019*, <https://www.aljazeera.com/news/2019/08/hiroshima-atomic-bomb-nuclear-attack-changed-history-190806100602771.html> (Accessed on 25/04/2020)

solution lies in the establishment of strict international control of all fissile materials.[55] The Treaty on the Non-proliferation of Nuclear Weapons of 1968 aims at preventing the spread of nuclear weapons or other nuclear explosive devices or control over such weapons or explosive devices and weapons' technology as well as the promotion of peaceful uses of nuclear energy.[56] Other treaties relate to the physical protection of nuclear materials and nuclear facilities used for peaceful purposes;[57] the suppression of terrorist bombings and acts of terrorism and punishment of the perpetrators;[58] and the suppression of the financing of terrorist activities.[59]

4. THE DEVELOPMENT AND REGULATION OF NUCLEAR ENERGY IN SUB-SAHARAN AFRICA: LESSONS FROM THE EU AND FRANCE

As SSA looks at developing nuclear energy power, there are vital lessons to learn from some regions and countries which have established strong nuclear sectors, more so through reliable and effective regulation. This chapter draws lessons from the EU nuclear experience, particularly France and South Africa as the leading nuclear user in SSA.

4.1 Nuclear Energy in the European Union

France is one of the few countries in the world which has posited nuclear success stories over the years. France is a member of the European Union (EU) and abides by its regulations and guidelines. The EU has got a total of 27 countries. Currently, several EU countries like Spain, France, Germany, Luxembourg, Romania, Belgium, Hungary, Slovakia, Finland, Sweden are operating or constructing nuclear power installations. The EU has got directives and measures in place to guide the nuclear industry, and these include the 2012 Energy Efficiency Directive

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[55] See Ira Helfand, Lachlan Forrow and Jaya Tiwari, '*Nuclear Terrorism'* BMJ. 2002 February 9; 324(7333): 356–359. doi: 10.1136/bmj.324.7333.356

[56] The Treaty on the Non-proliferation of Nuclear Weapons (Non-Proliferation Treaty), 1968< https://www.un.org/disarmament/wmd/nuclear/npt/text> See also Laura Rockwood, '*The Nuclear Non-Proliferation Treaty: A Permanent Commitment to Disarmament and Non-Proliferation*', 1995 Nuclear Law Bulletin No.56 at pp.9-18 at 9

[57] See Convention on the Physical Protection of Nuclear Material (CPPNM) of 1979 <https://www.oecd-nea.org/law/multilateral-agreements/convention-protection-material.html>; See also the Amendment to the Convention on the Physical Protection of Nuclear Material (Amendment to the CPPNM), 2005 <https://www.oecd-nea.org/law/multilateral-agreements/amendment-convention-protection-material.html> See also RB Pope, '*Packaging and transport of radioactive material in the nuclear fuel cycle*,' 2012, Nuclear Fuel Cycle Science and Engineering, Woodhead Publishing Series in Energy 2012, Pages 558-598 <https://doi.org/10.1533/9780857096388.4.558>

[58] International Convention for the Suppression of Terrorist Bombings (Terrorist Bombings Convention), 1997

[59] International Convention for the Suppression of the Financing of Terrorism (Terrorist Financing Convention), 1999; see also the International Convention for the Suppression of Acts of Nuclear Terrorism (ICSANT or Nuclear Terrorism Convention), 2005; the Comprehensive Nuclear-Test-Ban Treaty (CTBT), 1996, Art. 1 (Not yet in force); and the Treaty on the Prohibition of Nuclear Weapons (TPNW or Nuclear Weapon Ban Treaty), 2017 (Not in force)

and the 2015 Framework Strategy for a Resilient Energy Union. Further, the EU's nuclear energy mainly governed by the European Atomic Energy Community (EURATOM) Treaty. These provide for safeguards, for example, on nuclear safety, cooperation in nuclear-related activities, environmental protection, and decommissioning.

