REPUBLIC OF GHANA

MINISTRY OF ENVIRONMENT
SCIENCE AND TECHNOLOGY

NATIONAL SCIENCE TECHNOLOGY AND INNOVATION POLICY

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FOREWORD

Ghana's attainment of middle-income status with per capita GDP in excess of $1,000 currently is very much laudable. It is a long way from the $400 per capita of the 1990s. More importantly, the achievement sets the tone for the ambitious goal of attaining a per capita GDP of $3,000 as announced by the Government of Ghana. However, such national ambitions can only be attained on the wheels of a solid base of science, technology and innovation (STI). This is the resounding lesson from the advancement of the industrialized and newly industrialized countries such as Korea, China and India.

Since independence in 1957, Ghana realized the importance of creating a national capacity for STI. A number of scientific institutions were built to address the challenge of a young state emerging from a colonial era and establishing its membership in the Commonwealth of Nations. The Council for Scientific and Industrial Research (CSIR), the Ghana Atomic Energy Commission (GAEC) and the Kwame Nkrumah University of Science and Technology (KNUST) were key institutions set up to address the crucial challenge of forging a scientific and technological base for the country's socio-economic programmes.

Today, there is an even more crucial role for STI in national development. The technological advancement the world has experienced has been unimaginable two or three decades ago. The revolution of the new technologies, particularly information and communications technology (ICT) and biotechnology, has transformed human activities and inter-state relations in several dimensions. In agriculture, industry, education, health, commerce, finance and other sectors of the economy, the new technologies have enhanced production, processing and marketing quantitatively and qualitatively. With the Internet, the scope of socio-economic realities has

expanded into virtual space. The challenge of building a national scientific and technological capacity has become more intensive.

Indeed there is a new technological challenge coming with the prevailing nature of the global technological experience. Whereas previously the talk is mainly about "science and technology", now the talk is about "science, technology and innovation". It is about the application of STI in the national economy and society. The concern may still be about catching up technologically. But the emphasis is more on what essentially drives socio-economic transformation anywhere in the world – innovation. Innovation is the use of knowledge to bring about scientific and technological applications which are new in the context of usage even though they may not be new in other parts of the world. In every sector of the national economy, there are specific problems and innovation provides the solutions. Innovation is the pivot of economic growth and it is at the heart of Ghana's ability to attain its national economic vision.

The National Science, Technology and Innovation Policy therefore aims in broad terms to provide a framework for stimulating innovation in the economy and in the society. The Ministry of Environment, Science and Technology (MEST) has the mandate to promote science and technology application in the country and to create the conditions for innovations. In line with this mandate, MEST presents this policy document as the fundamental basis of its endeavours.

Hon. Sherry Ayittey
Minister of Environment, Science and Technology
Accra
31st May 2011

EXECUTIVE SUMMARY

Introduction

At the dawn of independence in 1957, Ghana nursed the dream of rapid social and economic development using science and technology (S&T). In spite of the post-independence push to create much of the current S&T capacity, there has not been much progress in ensuring that science, technology and innovation (STI) drove socio-economic activities. The vision which fuelled the passion for science-led development waned considerably after the fall of the first nationalist Government of Dr Kwame Nkrumah in 1966. Also lacking has been a definitive and prescriptive National STI policy to spell out the vision, goals, objectives and priorities for investment in STI. Such a policy would have committed Government, public and private sector organizations, including the scientific institutions, to specific targets for production, processing, research and development (R&D) and innovation.

On the specific issue of S&T policy formulation in Ghana, one such policy document was adopted by Cabinet in 2000. In 2001, a working document on the management of S&T policy was prepared. However, both documents were not advanced into implementation. A significant move was also made in 2004 to showcase S&T as a major tool for development when a high profile conference was convened. It was dubbed the **First National Forum on Research, Science and Technology (March 2004).** The President and his Ministers were present. It promised much in enthusiasm for S&T and closed with a communiqué which spelt out specific activities for implementation. However, S&T policy implementation suffered a setback again when the sector Ministry of Environment and Science was dissolved in 2006. The science portfolio was absorbed by the Ministry of Education which became the Ministry of Education, Science and Sports.

In the context of the above, the *National Science, Technology and Innovation Policy* was crafted for adoption. It has benefited from earlier documents, and

was reviewed by a cross section of the S&T community including social scientists. Unlike previous documents, the concept of *innovation* is strongly welded into the new framework of actions, policies and programmes to apply S&T to achieve social and economic objectives. Innovation is here defined as the use of *knowledge* to bring about scientific and technological applications to enhance socio-economic activities where such applications are new in the context of usage, although they may not be new outside of the context. Today, it is critical that scientific knowledge, in whatever form, be translated into direct application benefiting the economy and society in one form or the other. The policy stands on this leg.

Vision, Goals, Objectives

Ghana's ambition to become a middle-income country requires a vision of development which fully applies and integrates STI into national development strategies to fully harness the nation's total S&T capacity to achieve national objectives for poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth. The specific objectives, among others, are to:

- facilitate mastering of scientific and technological capabilities;
- provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy to provide the basic needs of the society;
- create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation;
- ensure that STI supports Ghana's trade and export drive for greater competitiveness; and
- promote a science, technology and innovation culture.

The policy will be driven on the principles of relevance, realism, cost-effectiveness, synergy, and partnership.

Sector-Specific Policy Strategies

The principal thrust of the National Science, Technology and Innovation Policy is to ensure that S&T drives all sectors of the economy. To achieve these objectives, sectoral policies, programmes and strategies would be implemented on the basis of the overall National Science, Technology and Innovation Policy. Sectoral policies in agriculture, health, education, environment, energy, trade, industry, natural resources, human settlements, and communications shall be driven by sector-specific S&T programmes and activities. In this regard, the policy document highlights some specific activities and programmes of individual sectors.

Management of Science, Technology and Innovation Policy

The Ministry of Environment, Science and Technology will have the responsibility for the nation's STI policy, and will manage and implement Government's STI policies. This mandate will be executed through the organizations operating under its auspices and, where necessary, through other relevant organizations. The Cabinet Minister, as the political head of the Ministry, would provide the needed leadership to link with other ministries and organizations for STI application and development in the country. The Policy, Planning, Monitoring and Evaluation (PPME) Directorate of the Ministry would be its nerve centre. The PPME Directorate is responsible for policy formulation and the development of appropriate strategies for the monitoring and evaluation of these policies. An apex STI body shall be established to ensure strong advocacy for STI in the country, to provide advice to the Ministry and the President, and to ensure coordination and harmonization of the nation's STI policy and programmes. With representation from Ghana Academy of Arts and Sciences, CSIR, faculties of science and engineering and technology of the universities, professional science and technology-based associations, this body would serve as a Think Tank to provide STI oversight and advice for policy formulation and implementation.

Financing S&T

Government would take stock of the inadequate funding that had handicapped the country's progress in the past, and would accordingly boost public expenditure in STI to achieve the ends of the renewed vision to use S&T as the major drivers for economic growth. Government would make appropriate arrangements for financing the S&T development and delivery system. To ensure the availability of funds at all times to meet the demands of innovation, Government will, among other things:

- take stock of all existing funding lines established to support development in S&T and industry with the aim of streamlining them to achieve economies in their operations;
- strengthen and modify the National Science and Technology Foundation to incorporate support for innovation in its sphere of operations;
- accelerate the allocation of a minimum of 1% of the Gross Domestic Product (GDP) to support the S&T sector; and
- institute an attractive tax incentive mechanism for contributors to the instituted funds or directly to R&D activities, but in a way that would not erode the national tax base.

