1 *Introduction: "No Country has Monopoly of Ability"*[1]

One Saturday in November 1964, Ghanaian physicists and political leaders assembled on a hill in the village of Kwabenya near the University of Ghana to lay the foundation stone of a building designed to house a nuclear research reactor. They invited the country's first president, Kwame Nkrumah, to dedicate the reactor site. With high hopes, the crowd listened to his speech for the day: "Let me say that in the age of science and technology, in this age of atomic revolution, neither Ghana nor Africa can afford to lag behind other nations, or to ignore the scientific developments of our time."[2] Ghanaians lived in a period when other countries such as the United States and Soviet Union were directing nuclear programs; why not Ghana? From their site in Kwabenya, Ghanaian elites were reassured to hear Nkrumah explain that, "We make our start from the great body of scientific and technological attainment which is the common heritage of mankind. Beginning so loftily as we do, there is no reason for us to be timid in joining the forward march of knowledge."[3] With Nkrumah, they visualized how the reactor would form the center of a "Science City for Ghana," from which they would guide research teams seeking innovative solutions to industrial questions in the new nation.

Leading the Kwame Nkrumah Nuclear Research Institute project, the engineer Robert Patrick Baffour worked tirelessly to bring the president's plans to fruition. Baffour was a stocky, energetic patriot who some say Nkrumah was grooming to be the next leader of the country. Baffour ran the Kwame Nkrumah University of Science and Technology, traveling at the behest of Nkrumah to the Soviet Union to negotiate a reactor for Ghana in 1961.[4] Baffour hoped that the Soviet research reactor would launch an era of unprecedented scientific achievement in the country, though he apparently advised Nkrumah against installing a power reactor and his Soviet contacts agreed. He planned out a series of experiments that the nuclear institute would be able to facilitate. He was devastated when the coup d'état in 1966

that ousted Nkrumah prompted Soviet consultants to abscond with the reactor blueprints and halt the shipment of fuel rods. On the eve of his removal as head of the Ghana Atomic Energy Commission (GAEC), Baffour confirmed that his team was on the cusp of realizing Nkrumah's vision, "the mechanism and construction of this reactor is peculiar to the Soviet Union and only an expert familiar with the construction and erection of this unit can undertake the task of erecting the one already acquired and waiting to be installed at Kwabenya."[5] In 1966, just as Ghanaian scientists were poised to start staging nuclear experiments, politics intervened and the Kwame Nkrumah Nuclear Institute stalled.

Baffour's disappointment was understandable given the heady atmosphere in Ghana in those days when Nkrumah's prestige projects could operate without any budgetary oversight, and dreams had no costs (Figure 1.1). After Ghana became the first African country to push aside colonial occupiers, Baffour witnessed a brief period when the nation could fantasize that it was a fully independent republic eligible for any new innovation, able to assert its authority on the world stage and negotiate as an equal with other countries. Baffour, known for his commitment to consensus-building in politics, served as president of the International Atomic Energy Commission's (IAEA) sixth conference in 1962. Believing that all nations were eligible for a seat at the table, and that Ghana's planned reactor was her inalienable right, he led the series of internal elections that brought Iran, Italy, Mexico, Brazil, and Indonesia onto the board of the IAEA.[6] As the Cold War buffeted countries on a sea of mistrust and unease, that September in Vienna, Baffour reminded delegates that, "Underneath, all were brothers of a single nation, a single people and a single creation. He earnestly hoped that the cordial spirit in which the General Conference had met would be an omen for the future, and that politics would be laid aside for the good of mankind."[7] Baffour represented a positive outlook for international cooperation in atomic energy where Africans could take leadership positions.

This book considers the afterlives of Baffour and Nkrumah's vision through a historical analysis of one of the first national nuclear reactor programs in postcolonial Africa.[8] While Nkrumah provided some early momentum and encouraged Baffour, he played a somewhat muted role in the overall story of Ghana's nuclear program after 1966. Rather, this book centers on how Ghanaian researchers took


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Atomic power programme moves ahead

NUCLEAR REACTOR FOR GHANA...

Editorial—
The Nation looks ahead

TWO years ago on July 1, the last relics of our colonial past were removed from Ghana's free land.

