



Mapping of Science, Technology and Innovation Policy Development in Ghana Using the Transformative Change Lens

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Science, technology, and innovation (STI) play pivotal roles in poverty eradication and sustainable development. Yet, tapping into the benefits of STI can only be achieved by creating robust STI systems and appropriate policy frameworks using novel approaches. In this regard and in order to achieve transformative change in Ghana, the emerging Transformative Innovation Policy frame - or 'Frame 3' lens - has been identified as a potential frame to guide the STI policy cycle. The Frame 3 lens aims to strengthen STI policy formulation, implementation, evaluation, and governance while contributing to addressing the sustainable Development Goals (SDGs). This report maps the STI policy development and STI ecosystem in Ghana through the Transformative Innovation ('Frame 3') lens with the objectives of tracing the evolution of STI policy in Ghana and identifying existing and emerging opportunities for Transformative Innovation Policy (TIP). The outcome of this mapping sets the stage for an in-depth case study using the Transformative Innovation Learning Histories (TILH) Methodology.

1. Introduction and Context of STI Policymaking in Ghana

Ghana is a lower middle-income country with a population of 28,308,301 (GSS, 2016) and per capita income of 1,641.49 USD (2017). Over the years, Ghana has demonstrated the striking role STI can play as a critical driver for socio-economic development. The 2030 Agenda adopted at the United Nations Sustainable Development Summit in September 2015 positioned Science, Technology and Innovation (STI) as key means of implementation of the SDGs (STI for SDGs Purpose Road Map, 2018). Meanwhile, Ghana's STI strategies have been enshrined in important international and national development agendas. For instance, as far back when poverty reduction strategies were the prevailing development agenda, Ghana's Poverty Reduction Strategy (GPRS) I (2003 – 2005) emphasized the need for robust development of S&T to bolster industrial production, employment, and natural resource exploitation, food security, sustainability, self-sufficiency and environmental health (Ghana Government, 2003). Then, the recent Ghana Shared Growth and Development Agenda (GSGDA II), 2014-2017, made reference to the critical role of STI in accelerating agricultural modernisation, competitiveness of the private sector and human resource development (NDPC, 2014). At present, Ghana's 7-year Coordinated Programme of Economic and Social Development Policies (2017-2020) being pursued emphasizes the critical role of STI in all the productive sectors of Ghana's economy and in the attainment of the SDGs.

Priority interventions in the Ghana Coordinated Programme of Economic and Social Development Policies are anchored on the following (Republic of Ghana, 2017):

- Revitalizing the economy;
- Transforming agriculture and industry;
- Strengthening social protection and inclusion;
- Revamping economic and social infrastructure; and
- Reforming public service delivery institutions

In addition to the prevailing national development policy, Ghana's STI strategies have been continuously enshrined in important international and national development agendas such as:

- AU Agenda 2030;
- National STI Roadmap for SDGs (proposed); and
- ECOWAS Policy S&T.

These provide solid frameworks on the bases of which the nation has embedded objectives and strategies for the national pursuit of development using STI.

In the rest of this paper, section 2 discusses the historical evolution of science and technology policy in Ghana. Following in section 3, the paper presents an overview of the public financing of STI in Ghana. In section 4 the paper discusses the governance and management of STI, including national STI policies and regulations. In section 5, the paper discusses Ghana's STI policies in the transformative innovative context (frame 3). On the bases of the discussion in sections 2 to 5, the paper draws on some conclusions in section 6 and ends with a brief description of the case study for this project.