Chapter 1

INTRODUCTION

Ghana, as a typical developing country, has several development challenges to grapple with. In agriculture, industry, health, environment and all other sectors, there are challenges prohibiting the improvement of the society and the quality of life for all people living in Ghana. Attaining the development vision is not impossible. However, the first and foremost step is harnessing science, technology and innovation to address the development challenges. To enable a constructive and structured harnessing of STI, the National Science, Technology and Innovation Policy is being formulated, taking into account the social and economic context and the imperatives of Ghana's development.

1.1 Background

Science and technology are perceived the world over as major tools for rapid social and economic development. The more industrialized countries of the world applied S&T to develop their economies. China, South Korea, India, Malaysia and Singapore, and a few other countries followed in their footsteps and have also successfully applied S&T to transform their economies. The very rapid economic transformation that has taken place in the Republic of Korea, for example, in contrast to Ghana is generally attributed to Korea's greater success in acquiring and using the knowledge and innovation based on S&T. Yet at the dawn of independence in 1957, Ghana also nursed the dream of rapid social and economic development using knowledge and tools derived from S&T. In a speech which the then founding Prime Minister of Ghana, Dr Kwame Nkrumah, delivered at the last meeting of the old legislative assembly on 5th March 1957, he spelt out a clear vision of rapid development based on the application of S&T. He said:

"Our whole educational system must be geared to producing a scientifically-technically minded people. Because of the limitations placed on us, we have to produce, of necessity, a higher standard of technical education than is necessary in many of the most advanced countries of the Western world … I believe that one of the most important services which Ghana can perform for

Africa is to devise a system of education based at its university level on concrete studies of the problems of the tropical world. The University will be the coordinating body for education research, and we hope that it will eventually be associated with Research Institutes dealing with agriculture, biology, and the physical and chemical sciences which we hope to establish …" (McWilliam & Kwamena-Poh, 1975:94; cited by Kwame Akyeampong, 2007).

This vision drove the impressive S&T institutions that sprang up within a few years after independence. Among these were the following:

- A National Research Council established in 1958 to operate full-time science research institutes to study and develop appropriate technologies.
- A Ghana Academy of Learning, a learned society, established in 1959 which became the Ghana Academy of Sciences in 1961.
- In 1963, the National Research Council merged with the Academy which assumed responsibility for 10 full-time research institutes and projects whose programmes were directly related to the nation's economic and social development.

President Kwame Nkrumah at the Fourth Anniversary of the Ghana Academy of Sciences again stressed the critical role S&T play in socio-economic development as follows:

"We believe not only in pure research as a legitimate endeavor, but we also attach great importance to applied research. Modern science has taught us enough, and has already given us enough, to be able to tackle our agricultural, industrial and economic problems. ***….Only the mastery and unremitting application of science and technology can guarantee human welfare and human happiness."*** *(See Obeng, 1997, p. 309[1])*

[1] Samuel Obeng (1997) "The Academy of Sciences Dinner", *Selected Speeches of Kwame Nkrumah Vol. 2,* Centenary Edition, Afram Publications (Ghana) Ltd, Accra, pp. 307-321.

In 1966, after the overthrow of Dr Nkrumah, changes were made to the Academy which was designated Ghana Academy of Arts and Sciences (GAAS). The research institutes were placed under a new body called Council for Scientific and Industrial Research (CSIR) which, in its present form, was re-established in 1996 with 13 Research Institutes. Over the years, more scientific and technological institutions were established. These include Ghana Atomic Energy Commission, Environmental Protection Agency, Noguchi Memorial Institute for Medical Research, and Ghana Standards Board.

Alongside the research establishments and Government agencies and central to their functioning are the universities which perform the important task of training the high level human resource to run and manage them. The University of Ghana began in 1948 as the University College of the Gold Coast. The Kwame Nkrumah University of Science and Technology began as the Kumasi College of Science and Technology in 1951. The University of Cape Coast started in 1961. As of 2009, Ghana has seven public and 25 private universities. With that number of universities as well as 10 polytechnics, and over 500 senior high schools, 23 technical institutes, and a large informal sector in which most artisanal skills training take place, Ghana can be said to have a substantial education and training capacity for human resource development in STI. However, inadequate staffing, laboratory and workshop facilities have limited the capacity of all these education and training institutions to produce the quantity and quality of high-level scientists and technologists, and middle-level technicians and artisans.

With the creation of the Ministry of Environment, Science and Technology in the Third Republic, which began as the Ministry of Industry, Science and Technology, the promotion, management, coordination and harmonization of S&T policies and institutions were finally placed in the mainstream of Ghana's Government machinery.

However, the premium placed on S&T as the main drivers of development has not been high in the eyes of policy makers and managers of the nation's resources. The proportion of the nation's budget allocated to STI has been low. It has fluctuated between 0.3% and 0.5% of the Gross Domestic Product (GDP). This is well below the target of 1% of the country's GDP prescribed at the Summit of African Heads of State of the Organization of African Unity (OAU) in 1980 under the Lagos Plan of Action and adopted by the African Union (AU) as a critical means of realizing the goals and objectives of the New Partnership for Africa's Development (NEPAD). Korea, Singapore and Taiwan have spent as much as 2% of GDP on S&T. Also, without industries to use the talents and skills of bright young men and women who opt for science at school, their attraction is for medicine and related disciplines rather than the pure sciences of physics, mathematics, chemistry and biology. The situation is even worse for middle-level professionals and technicians who are needed to keep industries and other technological systems functioning.

Thus, in spite of the post-independence push to create the current S&T capability, Ghana has not made as much progress as countries in South East Asia whose levels of development were not higher than Ghana's at the dawn of independence. Ghana has not had a definitive and prescriptive National Science, Technology and Innovation Policy document to spell out policy directions for various sectors of the economy and associated prioritized investments. Though a National Science and Technology Policy which provided a broad framework for defining goals and objectives for S&T for socio-economic development was approved in 2000, it did not travel beyond this stage into full implementation. In 2001 a working document on management of S&T policy was prepared. The convening of the First National Forum on Research, Science and Technology in 2005 brought much with the high level participation from the President and his Ministers. It closed with a communiqué which raised high expectations because it spelt out activities and programmes to advance S&T for development. However, S&T policy implementation suffered a setback again when the then Ministry of

Environment and Science was dissolved in 2006. The science portfolio was absorbed by the Ministry of Education which became the Ministry of Education, Science and Sports. However, during the intervening 8 years after 2000, new institutions for education and training in ICT, such as the Kofi Annan Centre of Excellence for ICT, were established.

More importantly, advances in S&T with wide applications make it imperative for Ghana to review the S&T policy. These include innovations in information and communications technologies (ICTs) and Internet applications, as well as emerging trends in biotechnology. Also, other technologies with great potential, such as nanotechnology, underscore the need for Ghana to formulate a more comprehensive and vigorous approach to building a more modern scientific and technological capacity.