Our Republic was born—proclaimed by the voice of all Ghana as expressed in a free, unhindered referendum.

The people of Ghana chose their Leader. Their Leader swore by the people—to rule the nation in accordance with its established constitution, to defend it against internal subversion and external aggression, and to promote the well-being of the people and the nation.

Our Republic has passed through thorny paths. It has faced conspiracy from foreign imperialists and their local stooges. It has faced counter-revolution engineered from without and aided from within.

It will be built near Achimota soon

A NEW ATOMIC RESEARCH REACTOR TO BE USED IN TRAINING SCIENTISTS FOR THE FUTURE GHANA ATOMIC POWER PROGRAMME IS TO BE BUILT AT KWABENYA, NEAR ACHIMOTA, ACCRA, SOON.

It will be used for advanced research in many fields, including solid-state physics (related to transistors), analysis of trace elements and the production of radioisotopes.

Dr. A. H. Ward, Senior Physics Lecturer in the University of Ghana, is expected to give details of the reactor to the Ghana Science Association at its annual congress in Accra this morning.

Scientists will do Research

Informed sources, however, revealed that the building of the reactor which would place Ghana in a leading position in West Africa would involve the use of 38 graduate engineers and scientists including the finest research men in the country.

It is further learnt that the "task-type" reactor has been given to Ghana by the Soviet Union under its technical aid programme.

Scientists and engineers from Ghana have gone to Moscow for specialised training in atomic reactors.

Paratroopers

Figure 1.1 "Atomic Power Programme Moves Ahead: Nuclear Reactor for Ghana." Adjacent photo: Kwame Nkrumah congratulates soldiers of the Airborne Training School at the Military Academy, Teshie, Accra. Editorial begins, "The nation looks ahead: Two years ago on July 1, the last relics of our colonial past were removed from Ghana's free land. Our Republic was born"
(*Source*: *The Ghanaian Times*, June 30, 1962)

leadership positions in nuclear affairs both at home and abroad over the next five decades. The initial push to install a nuclear reactor in Ghana occurred at a pivotal moment when members of the independence generation demanded to be stakeholders in scientific work and championed full rights to technological innovations. Their calls for scientific equity provide a new framework for understanding how Ghanaian scientists and political leaders sought full membership in science for all citizens not just in the 1960s, but into the twenty-first century. The Nkrumah generation of scientists benefited from this push toward scientific enfranchisement over the course of their careers. They continued to seek equal access to nuclear technology throughout the Cold War in their efforts to establish an independent

scientific regime. While the details are specific to Ghana, the challenges these scientists faced, and their strategies for circumventing them, are common to many emerging nations. Over half-a-century, these scientists made nuclear physics their own, becoming key players at the International Atomic Energy Agency, the Ghana Atomic Energy Commission, and other nuclear bodies in African countries. From their outpost in Kwabenya, they trained subsequent generations of African nuclear scientists.

Their quest for equal access to nuclear power in Ghana and beyond frame the chapters in the book. Ghanaians participated in a contest for atomic power in Africa during the Cold War, from their response to the atom bomb tests that France conducted in the Algerian desert that sent radioactive fallout to Ghana; to trips students made to learn physics in the Soviet Union; to the appropriation of land from Ghanaian farmers for independent Africa's first reactor; to the eventual transfer of a low-power reactor from China to Ghana. Over time, Ghanaians shifted their relationship with nuclear power from the signal of national autonomy and modernity to a sign of interdependency within an international community of outside agencies and governments. Thus, nuclear independence was hard-fought and incomplete for the scientists. Further, the experiences of select employees of the Ghana Atomic Energy Commission contrast sharply with those of community members in the Kwabenya environs who have not fully reaped the benefits of nuclear technology. It is along the Haatso-Atomic road that we gather traces of their stories, and map out the promise and perils of nuclear technology in an African suburb.