2. Evolution of STI policy in Ghana

A review of the evolution of STI policy in Ghana reveals three patterns: (i) the era of Ghana's First President, Kwame Nkrumah (1957-1966); (ii) the era immediately after Kwame Nkrumah (1966 to the 1990s); and (iii) the era of the 'new dawn,' which begins in 2000 onwards (Amankwah-Amoah, 2016, p. 136). At the dawn of independence, Ghana saw the importance of, and the need for, science and technology in the nation's development process. Consequently, the National Research Council was established in 1958 to study and develop appropriate technologies to support the country's development. In 1959, the Ghana Academy of Learning, a learned society that became the Ghana Academy of Sciences in 1961, was established. In 1963 the National Research Council merged with the Academy and assumed responsibility for ten full-time research institutes and projects whose programmes were directly related to the nation's economic and social development. In 1966 the Academy became the Ghana Academy of Arts and Sciences (GAAS), and in 1996, the Council for Scientific and Industrial Research (CSIR) was re-established in its present form with 13 Research Institutes. In addition to the establishment of these institutions to pursue science and technology for national development, the era of Kwame Nkrumah also saw the establishment of the Ghana Atomic Energy Commission and educational institutions. The educational institutions were to supply human resources to propel the nation's pursuit of science and technology for economic development. Among key educational institutions were the University of Science and Technology (now called Kwame Nkrumah University of Science and Technology [KNUST]) the University College of Science Education (now called University of Cape Coast). In spite of the many institutions established during this era, there was no single coordinated policy on science and technology. If anything at all, what prevailed at the time were the legal instruments establishing and designating functions for the institutions that were created, and these served as proxy directions for science and technology in Ghana.

The second era of science and technology development in Ghana could be compared to the "dark ages" in Europe. Indeed, it has been observed that the "seeds for 'destruction' and disruption of science and technology...were sown" during this era (Amankwah-Amoah, 2016, p.137). Several decades in this era saw political instability, economic decline, and downturns in expenditure on research and government commitments to science.

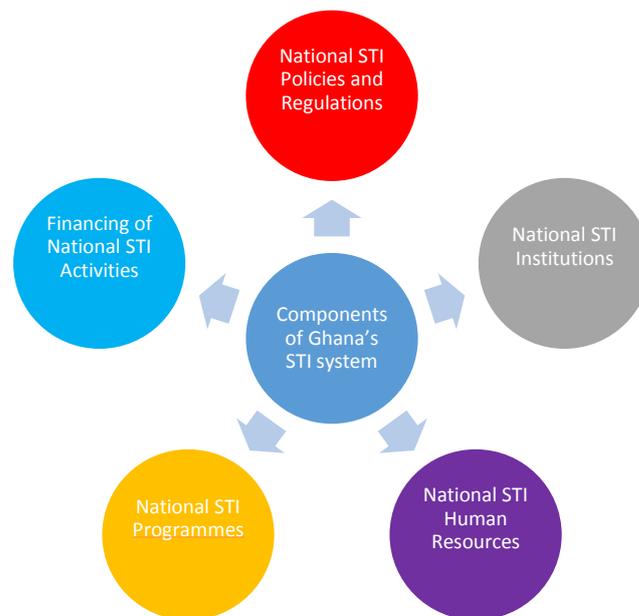
The third era of STI development in Ghana, for simplicity, would be marked from the year 2000 onwards, because it was in 2000 that Ghana first attempted to produce a coordinated policy on S&T. Ever Since 2000, Ghana has had two S&T policies and is currently in the process of finalizing a third STI Policy (2017), which is under cabinet considerations. The first coordinated policy of 2000, though not fully operationalised because it was in a draft form that never made it to Cabinet, was reviewed in 2009. The review ensured the produced document reflected advances in S&T with wide applications, such as innovations in ICT and internet applications as well as emerging trends in biotechnology and nanotechnology (MESTI, 2010). In the process leading to its adoption, the 2009 STI Policy (launched in 2010) had a much broader stakeholder consultation within and outside the science and technology

community. Unlike the 2000 S&T Policy (draft) document, the 2009 STI Policy had innovation as a critical driver for socio-economic and sustainable development. The policy document had a 5-year National STI Development Plan (STIDeP) that spelt out 17 programmes and 84 projects to be implemented. With such an articulated policy and action plan, the biggest challenge was the implementation process. Key challenges were lack of institutional framework for implementation, monitoring and evaluation of the STIDeP, lack of funding for implementing projects and activities, and lack of commitment from key institutions and agencies who were to lead or collaborate in implementing programmes and projects, amongst others.