Meanwhile, competitive pressures on the national economy are enormous. The global trade environment, dominated by rapidly emerging technologies and processes, is gradually becoming a threat to local African enterprises. Climate change and its consequences in terms of food crises and threats to human welfare are affecting Ghana just as it is doing to the world ecosystem. However, the opening up of trade opportunities in the global markets in general and the mounting requirements of the World Trade Organization Treaty on Technical Barriers to Trade (Uruguay Rounds of Talks) pose opportunities and risks to the developing economy of the country. Local enterprises can still be competitive in the global trade environment with enhanced innovation and scientific content in their operations in all areas. In this regard, Ghana, as a matter of urgency, has to make urgent policy decisions to harness STI in the development process.

In the context of the above, the Draft National Science, Technology and Innovation Policy was crafted for adoption. It has benefited from earlier documents, and was reviewed by a cross section of the S&T community including social scientists. The policy goals, objectives, approaches and mechanisms to achieve this have taken account of investment in

infrastructure, education and training, research and development and science acculturation, among others.

Unlike previous documents, the concept of *innovation* is strongly welded into the new framework of actions, policies and programmes to apply S&T to achieve social and economic objectives. Innovation is here defined as the use of *knowledge* to bring about scientific and technological applications to enhance socio-economic activities where such applications are new in the context of usage, although they may not be new outside of the context. Today, it is critical that scientific knowledge, in whatever form, be translated into direct application benefiting the economy and society in one form or the other.

The emphasis on innovation comes from the realization that technologies bring about desired changes only when they are fully integrated into local systems and practices. The sound application of scientific and technological knowledge to make positive changes has to consider cultural norms and the total world view of the people who are the users of the new technologies. Innovation, therefore, connotes these sometimes complex interactions of science, technology and the society. Thus, the policy provides a broad framework for addressing the multi-dimensional demands of STI development and usage.

1.2 Existing Institutional Arrangements for Science, Technology and Innovation

Over the years, there have been re-structuring and re-organization of the Ministry responsible for STI with the aim of addressing specific developmental challenges. The consensus is strong that the Ministry of Environment, Science and Technology (MEST), which was re-established in January 2009, should be the sector Ministry responsible for managing and implementing Ghana's S&T policies under the Presidency. This will make the Ministry oversee and coordinate the activities and programmes of the Council for Scientific and Industrial Research (CSIR) with its 13 research institutes, Ghana Atomic Energy Commission (GAEC), Environmental

Protection Agency, and Town and Country Planning Department, whose primary responsibilities are applied research and development (R&D) in Ghana.

A major role for the MEST, which has so far not been institutionalized, is linkage between it and the Ministries of Education, Trade and Industry, Employment and Social Welfare, Communications, Lands and Forestry, and indeed all other ministries to ensure that the educated, trained and skilled human resource in whom the national STI capability resides are available in adequate numbers to achieve national objectives in economic development. An issue of concern and redress is inadequate commitment over the years to train a larger number of scientists, engineers and technologists to sustain the national scientific capability. Ghana also lost many trained persons to the brain drain. Unlike other countries, use of the diaspora has not been factored into a national assets utilization plan. One of the contributions toward that should be a national register of skilled Ghanaians abroad. The country needs more than their remittances, which have become a major income base for the economy.

A third area of concern for building Ghana's STI capacity is the inadequacy and failure to develop further the capacity of the universities to educate and train larger numbers of scientists and technologists to the level of the PhD. Universities that are engaged in producing scientific and technological human resource at this level would have the capacity not only to conduct applied R&D, but also to conduct basic research. A National Science, Technology and Innovation Policy must encourage Ghana's scientists and technologists to link up with international research centres which conduct world-class basic research so that Ghana is not isolated from such pursuits that enlarge human knowledge and understanding. The polytechnics must be made to educate and train the high-level technicians and technologists in larger numbers to provide high-skilled support for national STI. This will not happen if immediate action is not taken to reverse the movement away from S&T that is happening in the polytechnics for reasons that are not beyond correction.

Major contributors to national STI capacity are the professional associations and bodies which meet annually to share results of their research and practice and pass resolutions which urge Government to act to advance STI. Unfortunately, most of their annual gatherings receive little national coverage and are often not patronized by sector Ministers and the Presidency. The National Forum on Harnessing Research, Science and Technology for Sustainable Development which was organized in 2004 was attended by the President, Chairman of the Council of State, and major sector Ministries. It set a pattern of participation which must be repeated regularly and consistently to show the Government's commitment to STI.

1.3 What Constrains STI Application?

Ghana has invested much in science and technology infrastructure. These investments have not yielded the expected improvements in economic growth. This can be attributed to several constraints including the following:

- Inadequate scientific expertise in the country;
- Lack of advocacy for S&T at high political and policy levels;
- Low science culture among the population;
- Weak mechanisms for the management of S&T;
- Ineffective coordination;
- Inadequate budget and resource allocation;
- Weak linkage between policy formulation and national development planning;
- Weak mechanisms for implementation, evaluation and review;
- Weak linkages between various agencies and organizations in S&T;
- Weak linkage between industry and S&T;
- Overreliance on the use of foreign expertise to the neglect of the use and development of local expertise;
- The narrow base of quality in our pre-tertiary education system; and
- Poor remuneration and conditions of service for S&T personnel of research institutions.

Ghana's STI would advance rapidly if these constraints are removed. Calls for their removal have come from annual and biennial resolutions from the professional bodies which represent the S&T communities. Advocacy for STI would be greatly manifest if Ministers of State and the President interact more often with scientists, engineers and technologists, and work with them to address the limiting constraints.

1.4 Justification for Science, Technology and Innovation Policy

The priority themes underpinning Ghana's National Science, Technology and Innovation Policy, and together form the agenda for the revived Ministry of Environment, Science and Technology, provide ample justification for the STI policy. These are as follows:

- Promoting competitiveness in productive sectors of the economy;
- Creating job opportunities and employment;
- Expanding industrialization;
- Enhancing the quality of life through innovation;
- Developing scientific human resources;
- Expanding infrastructure;
- Promoting an information society;
- Optimizing the sustainable use of the natural and environmental resources; and
- Commercializing research findings.

Ghana's development plans have integrated STI applications in socio-economic development (Box 1).

Box 1: Policy Statement on STI

The National Development Planning Commission (NDPC) stated its vision for Ghana as "a modern economy based on the development of science and technology." To achieve this vision, Ghana will need a modern, efficient framework for promoting science, technology and innovation (STI) and for managing the country's STI policies, programmes, and institutions. Ghana's STI framework should reflect international best practice, lessons and experiences, which should be modified for implementation in Ghana.

From independence onward, Ghana's leaders have recognized that STI should play a central role in modernizing Ghana's economy, improving living conditions, and solving social problems. This recognition spawned several previous efforts to modernize the STI system and ensure that Ghana's research institutes and universities live up to their promise of serving as an effective instrument for Ghana's growth and development. STI has been highlighted in almost every recent Government vision and planning document, including Vision 2020, the subsequent Vision 2015, the National Science and Technology Policy of 2000, and the Growth and Poverty Reduction Strategy (GPRS II). The Ghana Poverty Reduction Strategy Paper I (1996-2005) has a section on science and technology. Further, the Growth and Poverty Reduction Strategy (GPRS II, 2006-2009) also makes reference to the importance of Ghana's national development.