France's nuclear energy accounts for approximately 75 per cent of the total electricity in the country, with the country being the most extensive global net electricity exporter as a result of the low cost of generation, realising over 3 billion Euros yearly. France invested heavily in nuclear waste management and what does stand out is the nation's remarkable ability to recycle nuclear fuel, and this accounts for about 17 per cent of France's electricity.[60]

One of the reasons why France has managed to maintain a vigorous nuclear power industry and from which SSA could learn is its focus on the regulation of the environmental impacts of nuclear activities.[61] There are two categories of control, and these include radioactive waste management and decommissioning. This regulation extends to nuclear power plants, National Defence activities, nuclear fuel cycle facilities, research centres, medical activities and industrial activities. On the national arena, there were two chief Acts passed in 2006 to deal with waste management: - the "Transparency and Security in the nuclear field" Act"[62]; and the Planning Act on the sustainable management of radioactive materials and waste.[63]

In addition to the EUROTAM Treaty, France is also a signatory to several international instruments on the regulation of the use of nuclear energy. The country signed and ratified the Joint Convention on the safety of spent fuel management and the safety of radioactive waste management, in 1997 and 2000 respectively. Other agreements to which France is a party include – the Convention on Early Notification of a Nuclear Accident (1986); Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency (1986) and the London Convention.

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[60] World Nuclear Association, 'Nuclear Power in France.' <https://www.world-nuclear.org/information-library/country-profiles/countries-a-f/france.aspx> (Accessed on 3/3/2020)

[61] See Andra – ASN – CEA – IRSN, 'Radioactive Waste Management and Decommissioning in France', March 2013 <https://www.oecd-nea.org/rwm/profiles/france_report.pdf> (Accessed on 7/4/2020)

[62] Transparency and Security in the nuclear field" Act (June 13 2006). The Act is available in English at <http://www.frenchnuclear-safety.fr/index.php/English-version/Asn-s-publications> (Accessed on 7/4/2020)

[63] Planning Act on the sustainable management of radioactive materials and waste (June 28 2006). Act is available in English at <http://www.andra.fr/index.php?id=edition_1_5_2&recherche_thematique=all&global_id_item=387> (Accessed on 7/4/2020)

The country also has robust institutional and regulatory frameworks on nuclear energy. These are in charge of operationalising and overseeing the activities of the nuclear industry, with the management of the different types of atomic activities placed under various departments and bodies. They include the General Directorate for Energy and Climate under the Ministry of Ecology and Energy; the Nuclear Safety Authority; National Institute for Radiation Protection and Nuclear Safety (IRSN); the National Radioactive Waste Management Agency (ANDRA); National Institute for Radiation Protection and Nuclear Safety (IRSN) and the High Committee for Transparency and Information in Nuclear Safety (HCTISN), among others.

There are several lessons that SSA countries can learn from France with respect to nuclear energy development. These will be discussed after a brief overview of nuclear energy in SSA as highlighted in the next section.

4.2 Nuclear Energy in Sub-Saharan Africa

Many countries in Sub-Saharan Africa such as Uganda, Kenya, Ethiopia, Nigeria, Namibia, Ghana, and Sudan are exploring avenues for venturing into the production of nuclear power in a bid to meet their ever-growing electricity demands – energy access and energy security.[64] Nuclear power generation is a way of meeting the climate change mitigation targets of the countries since nuclear is a cleaner form of energy compared to traditional fossil fuels. Although there are many pressing issues like nuclear technology and financial costs, a significant challenge lies in establishing an adequate legal and regulatory regime for the sector.[65] Save for South Africa, which is already generating electricity from nuclear energy, the rest of the countries are mainly still at the preparatory stages. However, a few of them already have some form of regulation for the industry in place.

In Uganda, for instance, efforts are underway to establish a functioning nuclear industry. The country enacted the Atomic Energy Act[66] in 2008 and also set up a Nuclear Energy Unit and

[64] Chiponda Chimbelu, '*African countries mull nuclear energy as Russia extends offers*,' October 22 2019, Business and Human Rights Centre- Deutsche Welle (DW), <https://www.dw.com/en/african-countries-mull-nuclear-energy-as-russia-extends-offers/a-50872702?utm_source=Media+Review+for+October+23%2C+2019&utm_campaign=Media+Review+for+October+23%2C+2019&utm_medium=email> (accessed on 29/4/2020)
[65] *Ibid.*
[66], 2008 <https://ulii.org/ug/legislation/act/2015/24>

an Atomic Energy Council. The Act in particular addresses issues concerning the peaceful application of radioactive material, social and environmental protection, management of radioactive waste, development of nuclear energy power generation, and general compliance with international laws and standards. The country also promulgated the lawin 2012 in particular '*to specify the minimum requirements for the protection of individuals, society and environment from the dangers resulting from ionising radiation;*[67] and '*to provide for the safety and security of radiation sources…*'[68]

In Kenya, nuclear energy is also being considered for electricity supply across the country, and the state already has in place a Nuclear Power and Energy Agency, established under the Energy Act of 2019.[69] It is responsible for promoting and implementing Kenya's Nuclear Power Programme, carrying out research and development for the energy sector.[70]