In 2017, the Ministry of Environment, Science, Technology, and Innovation (MESTI) reviewed the 2010 STI policy to develop a new one, which is aimed at bridging the gap between STI policies on the one hand and sectoral policies and development agenda on the other. The aim of the new STI policy is to place STI at the centre of Ghana’s national development agenda. Despite being before cabinet, the policy has served as one of the key documents in developing Ghana’s 7-year Co-ordinated Programmes of Economic and Social Development Policies, which has a vision to establish a strong economy that creates opportunities, inspires people to start businesses, stimulates expansion of existing businesses, and, ultimately, leads to the creation of jobs, increased economic growth and higher incomes (see Appendix 2 on the visions and objectives of the STI policies developed in Ghana so far).

In addition to the formulation of specific policies for STI over the years, there have been key events in Ghana that have been significant for the development of an STI System in the country. These include a national STI policy review process that was undertaken jointly by UNCTAD, World Bank, and CSIR-STEPRI in 2009; national STI outlook in 2010 and 2012; national STI baseline study in 2016; establishment of the National STI Advisory Apex Body (Presidential Advisory Council on Science, Technology, and Innovation [PACSTI] in 2018; and ongoing processes to establish the National Innovation/Incubation Programme and of National Research Fund. Fig 1. Illustrates components of Ghana’s STI system.

Figure 1: Components of Ghana’s STI

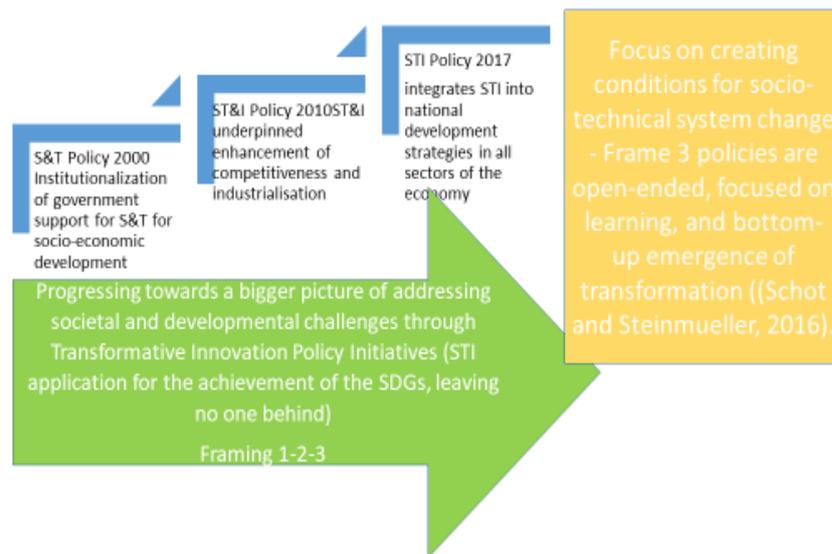


Source: authors

The evolution of the STI Policies in Ghana over the years could be analysed using the framework by Schot and Steinmueller (2018), which Fig. 2 illustrates. Aspects of the S&T Draft Policy of 2000 and