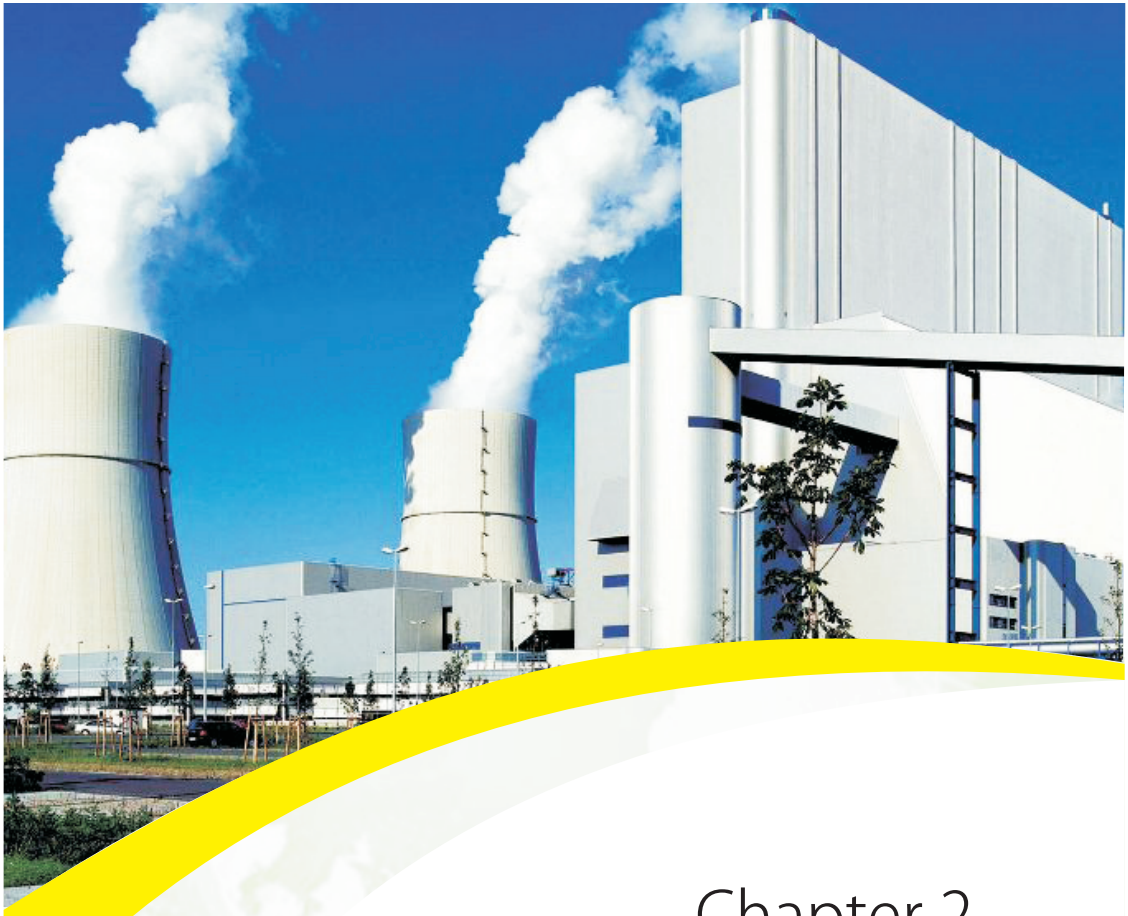
Currently, the NDPC has prepared and published in 2010, the Ghana Shared Growth and Development Agenda (GSGDA 2010-2013), which makes it clear that science, technology, and innovation are to be key elements of Ghana's development strategy. It is an affirmation of Ghana's recognition of the indispensable role of STI in national development.

Ghana's efforts to articulate the policy framework for STI application is also linked to the sub-regional commitments as defined by the ECOWAS Revised Treaty as well as NEPAD. The ECOWAS Revised Treaty requires member states to ensure proper application of S&T to the development of agriculture, transport and communications, industry, health and hygiene, energy, education and manpower, and the conservation of the environment. The NEPAD S&T Consolidated Plan of Action (2006-2010) outlines a series of "collective actions to develop and use science and technology for the socio-economic transformation of the continent and its integration into the world economy." These include such STI capacity building projects and programmes as: [2]

- Improving infrastructure or facilities for R&D;
- Creating institutional and policy arrangements that enable African countries to mobilize and share their scarce resources to conduct science and generate technological innovations;
- Strengthening the continent's human skills base by increasing the number of scientists, technicians and engineers;
- Improving the quality and intensity of regional cooperation;
- Building a strong political and civil society constituency for S&T in Africa;
- Improving the quality of STI policies of African countries;
- Strengthening the capacity of regional economic bodies to mainstream S&T into their sectoral programmes and projects;
- Promoting the application of S&T to achieve specific MDGs; and
- Promoting innovative ways and means of financing S&T in Africa.

The above statements show why African countries, Ghana included, must build national capacities for using STI to facilitate growth in all aspects of social and economic life. The National Science, Technology and Innovation Policy provides the framework to create the institutions and develop the human resource and make the appropriate financial arrangements to harness the available STI capacity for economic and social development.

[2] See AU / NEPAD S&T Consolidated Plan of Action, p. 10.



Chapter 2

VISION, GOALS OBJECTIVES AND GUIDING PRINCIPLES

Ghana in the 21st Century should not export its gold, cocoa, diamond, bauxite and other commodities unprocessed and unrefined. Ghana must have the industrial base to use the skills of a trained workforce to produce high value-added exports to generate more wealth. In today's globalised world, the country must create the capacity to produce more knowledge-intensive goods and services which are not dependent on natural resources. The STI policy plans for this future in which the country can earn more revenue to achieve social and economic objectives, and generate more high-value jobs for the thousands of school-leavers and university graduates. Without such a future, the most talented of Ghana's young people would not be attracted to careers in science, mathematics, engineering and technology. Those who choose these disciplines now would find their way out of the country to join the diaspora and the brain drain.

Ghana requires policies to build an educational system to produce skilled personnel to drive a modern economy. Such policies would minimize the brain drain. Investments in developing high STI capacity, and collaborations with developing and advanced economies must derive from a vision with this objective. In mapping the future, Ghana must seize the marketing opportunities for value-added products and services in the West African sub-region and in sub-Saharan Africa.

2.1 Vision

Ghana's STI policy is to drive a vision to build a strong STI capacity to support the social and economic developmental needs of a middle-income country. Ghana intends to migrate from the low science and technology-poor practices and world view associated with tradition-bound society to STI and knowledge-based society with an economy based on high levels of production, processing, industrialization and manufacturing. Simply put, Ghana's STI policy seeks for the country a future whose STI capability would enable it to produce and process maximally, the natural resources that she is blessed with; and also has the knowledge base to participate actively in

producing high-tech goods and services for local consumption and for export.

2.2 Goals

Given the historical background to Ghana's efforts in STI application and development, the STI policy must be contextualized and fully integrated into a national development strategy which fully harnesses the nation's total S&T capacity to achieve national objectives for wealth creation, poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth.

