



A Brief Scrutiny of Malawi's Policy on Nuclear Power

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ABSTRACT

Background: Malawi's 2018 National Energy Policy includes nuclear power as an energy option with an operational 100 MW targeted for 2035.

Materials and Methods: This paper challenges the scope of the policy on nuclear power by reviewing its implementation strategy and comparing it to: the strategy established for coal in the same policy; some experiences from other countries; and documents by the International Atomic Energy Agency (IAEA) relating to establishing a national position on nuclear power and infrastructural requirements for a nuclear power program.

Results and Discussion: It is found that the pro-nuclear position is uninformed, and targets are unrealistic owing to a lack of understanding of nature of nuclear power including the requirements for safety, security and safeguards, and nuclear infrastructure. It is apparent that neither consultation nor a proper analysis were comprehensively conducted for nuclear. Though the national energy policy suggests a national position for nuclear energy, the content does not demonstrate that the position was arrived at knowledgeably.

Conclusion: Thus, nuclear power may presently be viewed as a potential energy option that is yet to be seriously considered. It is important to build an appropriate level of literacy on nuclear science and technology for policy makers, key stakeholders, and the public to be better positioned for strategizing on nuclear power.

Keywords: National Energy Policy, Nuclear Power, Knowledgeable Commitment

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Introduction

Malawi is a land-locked Sub-Saharan country bordered by Tanzania in the north, Zambia in the west and Mozambique in the south and east. Its 2018 population was approximately 17.6 million growing at 2.9% per annum [1]. Primary energy consumption is biomass while total installed electric capacity of 430 MW [2] serves approximately 11% of the population. Despite the low electrification rate, this installed capacity, consisting 98% hydro [3], experiences regular power shortages due to reduced water levels arising from siltation during rainy seasons, accumulation of garbage, and evaporation during dry seasons or droughts [4]. Deficits of 14% have been reported [2], while the electricity demand growth rate was pegged at 6%–8% in 2010. Details of the country's energy situation, projections, growth incentives and strategies have been extensively covered in various literature including [2–4]. The remaining capacity is contributed by solar, bagasse, and diesel generators. Seeking to diversify its baseload energy options and improve access to electricity, Malawi's latest 2018 National Energy Policy (NEP18) has co-opted coal power plants and nuclear power plants into the energy mix

to be achieved by the year 2023 and 2035, respectively. Other technologies included in NEP18 are renewables (mostly solar), gases (biogas, liquified petroleum), and others. This paper focuses on coal and nuclear because they are “new” power technologies to Malawi.

When the earlier National Energy Policy was developed in 2003 (NEP03), both coal and nuclear were not included as electricity generation options through power plants even though the Department of Energy [5] had projected that they would contribute 6% and 4%, respectively, to the energy mix by the year 2050. While nuclear was explicitly excluded as a short- to medium-term target owing to country’s limited economic strength and wariness of its environmental impacts; coal was discussed mainly with respect to improving the economics and scale of its mining, and increasing its local consumption by combustion in industries and households. Nuclear was simply indicated as a potential option for the long-term with uranium reserves acknowledged. Over time, interest in uranium reserves progressed so that mining operations began in 2009.

Materials and Methods

NEP18 improves on NEP03 to account for changes on the local and international fronts including transitions from the second to the third Malawi Growth and Development Strategy (i.e., MGDS II and III, respectively) and from the Millennium Development Goals (MDGs) to Sustainable Development Goals (SDGs). It has eight priority areas including coal and nuclear. As a guiding document for the country’s strategic direction it is important for this document to be clear and coherent. Furthermore, considering the sensitivity and inherent risk associated with a nuclear power program, the national position on the technology needs to be clearly articulated and subsequently communicated to local, national, regional, and international stakeholders [6].

Inclusion of nuclear power in a country’s energy policy does not automatically translate to a commitment. The International Atomic Energy Agency (IAEA) places it just before phase one of the milestones approach [6] as a driver for pursuing a nuclear power program. This is based on the assumption and/or expectation of certain activities and considerations being carried out and culminating into a “national position” for nuclear power [7]. Malawi’s NEP18 appears to suggest a pro-nuclear national position. This article aims to challenge the scope of NEP18 regarding nuclear power. It

identifies the problems with the implementation strategy for nuclear by comparing it to the strategy established for coal power, experiences from other countries, and the IAEA documents [6, 7] on (1) establishing a national position for nuclear power and (2) the milestones approach for establishing a nuclear power program. The focus is on phase one, the pre-project phase, that leads up to milestone one: making a knowledgeable commitment to nuclear power. Thus, this paper serves as an admonishment towards a realistic, clear and coherent strategy for serious consideration of a nuclear power program in Malawi. This may also draw light to other countries in similar standing.