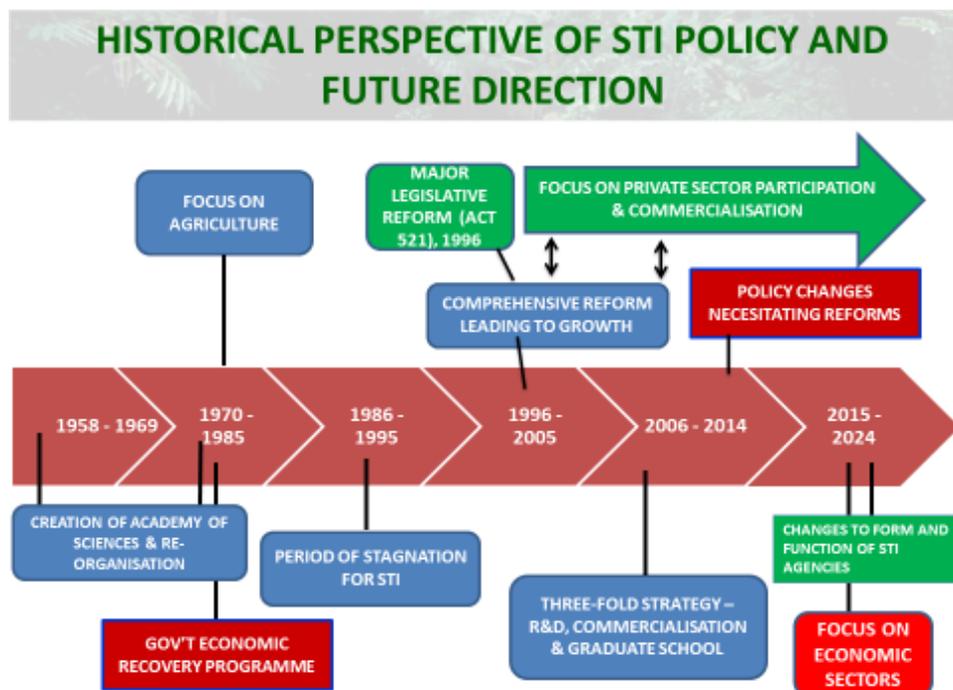
STI Policy of 2010 reflect Framings 1 and 2. The current draft STI Policy (2017), although reflects some elements of the Framing 3, still needs further elaboration. The experimentations proposed in this paper will help address gaps to be covered in the STI 2017 for it to fully reflect the tenets of Framing 3.

Figure 2: Transitions of Ghana’s STI Policies



Source: authors

Figure 3: Key trends in Ghana’s STI Policy over time



Source: authors

3. Financing of innovation

Government funding for STI activities in Ghana (including for infrastructure, research grants, and education) is channelled through the Ministry of Finance from the Consolidated Fund. International donor organisations and funders, such as the World Bank, DANIDA, USAID, and SIDA also fund STI activities in Ghana through various research programmes and projects that they implement through sector ministries or directly with various R&D institutions. As far as STI funding is concerned, key messages are that Government funds 70% of STI in Ghana, mainly from the consolidated fund of which a substantial proportion is used to pay salaries and emoluments of personnel. Over the past decade, STI funding per annum has been between 0.25 and 0.3% of GDP, which does not meet the AU target of 1%. Hence, to further support their activities, STI Institutions receive grants and donations representing about 20% of their annual budgets. There are, however, some STI Institutions that generate revenue internally (Internally Generated Funds) to fund their programmes and projects, which represents about 10%-30% of their annual budget.

One would say that currently there is the political will to improve the level of funding investment by the Government of Ghana (GoG), but the financial capabilities to support adherence to the political will and build capacities needed for STI application still remain a challenge. GoG is proposing the establishment of a National STI Fund which is anticipated to raise the funding of STI up to 1% of GDP. Under the STI for SDGs roadmaps, the UN Technology Facilitation Mechanism (TFM) emphasizes a 'bridging force' instead of catching up to serve both national and global interests in order to reduce cost. Consequently, other innovative options of funding STI will have to be found if this were to come to fruition.