South Africa is the only country in the SSA region which already generates power from nuclear energy. It began commercial nuclear power operations in 1984, and it currently has two nuclear reactors, accounting for about 6% of its entire energy[71] - the country set in place a robust legal and regulatory system to cater for the nuclear industry. The major laws are the Nuclear Energy Act of 1999[72]; the National Radioactive Waste Disposal Institute Act of 2008[73]; and the National Nuclear Regulator (NNR) Act of 1999[74] , and they are all under the auspices of the Department of Energy. There also exists a Chief Directorate which has the mandate to administer all nuclear energy-related matters both under the national and international legislations. The Chief Directorate has got subsidiaries, and these include the Nuclear Safety Directorate, Nuclear Technology Directorate and the Nuclear Non- Proliferation Directorate.

Other relevant laws in South Africa include the Hazardous Substances Act[75], the Non-Proliferation of Weapons of Mass Destruction Act[76], the National Strategic Intelligence Act, the National Water Act and the Dumping at Sea Control Act, the Mine Health and Safety Act,

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[67] *Ibid.*, Regulation 2(a)
[68] Atomic Nuclear Regulations, 2012 <https://ulii.org/ug/legislation/statutory-instrument/2012/4>
[69] The Energy Act No. 1 of 2019 <https://www.nuclear.co.ke/images/downloads/EnergyAct__No.1%20of%202019.pdf>
[70] Ibid., s.54, also Ss.54- 71
[71] Information available at <http://www.energy.gov.za/files/esources/nuclear/nuclear_back.html>
[72] Nuclear Energy Act 1999, Act 46 of 1999
[73] National Radioactive Waste Disposal Institute Act of 2008; Act 53 of 2008
[74] National Nuclear Regulator (NNR) Act 1999, At 47 of 1999
[75] 1973, Act 15 of 1973
[76] Non-Proliferation of Weapons of Mass Destruction Act 1993, Act 87 of 1993

the National Key Points Act, the Mineral and Petroleum Resources Development Act, the Protection of Constitutional Democracy Against Terrorist and Related Activities Act, and the National Environmental Management Act, among others. The country is also party to several international and regional treaties such as the 1970 Non-Proliferation Treaty, Safeguards Agreement 1991, Additional Protocol 2002, the Pelindaba Treaty of 2009, the Zangger Committee of 2000 and the Nuclear Supplier Group of 2011, *inter alia*.[77]

5. RECOMMENDATIONS AND CONCLUSIONS

Nuclear energy has the potential of solving Sub-Sharan Africa's energy access and security problems while contributing to climate change mitigation targets as per the Sustainable Development Goals and the Paris Climate Change Agreement. The lessons from the Chernobyl (1986) and the Fukushima Daichii (2011) nuclear power accidents, however, demonstrate the inherent disastrous nature of the nuclear industry on human health, economies, societies at large and the environment. Questions thus arise regarding nuclear safety, environmental protection and the liability burden should an accident occur. Also, the Hiroshima Bombing of 1945 and the increased global terrorist activities raises questions of nuclear security and non-proliferation. Moreover, the intense regulation of nuclear energy in France has led to the country being a worldwide leading example of how the industry can yield positive results through efficient management.

Despite there existing several fears regarding nuclear energy use, this chapter shows that these can be kept in check if countries develop proper mechanisms. These include (1) Adherence to international laws, regulations and standards; (2) Establishing stable domestic regimes on nuclear through sound policy and legal enactments; and (3) Setting up effective implementation and regulatory bodies to monitor the nuclear activities to ensure that there is maximum social and environmental protection. Significant features from both the global and France's legal regime also indicate the role of cooperation, multi-stakeholder engagement, accountability and access to information as well as adherence to the principles of sustainable development in establishing legal systems. Like the European Union, SSA should also consider putting in place a regional body and regulations to provide guidance and streamline the activities of the nuclear industry.

[77] Information available at the Republic of South Africa, Department of Energy website <http://www.energy.gov.za/files/policies_frame.html> (accessed on 20/04/2020)

This chapter highlights key areas of nuclear regulation. These include safety, spent fuels and waste radioactive materials management, accident liability, transboundary harm, pollution as well as security and non-proliferation. Therefore, as a more significant section of sub-Saharan African States braces itself for nuclear energy use, particular focus should be directed towards establishing clear, secure and effective regulatory approaches. The assertion is that proper regulation is vital in mitigating and addressing the challenges associated with the use of nuclear energy on both the society and environment in line with the principles of sustainable development.

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