2.3 Objectives

Thus, the basic objectives of the Science, Technology and Innovation Policy should be to:

- facilitate mastering of scientific and technological capabilities by a critical mass of the products of all institutions;
- provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy to provide the basic needs of the society;
- create the conditions for improving scientific and technological infrastructure for research and development and innovation;
- ensure that STI supports Ghana's trade and export drive for greater competitiveness; and
- promote a science and technology culture.

2.3.1 Long-Term Objectives (Over 10 years)

In the long-term, the main objectives are to create endogenous S&T capacities appropriate to national needs, priorities and resources; and to create a science and technology culture whereby solutions to socio-cultural and economic problems of the individual, the community, and the nation are recognized and sought within the domain of S&T.

In the long-term, Ghana's STI policies must address issues such as undue

population growth with its potential to slow social and economic growth and deterioration of the environment. Ghana's STI policies would also address climatic change and the movement away from carbon-based energy usage to the use of renewable energy.

2.3.2 Medium-Term Objectives (5 to 10 years)

In the medium-term, the objective is to accelerate the promotion of innovation through the development and utilization of modern scientific and technological capabilities to provide the basic needs of the citizenry and to compete ably in the global market.

In considering acquisition and development of new technologies, Ghana may wish to consider leapfrogging from old technologies to newer and more knowledge-intensive technologies. Two good examples may be considered. The speed with which telephone communication has improved, based on mobile phone technology rather than further development of the land-based technology, shows what new technologies can do. Second, the use of radio and television-based teaching and learning as well as distance-learning technologies may have the potential for leapfrogging the expansion of education rather than reliance on more conventional modes.

2.3.3 Short-Term Objectives (Up to 5 years)

The short-term objective is to restructure the S&T machinery, infrastructure and programmes to make them more responsive to national needs and priorities in all sectors of the economy. To that end, emphasis will be placed on:

- restructuring of the National Science and Technology Advisory system;
- improving basic and applied research infrastructure;
- revitalizing the teaching of science at the basic, secondary and tertiary levels of the education system;
- promoting the training of a critical mass of middle-level technical

personnel to address the provision of basic needs;

- acquisition of skills in high technology areas such as ICT,









Chapter 3

SECTOR-SPECIFIC POLICIES AND MEASURES TO APPLY STI

The principal thrust of the National Science, Technology and Innovation Policy is that advances, insights, tools and practices which derive from science and technology will be sought and applied in all ministries, departments and agencies; indeed in all sectors for social and economic development. In other words, STI will be the driver to achieving sectoral goals, objectives and programmes. All ministries will be expected to have STI desk offices to work in cooperation with the MEST to ensure that sectoral programmes and activities are indeed driven by STI programmes.

To achieve these objectives, it is essential to facilitate the implementation of sectoral policies, programmes and strategies by the respective sectors on the basis of the overall National Science, Technology and Innovation Policy. Agriculture, health, education, environment, energy, trade, industry, natural resources, human settlements and communications, among others, are expected to identify programmes and activities whose execution will be enhanced by the most appropriate and effective tools derived from STI and ICT.

This section of the National Science, Technology and Innovation Policy highlights some programmes and activities of selected sectors which can be driven by applications from STI. Core activities and programmes that are required in sector ministries, departments and agencies to apply STI will begin with knowledge and skills development as well as R&D in all sectors.

Well-educated and trained high-level scientists and technologists with specialist knowledge and skills will be required to provide specific services to enable all sectors discharge their vision and mission. Quality and diversity of education and training in the universities and polytechnics must meet international standards of excellence; otherwise quality service would continue to depend on expensive foreign expertise. Whereas such personnel may be required in specialized areas, Ghanaians in the diaspora must be recruited to augment and provide leadership where necessary. The GETFund

should provide funding to seek out Ghanaians abroad and foreign nationals to fill gaps in education and training.

Research institutes of the CSIR and other organizations must be well staffed and equipped to provide the R&D needs of all ministries, departments and agencies, and also the private sector. Their priorities must be well defined, reviewed regularly to ensure their relevance not only to the formal sector, but also indigenous businesses and the large informal sector in which most Ghanaian production and jobs are located. Changes in vision and mission will be made where necessary. New institutes may be set up if found necessary. Box 2 describes the Cocoa Research Institute of Ghana, its vision, mission and some successes achieved.

Box 2: Cocoa Research Institute of Ghana

The Cocoa Research Institute of Ghana (CRIG) originated from the West Africa Cocoa Research Institute (WACRI) which was established in 1938 to investigate problems of pests and diseases negatively affecting cocoa production in the sub-region. The mandate of CRIG was widened in 1966 to:

- **Research into all problems relating to production, processing and utilisation of cocoa and other mandate crops (e.g. kola, sheanut and cashew);**
- **Provide information and advice on all matters relating to the production of cocoa and the mandate crops; and**
- **Research into the development of by-products of cocoa and other mandate crops to enhance incomes to farmers.**

Notable achievements of CRIG include the following:

- **Control of capsids and other pests by spraying with insecticides.**
- **Isolation and characterisation of cocoa shoot virus and the development of diagnostic methods.**
- **Production of pectin, alcohol and alcoholic beverages, animal feed, jelly, soap and cosmetics from cocoa wastes.**

Extracted from Lecture by Dr M. R. Appiah, Executive Director, 2004

The programmes envisaged for the Ministries of Agriculture, Environment, Health, Energy, Education, Industry and Trade are highlighted below to show how some specific activities and programmes can enhance the quality of services that can be provided within the framework of mainstreamed STI policies.

3.1 Agriculture

Agriculture is critical to achieving food security. It provides jobs for 60% or more of the workforce and contributes about 40% to Ghana's GDP. Agricultural productivity at every level of the chain of production, processing,

packaging and marketing will be made to benefit from quality, relevant research and development. It will require the knowledge and skills of an army of scientists of many specializations, engineers and technologists, and many social scientists including economists, sociologists, geographers and statisticians. The success that the Gold Coast had with the production, storage and marketing of cocoa was largely based on the R&D activities of the Cocoa Research Institute of Ghana (CRIG). Applying the lessons of CRIG to other crops would require that the CSIR-Crops Research Institute, CSIR-Oil Palm Research Institute, and CSIR-Savanna Agriculture Research Institute are better strengthened and focused on agricultural productivity issues. Similarly, the CSIR-Animal Research Institute, CSIR-Water Research Institute and the field agricultural research stations of the University of Ghana at Nungua, Kade and Kpong must be positioned and better funded to advance in their operations. Other R&D programmes which can increase agricultural productivity and in the process increase wealth and reduce rural poverty include the following:

i. Promote the research and application of new technologies including safe biotechnology, which hold potential for increasing productivity;
ii. Reduce pre-harvest and post-harvest losses in agricultural production in cash and food crops;
iii. Promote the development of food processing industries and enhance value addition for the local market and for export;
iv. Strengthen the production of non-traditional export commodities to enhance the diversification of the economy;
v. Strengthen the linkage between research and agricultural extension;
vi. More proactive Government support for individual R&D projects which are applying tissue culture in banana, plantain, pineapple and yam production.