4. Governance and National STI Policies and Regulations

Although STI cuts across all sectors of Ghana's economy, at the policy level, MESTI is responsible for National STI policies while the Ministry of Education is responsible for the National STI education policies. At the implementation level, there are two Major Public Research bodies, namely the Council for Scientific and Industrial Research with 13 specialized Research Institutes and the Ghana Atomic Energy Commission (GAEC) with 6 Atomic and Nuclear Research Institutes operating. Other STI-related institutions include Ghana Space Science and Technology Institute under GAEC, Cocoa Research Institute of Ghana (CRIG), Noguchi Memorial Institute for Medical Research, Centre for Scientific Research in Plants Medicine (CSRPM), GRATIS Foundation, Ghana Standards Authority, and Food and Drugs Board. For human resource development, Ghana has 10 Public Universities, 8 Technical Universities, 2 Polytechnics, 38 Colleges of Education and 8 Technical Institutes. Approximately 6 out of the 60+ accredited private Universities run some Science, Technology, Engineering and Mathematics (STEM) related programmes.

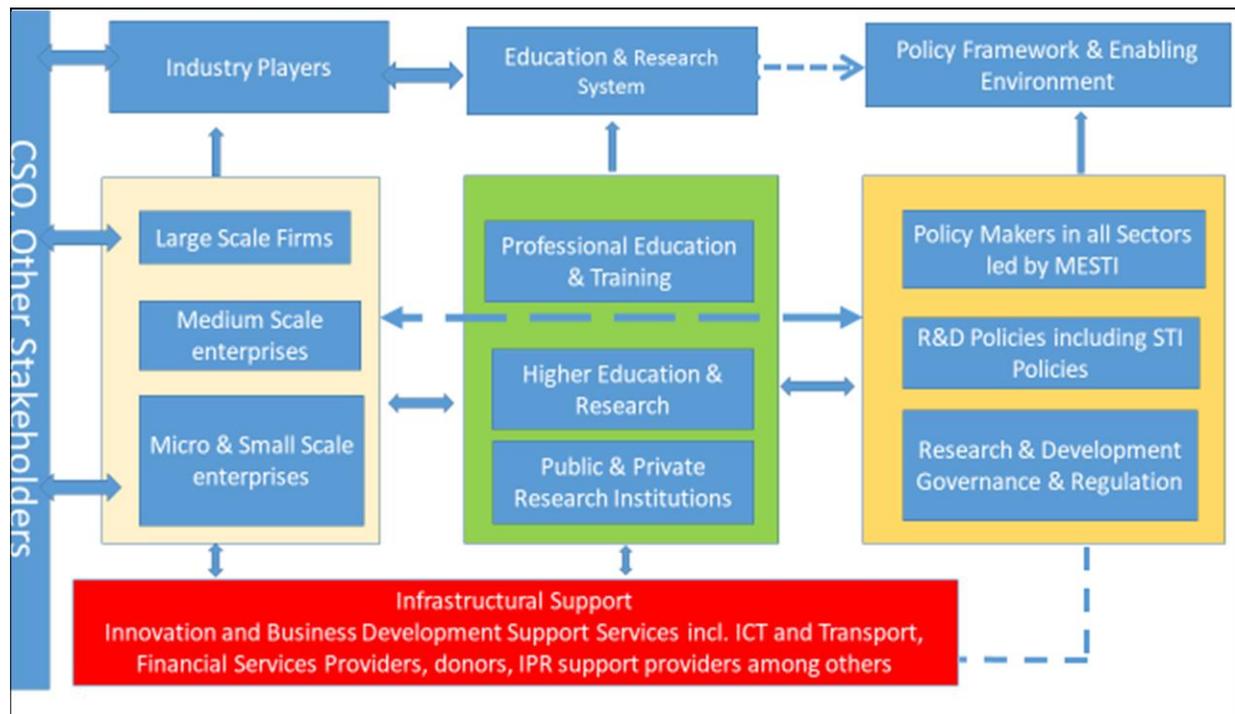
All these institutions and organizations are complemented, enabled, and governed by national policies, plans and regulations, including:

- National STI Policy and 5 National STI Development Plan
- Technology Transfer Regulation, 1992
- Council for Scientific and Industrial Research Act, 1996
- Cocoa Research Institute Act
- Ghana Atomic Energy Commission Act, 2000
- Intellectual property Act, 2003
- Industrial Design Act, 2003

- Copy Right Act, 2005
- Various public universities' acts (e.g., KNUST Act, UG Act, etc....)