Results and Discussion

1. Nuclear Power in NEP18

1) Comparison between coal and nuclear

Nuclear power is recognized as an integral part of the solution to global climate change. Adler et al. [8] assessed the hidden benefits and social costs of nuclear power in the United States since 1970 and found that displacing conventional coal-fired electricity generation with nuclear resulted in average emissions reduction of 2 million metric tons for CO₂, 5,200 metric tons for SO₂, and 2,200 metric tons for NO_x. Their analysis also revealed that, between 2008 and 2014, the external cost of greenhouse gas emissions from coal plants was US\$115–165 per MWh compared to nearly zero for nuclear. However, they noted that there is a greater cost for nuclear associated with risk perception which results in higher safety-related costs for nuclear than coal wherein costs increases arose from pollution control technologies. Improved clean coal technologies, such as carbon capture and storage, can also significantly reduce global greenhouse emissions from coal power generation and, likely due to the lesser perceived risk compared to nuclear, may affect its preference over nuclear. Though coal power has higher fuel costs due to the requirement for large and constant supply compared to nuclear, they are offset by higher operational and maintenance costs in nuclear power [8].

Both coal and nuclear in NEP18 target diversification of energy sources. The emphasis for coal is efficiency, competitiveness, and clean harnessing while for nuclear the emphasis is placed on strengthening the electricity supply industry. The implementation plan for coal contains ten objectives five of which address safety, health, and environment (SHE) while the others target the promotion of local coal mining

and introduction of coal-fired power plants: 300 MW by 2023 and additional 220 MW by 2035. The SHE strategy encapsulates the entire coal supply chain from mining to end uses such as combustion and electricity generation as well as waste management. The status of and need for legislation, regulation, standards, and other supporting mechanisms appear to be well-known with specification of what needs to be reviewed, updated, developed as well as allocation of responsibility for enforcement. This reflects a strong appreciation and understanding of the underlying environmental, technical, legislative, and other issues.

Two objectives are specified for nuclear one of which barely “mentions” SHE by stating “to decrease negative environmental, health, and social impacts of nuclear energy” and the other focuses on utilizing locally mined uranium for nuclear power indicating a uranium processing facility by 2027 and a 100 MW power plant by 2035. No clear detail provided for how this is to be achieved so that a power plant can materialize by 2035. Apart from environmental impact assessments and their mitigation plans, no other information on legislations, regulations, standards, and responsibility for enforcement are articulated as done for coal. Despite utilization of “locally-mined” uranium as a driving factor, no reference is made to its supply chain and fuel cycle. Table 1 summarizes aspects covered in NEP18 for coal, uranium processing and nuclear based on the targets and implementation strategy outlined in the policy document.

2. Issues with Nuclear

From Table 1, it can be seen that a very simplistic approach has been taken for nuclear which brings into question the seriousness of the interest to develop nuclear power. Three problems stand out from the strategy: nuclear energy is not well understood, the pro-nuclear position is uninformed, and the targets are unrealistic. Each of these is discussed in detail below.

1) Lack of understanding of nuclear energy

Several features in the implementation strategy for nuclear indicate a lack of understanding of the nature of nuclear power. The first is that no attention is drawn to safety, security and safeguards which are critically important to the use of nuclear material. These safety, security and safeguards are required across the entire nuclear material supply chain, their utilization, and waste disposal. The nuclear power program has local, national, regional, and international ramifications and is a long commitment of 100 years [6]. This also comes with the obligation to protect people and the environment from harmful effects of ionizing radiation by setting up appropriate legal and regulatory frameworks, and to secure nuclear material from proliferation. Malawi partly meets this obligation, as a member of the IAEA, by ratifying a Comprehensive Safeguards Agreement and Additional Protocols, the Africa Nuclear Weapons-Free-Zone Treaty, and the Treaty of Non-Proliferation of Nuclear Weapons [9, 10]. Some sections

Table 1. Summary of Contents Covered in 2018 National Energy Policy [3] for Coal, Uranium Processing, and Nuclear

Item covered/defined	Coal	Uranium processing	Nuclear
Operational power plant (yr)	2023; 2035	2027	2035
Planned capacity (MW)	520	N/A	100
Feasibility studies	2019	☑	☑
Bankable documents and investor availability (year/number)	2020/3; 2023/5	2020/1	2020/1
Power purchase agreements	2023/3	2027/2; 2035/3	☑
Environmental and social impact assessments	☑	☑	☑
Environmental and social impact mitigation plans implementation (year/number)	2023/3	☑	☑
Resettlement action plans and/or fair compensation implementation	☑	☑	☑
Site development	2019–2023	☑	☑
Applicable legislation & regulation	☑	☑	☑
Laws/standards	☑	☑	☑
Enforcement responsibility	☑	☑	☑
Need for update/review	☑	☑	☑
Public & occupational protection (safety, health, environment, social)	☑	☑	☑
Preferred technology	☑ clean-coal (CC)		☑
Human resource development, capacity building	☑		☑
Social & gender inclusion plans	☑		☑