On this bustling road to nuclear power, the Ghana Atomic Energy Commission campus has nonetheless emerged as a major gathering place for African scientists interested in furthering their nuclear programs, including researchers from as far away as Tanzania and Zimbabwe. While Ghana's current 30kW Miniature Neutron Source Reactor is relatively small, scientists there use it to train hundreds of students in nuclear physics. The hope is that this next generation of nuclear physicists will help maintain much larger reactors, perhaps with enough capacity to generate power, that Ghana and other countries hope to install within the next decade. This study examines the historical context of these grand ambitions and considers possible nuclear futures not only in Ghana but throughout Africa.

Scientific Equity: African Independence and the Atom

After World War II, emerging from a century of colonial rule, new countries in Africa and Asia sought equal access to scientific goods for all their citizens, or what I conceptualize as "scientific equity."[9] They were no longer content to serve as vassals of colonial powers, restricted by inferior training in medicine, science, and engineering. They built modern hospitals, laboratories, hydroelectric dams, and even nuclear reactors. In this sense, independent scientists, like Baffour in Ghana, wanted to be able to fully participate in scientific life. They sought shares in what was increasingly a highly regarded, valuable system of testing and creating new knowledge on plants, fluids, metals, and the universe through scientific research. For them, full access and participation in world science meant the well-being of their citizens and the success of their nations. Particularly, access to nuclear physics became a test case for a nation's level of full participation in scientific endeavors.

The concept of "scientific equity" captures this desire of scientific and medical workers, and their advocates, to gain equivalent training, and to participate fully in international discussions of scientific research. It is a term that only recently has been gaining currency in discussions of the preparedness of African countries for the impact of changes in the global climate.[10] Here, I use scientific equity retrospectively to capture a mood of fair and just participation of Africans in scientific endeavors since the 1960s. It is a concept that would work broadly throughout the Global South, where scientists, engineers, doctors, and nurses continue the fight for access to global science, as knowledge "producers" rather than dependent "consumers."[11] In a call to action for the improvement of medical publishing in Brazil, journal editors stated, "In trying to avoid reproducing the asymmetrical power relations we experience internationally … we have taken some initiatives that we believe move us towards greater scientific equity."[12] These initiatives included publishing in Portuguese, Spanish, as well as English, plus "capacity building to achieve common and quality-based standards for nursing journals in Brazil, Latin America, and Ibero-America."[13]

Scientific equity began in the primary and secondary schools in newly independent nations. Through ambitious national programs, young students learned basic scientific and mathematical concepts grafted onto lingering colonial curriculums that emphasized vocational

skills like carpentry and welding. For instance, in Ghana, Nkrumah implemented no-fee compulsory education to encourage families to send their children to school beginning in 1961. Nkrumah had attended the innovative government school Achimota in the Gold Coast Colony and then continued his undergraduate and graduate studies at Lincoln College and the University of Pennsylvania in the United States. When Nkrumah returned to the Gold Coast and worked to usher in independence, improving education and adult literacy became a primary goal to redress colonial wrongs. In particular, Nkrumah's socialist CPP government was committed to the full popularization of science among everyday people. Nkrumah demanded that officials, "reach out to the mass of the people who have not had the opportunities of formal education. We must use every means mass communication – the press, the radio, television and films – to carry science to the whole population – the people."[14] Some of these students went on to be farmers, or factory workers, while new universities like the Kwame Nkrumah University of Science and Technology and Cape Coast University allowed more to pursue tertiary training in science.

The desire for broad science learning in Ghana stemmed from the prevailing principles of social justice and equity that Nkrumah embraced in his agenda for African socialism as the leader of the first independent country on the continent south of the Sahara. The cult of science ushered in during the Nkrumah era can be read as part of this radical call for equality and equity, which culminated in the request for a nuclear reactor. Nkrumah traded on a new moral equivalence between Africans, Europeans, Americans, or Asians where there was "no monopoly of ability," and any country could be expected to have mechanized agriculture, robust factories, and the capacity to sponsor nuclear research. Scientific equity implies a level playing field in terms of actual intellectual capabilities and intelligence between people living in different countries. Nkrumah emerged as a charismatic independence leader not just for Ghana, but for all of Africa as he supported anticolonial movements from Algeria, to Guinea, to the Congo and worked to establish a United States of Africa with himself as president. Thus, the initial push to install a nuclear reactor in Ghana occurred at a critical moment when members of the independence generation demanded to be stakeholders in scientific work and championed full rights to technological innovations for all citizens. While Nkrumah did not live to

see it realized himself, his ambitious goals provided the energy and vision to fuel them for many years to come.