The figure below gives a pictorial presentation of actors and institutions in the Ghana' STI System

Fig. 4: Key actors in Ghana's STI System



5. Innovation Policy within the Transformative Innovation (Frame 3) context

From the analyses of the three eras of STI development in Ghana, above, one notes that in terms of the various framings of STI Policy, Ghana went through Frame 1 where the focus of STI development and application was geared towards “tapping the potential of science and technology for prosperity and nurturing.... mass production and consumption” (Schot & Steinmueller, 2018, p. 1555). This was exemplified in the Kwame Nkrumah era where there was deliberate attempt to use science and technology. This is not to say, however, that the country has totally emerged from the shadows of Frame 1. The objectives of the past national policies (2000 [draft] and 2010) and the goal of the draft 2017 STI policy still include the pursuit of national prosperity, enterprises development, and sustained economic growth. In respect of Ghana's STI experience with Frame 2, i.e., the national innovation system, the evidence is that it has only been after the 2000 draft policy (i.e., 2010 and 2017 [draft] policies) that Frame 2 reflects. For instance, the objectives of the STI policies for 2010 and 2017 reflect the need for a framework to coordinate STI activities and development in Ghana and create conditions for STI to flourish. In considering the objectives of the three policies (see Appendix 2) Frame 3 does not feature. Frame 3—transformative change—“involves a questioning of how to use science and

technology policy for meeting social needs and addresses the issues of sustainable and inclusive societies at a more fundamental level” (Schot & Steinmueller, 2018, p. 1555).

The new framing for science, technology, and innovation (STI) policy, termed “transformative innovation,” has the potential to promote transformation of systems and societies in ways that foster environmental sustainability, achieve more equitable income distribution and help address other social challenges including gender, inequality, and exclusion (Chataway et al., 2017; Schot et al., 2017; Schot & Kanger, 2018; Schot & Steinmueller, 2018; Weber & Rohracher, 2012). Hence, using a Frame 3 approach in Ghana could potentially harness the power of STI as a driver for the achievement of not only sectoral goals, objectives and programmes, but also for addressing critical societal social, economic, and ecological challenges.

Ghana is one of the member states that has signed onto the STI for SDGs Roadmaps that looks at a three-tiered approach for foundation of STI Policy framework and enabling conditions, adaptation to emerging technology, and societal preparedness and integration of STI to national sustainable development plan (IATT, 2018). Ghana has the political championship for the SDGs and is in the process of elaborating on its country specific STI for SDGs roadmap.

Moving forward in Ghana, it is expected that all ministries will have STI desk officers to work in cooperation with MESTI to ensure that sector programmes and activities are indeed driven by STI programmes. The Ghana National STI Policy will be further reviewed to reflect the transformative potential of STI applications in all sectors of the Ghanaian economy. Various sectors, such as agriculture, health, education, environment, energy, trade, industry, natural resources, human settlements and communications, are expected to identify programmes and activities whose execution will be enhanced by the most appropriate and effective tools derived from STI. An implementation and investment plan will be needed for the transformation of human and institutional systems, effective coordination and collaboration at the local, national and regional levels, and to promote sustainable financing of STI in all the sectors of the Ghanaian economy.