The tick mark (☑) and cross (☒) indicate whether that content/aspect is included or not.

of country's Atomic Energy Act (AEA) promulgated in 2011, and the Atomic Energy Regulations established in 2012, address nuclear security and safeguards. However, the scope of this legislation does not adequately cover nuclear power [11]. AEA also established the Atomic Energy Regulatory Authority (AERA) which was only officially launched in 2018. An inadequate legal framework contributed to Turkey's derailed progress in establishing a nuclear power program [12], which started construction in 2018 despite interest dating back to the 1960s. NEP18 demonstrates neither cognizance of the safety, security and safeguards requirements of nuclear power nor an awareness of status of the country's nuclear legislative infrastructure. It omits considerations for legislation, standards, as done for coal.

Secondly, NEP18 fails to distinguish uranium processing from nuclear power with both considered as "power" options as demonstrated by the inclusion of power purchase agreements under each. However, processing facilities must rely on already available power for its operation. What level of processing or the nuclear fuel cycle is being considered here is also unclear, further demonstrating knowledge gaps. This may reflect the limited experience with nuclear science and technology (NST) in the country which consists mainly of medical applications in diagnostic radiology, uranium mining, and, to a lesser extent, applications in industry and research [11]. Heffron [13] noted that decision-making on nuclear power faces fragmentation due to a lack of understanding of the issues involved. They attributed this to insufficient dissemination of information on nuclear energy connected education and a lack of pro-nuclear lobbyist. Malawi does not have a dedicated NST-promoting body nor are there presently any university programs dedicated to NST except for modules within (very few) programs or topics within modules. Building NST literacy for the policy makers and other stakeholders including the public may help to improve such strategies.

2) Uninformed rushed national position

Establishing a national position for nuclear power program requires comprehensive consultation from experts (local or international), industry, government, regulator, public, and literature. NEP03 provided details on the consultative process that led to its development. This involved expert consultations, stakeholder symposia, public hearings, political clearance and literature review [5]. NEP18 provides no such detail. This lack of consultation cast doubt on the valid-

ity of including nuclear in the policy. One of the derailments encountered by potential nuclear newcomer countries has been lack of partisan and public consensus and support [12, 14, 15]. This has resulted in either abandonment or delays of nuclear power program with regime changes. Even in the absence of experts or nuclear-associated bodies such as AERA, because it may have launched after NEP18's developmental stages, there is numerous guidance in literature particularly by the IAEA for potential newcomer countries to consider when deciding on whether to pursue a nuclear power program. Such study is obviously not captured within the NEP18.

Another important aspect to aid development of a national position for nuclear is a detailed energy planning study considering various scenarios, economics, and technology options [7]. Proven, hence typically preferred, conventional large nuclear power plants (1,000 MW_e capacities) require not only billions of dollars [16] but also pre-existing grid sizes that are 10 times the planned capacity in order to stably support the new installation [6]. Though economies of scale show that larger projects are more profitable [17], a study by Carelli et al. [18] argued that such a comparison may not be appropriate for differently sized reactors so that small modular reactors (SMR) cannot be directly compared to large reactors. SMRs are considered a better and affordable option for lower income countries [15, 19, 20] with latest data indicating overnight costs below US\$1 billion [17]. Despite the lower overnight costs promised by SMR, financing applies not only for the nuclear power plant project itself but also for developing the necessary supporting nuclear infrastructure and environment in order to attract investors [14, 16] and beyond operation to decommissioning and waste disposal. Inclusion of a fuel cycle option, as seems the case for Malawi, also has repercussions for economics, safety, security, and safeguards. While NEP03 excluded nuclear because of limited financial resources and unarticulated environmental effects; NEP18 completely disregards the financing element even though this is a major factor for successful deployment of nuclear power [16, 19].

The planned 100 MW power plant for Malawi means that small reactors are the only technology option and, assuming a viable technology is identified, would be amply supported by the projected grid capacity for 2035. However, most small nuclear reactors are presently still in research and development [14, 17] making them an unproven technology. Some SMR are set for deployment in their originating countries

such as Russia, China, Argentina, and United States in 2020 [17]. Thus, it will take some time for these technologies to achieve “proven” status in performance, licensing, regulation, and others. For example, exporting of the Canadian CANDU (Canada Deuterium Uranium) reactor, initially hailed as good for small grids, was later stopped due to poor performance and cost [14]. An appropriate scenario analysis would have revealed the status of existing nuclear technology vis-à-vis the targeted operation and capacity for Malawi. One of the reasons for the difficulty in China's transitioning from military to civil nuclear power was inconsistency in the technological development strategy and execution which made it struggle to determine the type of nuclear technology to develop because the plan was vague [20]. Turkey also encountered challenges in implementing its nuclear power program partly because they did not define the type of technology to pursue [12].