Ghanaians embraced this vision for African nationalism linked to access to science and ultimately atoms. Recognizant of the colonial structures that emphasized rudimentary and vocational skills, truncating opportunities for those with black skin, they welcomed Nkrumah's scholarships and furthered their studies far beyond what had been possible just a few years before.[15] They strongly believed that people of African descent have a right to scientific training at the highest levels and can be expected to succeed as well as anyone else. These nationalist scientists were eager to gain access to atomic theory and nuclear physics, to mine the vast gold deposits in the country themselves. In the process, the emerging Ghanaian scientists were happy to have strange bed fellows, including the controversial British physicist Allan May, who joined the University of Ghana in the early 1960s as a lecturer after spending over half-a-decade in jail for sharing nuclear secrets with the Soviet Union. Ghanaian academics listened when, in his inaugural lecture at Legon, May emphasized that "a lively and wholehearted grasp of the atomic nature of matter" would allow students to exploit Ghana's vast mineral wealth.[16] According to May, a staunch communist, atoms were merely the building blocks of the world, which anyone should be able to manipulate and control, including people living in Africa.

The passion for science and atomic theory spread across the globe by the 1960s. Ghanaians were not alone in their sense that access to atoms would strengthen independent African countries. The Senegalese scholar and political activist Chiek Anta Diop pursued a course in nuclear physics while at the University of Paris in the late 1950s and translated Einstein's theory of relativity into Wolof. In 1960, he founded a radiocarbon laboratory at the Institut Fondamental d'Afrique Noire/Fundamental Institute of Black Africa at the University of Dakar.[17] Tanzania's first president Julius Nyerere stressed that African scientists might be better situated to handle the military and energy potential of nuclear fission than their white counterparts. In a speech on nuclear imperialism, which he called "The Second Scramble," Nyerere noted that Western nuclear scientists were actually the ones who were backward and out of step with the times (as opposed to Africans attempting to industrialize): "one of the troubles in the modern world is that nuclear power is being handled by people who were born in

the Nineteenth Century and educated in the Nineteenth Century; people with a Victorian turn of mind, who have been overtaken by the achievements of science and by modern ideas about human society."[18] More egregiously, white South Africans sought to create a nuclear bomb with US and Israeli assistance. In the context of white-minority rule under apartheid (1948–1992), how could they be trusted not to expose all of Africa to radioactive particles?[19]

For black African nations, being shut out of nuclear science meant infantalization within an imperialist world order that misjudged their potential and saw their emerging nuclear capabilities as a threat. As Indian historian Itty Abraham has argued for the case of Indian nationalists, atomic expertise represented not only "a means of overcoming neo-colonial domination," but also "a sign of masculinity and intellectual prowess to scientists."[20] In advocating that African countries in the early 1980s forgo signing nuclear non-proliferation treaties, the Kenyan political scientist Ali Mazuri stressed that Nigeria in particular should take the lead in an African nuclear renaissance. "Going nuclear," he wrote, "would be a new initiation, an important rite de passage, a recovery of adulthood. No longer will the great powers be permitted to say that such and such a weapon is not for Africans and children under 16."[21] New nations, extricating themselves from colonial occupations, used nuclear technology to bolster their sense of independence, both scientifically and politically. In the span of several decades, African countries transitioned from a more pacifist stance, decrying nuclear weapons, to one in which they might be a necessary evil. African nuclear desires are a further example of what US sociologist Alondra Nelson terms "African diasporic technophilia."[22]

Thus, this book examines how Africans sought a stake in modern science and all that it might offer. It considers how scientists in Ghana pursued recognition and equality on the world stage through nuclear power. Fundamentally, this book suggests ways that nuclear science became "more real" outside of Europe. Much as you might find Catholicism to be more cherished in Rio de Janeiro or Lagos than in Rome, adherents to the faith of nuclear technology proliferated outside traditional centers of nuclear expertise (creating new anxieties in Washington, Paris, London, and Moscow).[23] On the supply side, some Africans of course were laborers mining uranium for growing global demand, as historian Gabriel Hecht unearths in her compelling

study of the extraction of uranium, for the benefit of the West.[24] On the demand side, however, black African scientists pursued nuclear reactions themselves.