Recently, Ghana’s effort and strategies for developing an STI System have involved the development of a National STI Baseline Survey Report, a review of the national STI policy, establishment of a National STI Advisory Apex Body, establishment of the National Research Advisory System and Programmes, consideration of the establishment of the National Innovation/Incubation Programme and considerations for the establishment of National STI Fund. In addition, it is envisioned that the newly established Presidential Advisory Council on Science, Technology, and Innovation (PACSTI) will provide advice to the President of the Republic of Ghana on Science, Technology and Innovation (STI) issues. Especially, with respect to functions of the PACSTI that include advising the President of Ghana on global trends in STI relevant for national development; developing and applying STI for development; appraising various government programmes and projects from the perspective of STI development and application; and advising the President on means to ensure the effectiveness of research and development in Ghana. In addition, MESTI is considering the establishment of the Ghana Innovation and Research Commercialization Centre (GIRC-Centre) as the new partnership between Government, Public Research Institutions, Academia and the Private Sector.

6. Conclusion and Case Study for Further Investigation

Ghana has a strong institutional arrangement made of legal instruments and policy instruments, programmes, and organizations to develop a dynamic and productive system for science, technology, and innovation. Ghana’s aspiration to become a developed country will depend to a large extent on what it does to improve its technological performance and the dynamism of its innovation system.

There is more room for improvement in order to put this framework to its highest potential use. A review of the evolution of STI policy in Ghana has shown that Ghana has been through the first two frames of STI policymaking and there is room to consider and adopt the Frame 3 approach for which some case studies could be piloted.

Case study for further investigation: innovative policy for waste management

Currently, the Ministry of Environment, Science, Technology, and Innovation in collaboration with other key Ministries, Agencies and the private sector is implementing a number of policy initiatives aimed at achieving the “Ghana Beyond Aid Agenda.” Ghana is currently participating in the TIP initiative through the innovative policy for waste management case study.

Waste management is a major challenge in Ghana. Various governments have developed several policies and strategies aimed at addressing waste disposal and management in the country. The President, in his quest to solve the waste management issue in the country, has established a Ministry for Sanitation and has tasked various related ministries such as MESTI, the Ministry of Local Government and other state agencies to work together to develop policies and programmes that will aggressively tackle the menace of waste in the country. In the light of this, several policies have been developed and some being developed for waste management. Some of these policies include, the Environment Policy, the Plastic waste policy, the E-waste Policy and law, and the Sanitation Policy, to name a few. The TIP approach will be a good means to review the policy framework surrounding our waste management approach in Ghana and to recommend ways for improvements.

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Appendix 1: Summary of Early Two Eras of S&T development in Ghana

Phases	Nkrumah period	Immediate post-Nkrumah era
Years	1957–1966	1967–1979
Heads of State/Presidents	Osagyefo Dr. Kwame Nkrumah	Lt. Gen Akwasi Afrifa (1966–1969); Joseph A. Ankrah (1966–1969); Lt-Gen Emmanuel Kotoka (1966–1969); Kwasi Kotoka (1966–1969); Lt. General Dr. Kofi Abrefa Busia (1969–1972); Edward Akufo-Addo (1970–1972); Ignatius Kutu Acheampong (1972–1978); Fredrick Akuffo (1978–1979); Flt.-Lt. (Rtd) J. J. Rawlings (1979); Dr. Hilla Limann (1979–1981); Flt.-Lt. (Rtd) J. J. Rawlings (1981–2000).
Level of government intervention and dynamics Key features and events	<ul style="list-style-type: none"> Centrally planned and implemented STI policy with collaboration from multiple stakeholders. Comprehensive programme to promote the development of science and technology through universities. Introduction of the concept of "science for development". Effective collaboration and coordination of science policy and industrial policy. 	<ul style="list-style-type: none"> Largely dictated to the regions until the 1990s. Divergence of science policy and industrial policy. In 1994, the African Technology Policy Studies Network was established to replace Eastern and African Technology Policy Network and the West African Technology Studies Network to help forge close links between government policy, science and public policy formulation. Technological backwardness was apparent in government policy in the 1970s.
Feature of government policy	<ul style="list-style-type: none"> Development of teachers for the next generation of Ghanaians. Development of science and technology infrastructures. Funding for the establishment of local universities. Government funding to promote local innovation and for research and development activities. 	<ul style="list-style-type: none"> From late 1960s–1970s, the dismantling of major STI initiatives during the Nkrumah period. Declining quality of facilities at educational institutions. Major promotion of "made-in-Ghana" products in late 1990s.
Constraints	<ul style="list-style-type: none"> The government policies were biased towards resource-rich large firms and state-owned firms. 	<ul style="list-style-type: none"> Limited interaction between universities and industry. Low priority afforded to science, innovation and technology. Lack of visionary leaders and effective advocacy for science and technology. Weak links between universities, government and industry. Limited incentive for basic science research.