3) Unrealistic targets

Nineteen infrastructural issues must be addressed in order to successfully establish a nuclear power program [6], the first among them being a national position incentivized by a national energy policy and arrived at after comprehensive assessment of the other 18 issues namely: nuclear safety, management, funding and financing, legal framework, safeguards, regulatory framework, radiation protection, electrical grid, radioactive waste management, human resource development, site and supporting facilities, environmental protection, emergency planning, nuclear security, nuclear fuel cycle, procurement, industrial involvement, and stakeholder involvement.

Of the 18, only human resource development has received some attention in NEP18. It targets 50 NST trainees within Malawi's civil service and three NST undergraduate training programs in public universities by 2035. However, without consideration of the other infrastructural issues, training targets are rendered ineffective because the requisite skills, competencies, professions, and manpower are not streamlined. A common feature among newcomer countries that have made considerable progress in their pursuit of nuclear power—for example, Bangladesh [21], Nigeria [19, 22, 23], and Ghana [15, 24]—is a comprehensive plan or roadmap for the power program which helps to clarify its training needs. Technology and skills transfer usually constitutes an integral part of the terms of contracts in bilateral cooperation with supplier countries in order to build local competency

and build industrial infrastructure [25]. South Korea is noted as model of a country that quickly developed a strong nuclear industry though its well-crafted long-term plan for nuclear power program [12] with support from its suppliers. Argentina and Brazil were also noted for their success in harnessing bilateral cooperation for their nuclear power program [25]. China struggled to transition to civil nuclear power due to vague long-term planning [20]. Turkey's lack of a long-term plan and policy framework were also faulted for delays in their nuclear power program [12].

It typically takes 10–15 years from initial commitment to a nuclear power programs to commissioning the first power plant [6, 7]. This lead time may be even longer for low-income newcomer countries as seen from the experiences in other African countries that have expressed a formal interest to the IAEA. For example, Nigeria developed interest in nuclear in the 1970s and eventually signed a construction agreement with Russia's Rosatom in 2009 [22, 23] but construction is yet to start even though the nuclear roadmap indicated an operational 1,000 MW power plant by 2020 [23]. Another example is Ghana where early interest in nuclear power in the 1960s staled due to political reasons, reignited in 2007 with a cabinet- and government-approved plan targeting 4,000 MW of nuclear power by 2018 [15]. Considerable progress has been made including fulfilling the infrastructural requirements for phase one of the milestones approach [24], however, the nuclear power plant project is yet to start. Add in the issues raised above, the targeted operational 100 MW nuclear power plant by 2035 may not be realistic.

3. Way Forward

Though the broader policy statement appears to give a national position for nuclear, NEP18's content fails to back up this position especially in demonstrating that it was arrived at “knowledgeably”. It, thus, indicates a rhetorical stance that lacks the commitment to see it through. A commonality for countries with existing and planned nuclear power programs is to have a body or institution that is dedicated to promoting nuclear applications (power and non-power). This, in most countries consists of a state-owned atomic energy commission or corporation (AEC) that helps to clarify and strategize the direction for a nuclear power program. No such body exists in Malawi and none appears to be in the pipeline. Taking NEP18's inclusion of nuclear power as a viable energy prospect, a serious consideration of nuclear pow-

er will need a specialized body or temporally committee to thoroughly explore this option as recommended by the IAEA which calls such a body the NEPIO (Nuclear Energy Programme Implementation Organization) [6]. Milestone one is achieved when, based on the NEPIO's report, a country is "ready to make a knowledgeable commitment to a nuclear power program". At the present stage it is better said that Malawi considers nuclear as a potential energy option, but it requires detailed assessment in order to commit. Such a consideration could benefit from the IAEA which offers assistance in assessing, planning, and implementing nuclear power including overall energy and electricity planning, determining economically optimal extent and schedule for introducing nuclear power, and assessing the status, needs, challenges and potential for nuclear infrastructure [25]. Regional cooperation could be through the African Network for Enhancing Nuclear Power Programme Development that was initiated by ten African countries in order to strengthen and build capacity for planning, developing, and managing infrastructure for nuclear power [26].

Conclusion

Malawi's NEP18 suggests a national position for a nuclear program, but the content does not demonstrate that the position was arrived at knowledgeably. A simplistic approach, including unrealistic targets, has been adopted for the implementation strategy reflecting a poor understanding of the nature of nuclear power likely resulting from little to no consultation. There are a host of issues that will need to be addressed if such a "knowledgeable commitment" to a nuclear power program is to be made. It is recommended that a thorough analysis is required in order to arrive at a well-informed national position. As it stands, nuclear may be considered as a potential option yet to be explored.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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