3.2 Health

The mission of Ghana's health system is the promotion of activities and programmes to prevent, control and treat diseases affecting the citizenry. Science, technology and appropriate innovations can facilitate the processes

to achieve the goals and objectives of the health care delivery system. Preventive and public health measures to improve sanitation, hygiene and supply of good drinking water, and also improved nutrition will be more vigorously pursued within increased use of STI. Ghana's health burden is unduly exacerbated by ignorance and superstitious beliefs and practices of the people. Investment in dissemination of scientific information in the mass media to change the world view of the Ghanaian people would save more lives and reduce the national cost of health care.

A major aspect of the mission of the health care system pertains to the education, training, attraction and retention of health professionals. From the early successes of training and education of preventive and public health technicians and technologists, Ghana's health sector advanced into establishing the premier Medical School at Korle Bu with local medical specialists. These locally trained doctors have been accepted all over the world. Recent success in establishing the National Cardiothoracic Centre is evidence that local capacity can be developed locally. With the establishment of the Noguchi Memorial Institute for Medical Research, Ghana has shown that preventive and public health care can coexist with high-tech medical practice.

The foregoing is the context in which to craft a vision and mission for quality health services that are driven by appropriate technologies and innovations driven by S&T. Some programmes to implement in the health sector include the following:

i. Promote preventive and regenerative health care;
ii. Support biomedical research in prevalent diseases in the areas of prevention, diagnosis, therapy and management;
iii. Improve access and services in the general health care delivery system;
iv. Promote technologies in support of sanitation, environmental and occupational health;

v. Promote research and development in the area of bio-medical engineering and instrumentation, as well as the potential of information technology application in the health care delivery system;

vi. Enhance the development of human resource for health care delivery;

vii. Promote and support research into plant medicine to complement allopathic medicine including the commercialization of the research results; and

viii. Establish specialized health centres to promote health tourism.

3.3 Education

The strength of the nation's STI base depends on the quality of education and training in science and mathematics in basic and second cycle schools to produce a critical mass of young people who are well prepared for courses in science, mathematics, engineering and technology at the polytechnics and universities. The quality of the education and training in these tertiary institutions determine the quality of these trained and skilled personnel and, therefore, the nation's STI capacity. More investments in education and in incentive structures would be required to achieve this. Business-as-usual policies would not improve the teaching of science and mathematics in schools, and would not produce qualified students in the numbers required to make a difference. Inadequate numbers of high-level jobs for science, mathematics and engineering graduates would continue to discourage the more talented students who are required for education and training in S & T. Effective strategies are required to respond to the challenges mentioned. Leapfrogging the quality and scope of science and mathematics education would be greatly assisted by ICT-driven distance-learning methodology.

Some programmes to drive the vision and mission for education include the following:

i. Ensure that by 2020, 60% of all students in the public universities

and 80% of those in the polytechnics and vocational institutions are registered in science and science-related disciplines;

ii. Promote postgraduate education in scientific disciplines, targeting 10% of the student population in tertiary educational institutions enrolling at the post-graduate level;

iii. Create special incentives for students and graduates of S&T;

iv. Improve science education at all levels and in all aspects of the educational system, especially at the basic and secondary levels;

v. Promote technical and vocational education and training to enhance middle-level management in S&T delivery to all sectors;

vi. Promote S&T innovativeness within the educational system;

vii. Increase the country's capacity in the training of personnel in the new and emerging technologies such as biotechnology, nanotechnology and materials science;

viii. Use the mass media to popularize STI;

ix. Enhance collaboration between research institutions and universities to train high-level scientific manpower;

x. Ensure that adult literacy classes include studies into cause-and-effect relations and how things work;

xi. Facilitate regular review to identify skill gaps in STI (new and emerging technologies);

xii. Revamp the practice of industrial attachments for technical, vocational education as well as science, technology and engineering students;

xiii. Devise ICT-driven education and training programmes in science and mathematics in basic and second cycle education; and

xiv. The Ministry of Education and the Ministry of Environment, Science and Technology must together revive the National Science and Technology Museum project which began as far back as 1965 to use it as a major instrument to promote science acculturation nationally. Regional Science and Technology Museums should be built nationally as a major project to promote S&T education.

3.4 Energy

Ghana needs a supply of sustainable, affordable, safe, and reliable energy for domestic and industrial use. Energy must be safely produced, distributed and utilized. Well-trained scientists, technologists and technicians are required in adequate numbers to do this. Ghana's main energy supply has come from electricity generated from the Akosombo hydroelectric dam and thermal plants. While Ghana prides itself on the fact that the engineers, technologists and technicians who produce, distribute and utilize power are Ghanaians, serious interruptions have been common for the past decade or more. This is a big challenge to the nation's capacity to apply S&T in large-scale projects.

Some programmes which will be considered in the short, medium and long-term include the following:

i. Promote a research and development programme relating to alternate energy sources such as solar energy, biomass, wind and other renewable energy sources to supplement the current traditional energy sources;
ii. Facilitate efforts to acquire and adapt sustainable, safe and economical energy technologies for national development;
iii. Support research aimed at upgrading hydropower energy production technology;
iv. Promote R&D efforts aimed at popularizing and disseminating energy technology for rural development;
v. Promote public support for energy conservation and encourage private investment in energy technologies;
vi. Encourage community investment and ownership of energy systems, e.g. solar farms, windmills and biomass plants;
vii. Exploit the utilization of nuclear energy resources for domestic and industrial use; and
viii. Develop an integrated petrochemical industry to respond to the oil and gas industry.

3.5 Industry

Ghanaians engage in a wide variety of activities and enterprises which can be classified as industry. A list of these industries will open more eyes to how a more developed science, technology and innovation capacity can enhance production and processing to increase value addition to increase wealth and create jobs. These industries include cocoa, mining, textile, timber, farming, fishing, aquaculture, crafts, pottery, wood, furniture, tourism, finance and banking, export of banana, citrus and pineapple (non-traditional exports), food and beverages.

Some of these industries are rooted in the informal sector and operate with indigenous technologies whose capacities can be enhanced using STI. Evaluation of indigenous technologies in fishing, farming, craft manufacture and others will indicate how it can be done. The role of STI should be to increase the national capacity for industrial production and value addition. Fish storage and consumption patterns in Ghana before and after cold stores were installed is one example of how new technologies change social and consumption patterns. Oil and gas exploration opens up new opportunities for the Ghanaian industry, which require skilled human resource to develop into a new petrochemical industry.

As a largely agricultural country with a wide variety of farm products other than cocoa such as cassava, citrus, pineapple, banana and plantain agri-processing, food and beverages have potentials well beyond their export as non-traditional commodities. A massive fruit juice industry can capture major markets in West Africa and beyond.

Ghana's early period of industrialization featured non-resource-based industries like those that assemble radio, television and motor vehicles. These need to be revisited with the better-trained and skilled workforce that Ghana has now.

Some programmes and activities to be pursued include the following:

i. Strengthen systems and mechanisms for acquiring, assessing, adapting, adopting and applying essential technologies for industrial activities;
ii. Encourage R&D activities that develop tools, equipment and machinery for industries;
iii. Encourage quality assurance in manufacturing;
iv. Promote S&T activities that would accelerate technology transfer and innovations;
v. Create incentives to promote investment and support in R&D by the private sector;
vi. Facilitate capacity building in engineering design and manufacturing technology to enhance national development;
vii. Enhance industrial technology development infrastructure;
viii. Promote and facilitate recyclable materials technologies, and apply to minimize industrial waste in the environment;
ix. Promote scientific knowledge acquisition and development of technologies in the new and emerging sciences of biotechnology, materials science, micro-electronic and laser technology;
x. Create the national capacity to exploit opportunities for innovation addressing climate change;
xi. Establish industrial parks, innovation centres, and business incubators to foster linkages between the knowledge centres (i.e. research institutes and universities) and productive enterprises;
xii. Institutionalize regular interaction between research institutes/universities and the private sector; and
xiii. Promote industrial attachments for S&T students .