In subsequent years, the expense and complexity of the nuclear enterprise defied national scientific autonomy. Securing a nuclear age for Africa demanded dependence on external support for training and equipment, and supervision within international regulatory authorities, like the International Atomic Energy Agency (IAEA). Given the high costs, representatives of different countries, for instance, Soviet experts or British consultants had the power to bar or clear Ghana's access to nuclear physics and associated equipment. These moments of gatekeeping shaped Ghana's access to nuclear goods. At these critical points, Ghanaian scientists were keenly aware of how their course compared with that of scientists in other African countries including Egypt, Libya, South Africa, Senegal, and the Democratic Republic of the Congo. Ghanaian experiences intertwine in this book with stories from other African states seeking nuclear power. Further, not all in Ghana's nuclear neighborhood benefited from the proximity of a reactor. The goal of science for all was only a partial reality in the years after independence.

Manpower: Energy and its Producers

Kwame Nkrumah's quest for global recognition and wealth centered on access to energy. Development and rapid industrialization required access to electrical power. Ghana joined the World Power Conference in 1959, an organization dedicated to finding ways to balance access to "sources of heat and power … nationally and internationally." The following year, Ghana became a member state to the International Atomic Energy Agency. Ghana expected to open a nuclear power plant with Soviet support, although Baffour and others tempered Nkrumah's plans. As this book details, even the smaller swimming pool research reactor to be constructed at Kwabenya was not fully realized during Nkrumah's tenure as leader of independent Ghana (1957–1966) and the citizens of Ghana were hardly part of a world power in the sense of having access to nuclear weapons. But during the early years after independence, Ghana's leadership stressed the need to increase several forms of power in the coming years, including hydropower, atomic power, and the crux of it all, "manpower."

In addition to the nuclear reactor project, Nkrumah authorized the damming of the Volta River in 1964 to create the largest human-made lake in West Africa and establish the necessary conditions for Ghana's hydroelectric power plant. He built on British colonial plans to use hydroelectricity to produce aluminum after the discovery of bauxite deposits in the Gold Coast. In the end, Nkrumah awarded the contract to US and Canadian companies.[25] The dam displaced communities, flooded ancient forests, and introduced new diseases and ecologies, along with providing significant gains in electricity for Ghana and neighboring countries. While this book considers the legacy of Nkrumah's nuclear visions, it takes cues from related investigations on the Volta dam that place Ghana's infrastructure schemes in ecological, historical, and ethnographic context.[26]

Large projects like the nuclear reactor and hydroelectric dam were part of ambitious development plans in the 1950s and 1960s as new nations set their sights high after World War II. Nkrumah's government formulated elaborate and frequent "Development Plans," which the more progressive Colonial Governor Gordon Guggisberg had initiated from the 1920s. In 1957, Ghana introduced its "Consolidation Development Plan," followed by the "Second Development Plan" in 1958.[27] Government officials took inspiration from rapid industrialization efforts, particularly in the Soviet Union after Nkrumah's visit there in 1961. With the "Seven Year Plan for National Reconstruction" in 1964, government presented the most ambitious plan for industrialization of the country to date.[28] The plan called for the implementation of mechanized agriculture and a twofold increase in production. The government moved further toward centralized planning with state control of construction projects, cocoa marketing, universities, and all major industries.

The development plans put manpower front and center. Government was certain that, "Science personnel will be required in ever-increasing numbers in industry and agriculture as well as for teaching in the secondary schools."[29] Manpower – an educated citizenry – was necessary to produce the electricity and distribute it and run the new industries and mechanized agriculture. Manpower would allow for a cadre of elite scientists to run the planned hydroelectric and nuclear power reactors Nkrumah felt would amplify the industrial ambitions of the new nation, perhaps even propelling them to space someday.

Nkrumah sought to balance access to scientific information, including training in physics to allow for better access to electrical