Source: Amankwah-Amoah (2016, p. 138).

Appendix 2: Key directions of Ghana’s science and technology policies since 2000

Policy	Vision and goal	Objectives	Elements that map to F1, F2 and F3
Draft S&T Policy 2000¹	<p>The vision is to support national socio-economic development goals with a view to lifting Ghana to a middle-income status by the year 2020 through the perpetuation of a science and technology culture at all levels of society. There are three goals. First, establish a well-coordinated and integrated system of scientific, technological and social innovation within which the private and public sectors collaboratively forge partnership; and all stakeholders are part of a more inclusive and consultative approach to policy decision-making and resource allocation for science and technology activities</p> <p>Second, encourage a culture within which the advancement of scientific knowledge is valued as an essential component of national development</p> <p>Third, improve support for all kinds of innovation fundamental to sustainable economic growth, employment and socio-cultural development.</p>	<p>The basic objectives of the policy include</p> <ul style="list-style-type: none"> i. to seek mastery of scientific and technological capabilities; ii. to develop infrastructures which will enable industry and other sectors of the economy to provide the basic needs of society; and iii. to adopt a science and technology culture 	<p>This presents a mixture of Frames 1 and to a lesser extent, Frame 2, given the objectives. i and ii directly map unto Frame 1 while objective iii could be interpreted to reflect Frame 2.</p>
STI Policy 2010 MESTI (2010)	<p>The vision was to apply STI to become a middle-income economy in the shortest possible time. The goal of the STI policy was to fully integrate application of STI into national development strategy for poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth.</p>	<ul style="list-style-type: none"> i. facilitate mastering of scientific and technological capabilities; ii. provide the framework for inter-institutional efforts in developing STI and iii. programmes in all sectors of the economy to provide the basic needs of the society; iv. create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation. 	<p>For the 2010 STI Policy, with the exception of objectives ii, all other objectives reflect Frame 1. Unlike the previous policy, the 2010 STI policy explicitly reflects Frame 2 with policy objective ii.</p> <p>Per the policy objectives, there is no representation of Frame 3 in the 2010 and 2000 science policies.</p>
STI Policy 2017 (2017-2020)²	<p>The vision is to develop to become a high-income country which fully applies and integrates STI into national development strategies. This positions the country to harness the nation’s total science and technology capacity to achieve national objectives for poverty</p>	<ul style="list-style-type: none"> i. facilitate mastering of scientific and technological capabilities; 	<p>As reflected in the 2010 STI policy, the draft 2017 STI policy mainly represents Frames 1 and 2.</p>

¹ MEST (2000).

² MESTI (2017)

	reduction, competitiveness of enterprises, sustainable environmental management and industrial growth	<ul style="list-style-type: none"> ii. provide a framework for inter-institutional collaborations in developing STI programmes in all sectors of the economy to meet the basic needs of the society; iii. create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation; iv. ensure that STI supports Ghana's trade and export drive for greater competitiveness; v. promote a science, technology and innovation culture in the wider society. 	The policy objectives of the STI 2017 (draft), including objectives i and iv reflect Frame 1; objectives ii and iii reflect Frame 2; while objective v hints at Frame 3.
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