3.6 Trade

To promote STI applications in commercial activities to ensure quality, reliability and efficiency in the delivery of goods and services in conformity with appropriate local and international standards. Some of these activities are listed below:

i. Encourage the adoption of scientific and technological innovations to ensure effectiveness and efficiency of product output and high quality of products.
ii. Utilize S&T in improving national standardization and quality management programmes.
iii. Utilize S&T to improve packaging.
iv. Promote the adoption of standards for producing goods and services for the local and international markets.

3.7 Environment

The environment is a source of natural resources, food, medicines and some basic necessities of life. It is a source of recreation for improved well-being. As the primary source of the inputs for industry, the environment has to be used in a sustainable manner. Its deterioration has been recognized worldwide, and its protection has been responsible for establishing Environmental Protection Agencies in Ghana and elsewhere. Application of STI to all aspects of managing the environment would enhance sustainability. Some activities and programmes to apply STI in managing the environment to maintain and enhance quality and sustainability, and to integrate environmental concerns in all development policies include the following:

i. Integrate environmental concerns in all development policies and ensure public understanding of the scientific basis of their actions on the environment.
ii. Encourage and support S&T interventions that promote sustainable environmental conservation and management.
iii. Strengthen R&D activities that would promote sustainable development, especially of ecosystems and ecological processes.
iv. Develop the STI capacity to monitor, predict and mitigate the adverse effects of natural phenomena such as earthquakes, floods, droughts, desertification, and bushfires.
v. Develop an efficient integrated waste management system for using the principle of waste as a resource.
vi. Promote the use of clean technologies in production systems.

3.8 Human Settlements

To promote the use of STI in planning and managing human settlements as well as all spatial developments, some STI applications will be required to promote efficient and effective delivery of utilities and services, and to integrate planning technologies in controlling urban sprawl. More use will be made of STI applications to establish standards, guides and codes for buildings to ensure durability and integration with the building materials fabrication industry.

Management and efficient delivery of services like water, electricity, disposal of domestic and industrial waste, and the operation of local markets have tasked the capacity of the Government and city officials to the extent that slums have characterized our cities. More sophisticated management of urbanization and its problems have so far eluded our governments. New solutions must be found in more sophisticated planning and implementation. Government would consider setting up centres for the study of urbanization in selected universities to advance the professional management of the city to move national efforts which have so far been more philistine than scientific. Strategies would be formulated, among other things, to:

i. Encourage the use of STI to minimize the impact of natural disasters;
ii. Encourage, through constant education and legislation, the greening of human settlements;
iii. Encourage the use of STI to establish standards, guides and codes for buildings to ensure durability and integration with the building materials fabrication industry; and
iv. Emphasize sound environmental management in human settlements for sustainability of human societies.

3.9 Natural Resources (Land, Minerals, Water, Oil, Gas, Wildlife, etc.)

The primary goals for the application of STI for natural resource exploitation and management are to strengthen the development and extension of technologies and innovations that form the basis for sustainable use of

natural resources, to enhance local participation in STI associated with exploring and exploiting Ghana's oil and gas resources, and to facilitate research and ensure prevention or control of pollution of the environment. Strategies would be formulated, among other things, to:

i. Support research in exploring and exploiting additional mineral resources;
ii. Ensure effective development and use of natural resources;
iii. Strengthen the development and extension of technologies and innovations that form the basis for sustainable use of natural resources; and
iv. Promote research and measures to protect and conserve biological diversity of the country.

3.10 Science Acculturation

The STI policy aims at promoting a culture of science, technology and innovation through public and private awareness campaigns, and developing an information system to enhance the scientific thinking of Ghanaians in their everyday lives. It would promote and support STI literacy programmes to facilitate the adoption and application of S&T. Among other things, there would be strategies to:

i. Facilitate the packaging of research findings to be disseminated by the mass media;
ii. Facilitate the training of human resources in STI writing and communication; and
iii. Popularize STI through the establishment, investment and management of science museums, STI fairs, and exhibitions to allow public participation in STI activities in all parts of the country.

3.11 Information and Communications Technologies

The ICT is a dominant new technology which must be fully popularized and deployed in all sectors of the economy. The STI policy would aim to promote the use of STI to ensure that modern information and communications

technologies are available and used at all levels of society. Specific ICT strategies include the following:

i. Ensure STI capabilities exist to integrate ICT into all sectors of the economy including education, industry, agriculture, health and e-governance.
ii. Develop a national competence for computer hardware and software engineering and information security.
iii. Facilitate the development of a modern ICT infrastructure to improve teaching, learning and research.

3.12 Building and Construction

Infrastructural development, especially in housing, is fundamental to the attainment of the national vision. A primary aim in this policy is to develop the STI capacity to support the building and construction sector, including the development of local raw materials and equipment, and to encourage their use. Some interventions are as follows:

i. Develop the necessary capability in building and construction design, management, execution, and in production of building and construction materials and equipment.
ii. Support the popularization of appropriate and locally specific building and construction and low-cost materials and technologies.
iii. Ensure the standardization of building, design and construction materials for rationalizing their use and public safety, especially in the informal sector.
iv. Encourage the training of artisans in the use of local materials and equipment.

3.13 Science, Technology and Innovation and National Security

National security is paramount in ensuring stability and sustainable governance in Ghana. The policy aims to develop STI capacity for the country's security services to enhance efficiency and effectiveness in their

operations. The following are some specific interventions:

i. Support the development of STI to enhance the country's security infrastructure.
ii. Promote the use of STI to combat sophisticated crimes.
iii. Enhance the teaching, research and application of S&T in the security services.

3.14 Nuclear Science and Technology

In line with efforts to explore the application of all the sciences, nuclear science and technology will be exploited for national development. The policy will aim to further promote the peaceful uses of nuclear science and technology in the national development process. Expected interventions include:

i. Developing the requisite infrastructure and human capacity for nuclear science and technology;
ii. Accelerating the application of nuclear science and technology in all sectors including energy, health, agriculture and industry;
iii. Establishing a national regulatory framework for ionizing and non-ionizing radiations to ensure public safety; and
iv. Following up decision to develop nuclear energy as an additional source of energy with planning and investments.

3.15 Basic Research

Scientific enterprise thrives on active basic research. Though Ghana must adhere to the principle of not re-inventing the wheel, researchers will be supported to undertake basic research relevant to socio-economic activities. The policy will aim to promote and encourage basic research as the bedrock of scientific and technological innovation. Expected interventions include the following:

i. Encourage and support basic research by providing adequate resources;
ii. Acquire the requisite state-of-the-art infrastructure for the furtherance of education, training and research;

iii. Create incentives for the study of basic science at undergraduate and postgraduate levels;

iv. Educate, train and retain appropriate and adequate research and technical personnel for basic research;

v. Seek opportunities to collaborate with partners in the African Union and foreign partners for education, training and research; and

vi. Seek out all known and innovative strategies to fully use the special knowledge and skills of Ghanaians and other Africans in the diaspora. A national register will be kept of all accomplished Ghanaians who will be regarded as external faculty of our universities, and will be honoured accordingly if they make their contributions available nationally.

3.16 Sports and Recreation

Ghana is a sporting nation. The experiences of the leading sporting nations of the world show the huge impact STI could have on sports. The STI policy will promote scientific and technological methods which enhance the development of all sports. The following interventions will be made:

I. Promote R&D in sports medicine and nutrition, physical education and other disciplines to produce high calibre of sportsmen, and sportswomen, including the physically challenged.

ii. Facilitate the development of recreation as a health maintenance factor.

iii. Encourage STI courses related to sports at all levels of education.

3.17 Youth Innovation

Every effort will be made in the educational system and popularized through the mass media, the applications of science, technology and innovation among the youth. The youth are the heart of the nation and will accordingly be critically groomed and integrated into the National Innovation System.

Specific interventions will include the following:

i. Promote innovation at all levels of the educational system.
ii. Encourage activities that bring out the STI capabilities of the youth; for example hold regular science and mathematics clinics and computer programming clinics for girls and boys to encourage science learning, and promote STI competition among the youth.
iii. Establish award schemes that reward innovation among the youth.
iv. Provide scholarships for promising science students.
v. Establish mechanisms for encouraging young people to move into the sciences.
vi. Initiate mechanisms to identify young scientists.
vii. Establish mentoring programmes in STI for the youth.

3.18 Roads and Transport

An efficient and modern economy requires a modern and well-developed transportation network. STI will be applied to improve the road and transportation system and promote more efficient and safe movement of people, goods and services.

Specific interventions will include:

i. Promoting R&D in the road and transportation system;
ii. Facilitating the adoption and use of R&D outputs and local innovations for road design and construction;
iii. Encouraging investment in local innovation in the transport sector;
iv. Creating information management systems for transport companies to improve on service delivery; and
v. Developing appropriate scientific human resource for the transportation system.

3.19 Tourism

As a major source of revenue and job creation, the application of STI to improve service delivery in the tourist industry will be vigorously pursued.

The industry holds the potential as a major source of foreign exchange for Ghana. The STI applications will enhance such earnings.

Specific interventions will include the following:

i. Promote STI in marketing Ghana's tourist resources.
ii. Adopt relevant technologies in the operations of tourist industries.
iii. Design and implement training schemes to enhance the competence of technical staff of the tourist industry.

3.20 Space Science and Technology

Ghana aims to become one of the few African countries, besides South Africa, Egypt and Nigeria, that have made serious efforts to launch into space. However, there is a long way to go and the country needs to begin working on the rudiments of space science capacity building. The general awareness must be created among stakeholders that space science is not a luxury, but it is fundamental to a dependable STI base for national development.

The programmes to be pursued will, among others, be orientated toward the following:

i. Assess existing national infrastructure and capacity for space science and technology.
ii. Build and enhance national capacity for space science and technology.
iii. Increase knowledge and understanding in all aspects of space science and technology, including radio astronomy.
iv. Apply space science and technology to socio-economic development of the nation.
v. Connect to regional and international networks in space science and technology.
vi. Support international actions and programmes on space science and technology.

Chapter 4

MANAGING SCIENCE TECHNOLOGY AND INNOVATION POLICY

A sector Ministry in charge of Science, Technology, and Innovation will manage and implement Government's STI policies. This mandate will be executed through the organizations operating under its auspices and, where necessary, through other relevant organizations. The sector Minister, as a Cabinet Member, will provide the needed leadership to link with other ministries and organizations for STI application and development in the country. The Ministry of Environment, Science and Technology (MEST) will work through the following departments and agencies under it to achieve its overall goal:

- Council for Scientific and Industrial Research
- Ghana Atomic Energy Commission
- Environmental Protection Agency
- Town and Country Planning Department

The Ministry will be structured with a head of policy planning (with the status equal to the Director of any CSIR research institute) who has the appropriate experience to interact with the country's scientific and technical experts as well as with Government policymakers. The Ministry will have representatives assigned to interact with each of the relevant sector ministries to ensure the implementation of the sector STI strategies in Chapter 3.

4.1 Apex STI Body

An apex STI body will be established to ensure strong advocacy for STI in the country, to provide STI advice to the Ministry and the President, and to ensure coordination and harmonization of the nation's STI policy and programmes. This body would serve as a Think Tank institution that would provide the brainpower for national strategic STI policy formulation. The body, rather than diminish the MEST, would provide the Ministry added space to influence STI policies in all sectors by creating a think-tank capacity for STI that can advise the highest offices of the land.

The apex STI body will be established as an STI Commission (or Council) composed of representatives of Ghana's STI institutions including Government, research institutes, universities, the private sector, and other relevant institutions. The Commission will be chaired by a distinguished Ghanaian scientist, engineer or technologist to be appointed by the President. The Commission will be limited to no more than 12 members to ensure its ability to operate efficiently. The Commission will be supported by a small cadre of technical staff with expertise in STI policy matters.

The apex STI body will liaise with MEST to ensure that the following STI management functions are performed:

i. Provide advice to the President and ministries on STI policy formulation and programme design, so that they will best serve the specific needs of the country.
ii. Provide STI advocacy, so that the voice of the country's STI community will be represented in the country's programmes and policies at all levels.
iii. Ensure coordination and harmonization of the country's STI policies through the establishment of the STI Directorate under the Ministry, so that STI activities are comprehensive, complementary, and reinforcing across all sectors and ministries.
iv. Provide monitoring and evaluation of the implementation of the STI policy to ensure that the activities initiated to this end are for the benefit of the Ghanaian society. Thus, a body (or bodies) of experts will be set up under the apex STI body to perform the role of reviewers of the implementation strategies of all STI activities.

4.2 Measuring the Performance of Science, Technology and Innovation

To ensure that the implementation of science and technology is on course for the benefit of the Ghanaian society, Government will put in place mechanisms for monitoring and evaluating the performance of activities initiated.

Thus, a separate body (or bodies) of experts functioning on part-time basis will be set up to perform the role of reviewers of the implementation strategies of all S&T activities. The distinguished experts may come from local institutions, the diaspora, or may be foreign experts. Incentive schemes will be developed for individuals and institutions identified as contributing positively to developing and promoting S&T in the country.

4.3 Promoting the Development and Utilization of STI Capabilities

In line with the vision for science and technology-led economic growth and enhancement in the quality of life, Government will take necessary measures to develop fully, national S&T capabilities to enable it achieve greater productivity and efficiency, and to attain self-reliance in terms of trained skills and technical know-how.

Thus, various actions will be carried out in broad terms to create the required capabilities. A comprehensive training programme will be designed and implemented, with special emphasis on indigenous capabilities concerning adaptation, absorption and mastery of imported technologies, skills and know-how for basic research, research and development, and information management. New and emerging technologies, commercialization, and dissemination of research results will be strengthened and expanded.

National education policies will be periodically reviewed by collaborating with the Ministry of Education and other relevant bodies to enable them respond to national needs. These reviews will target science education, teacher training, curriculum development, teaching and learning methods, engineering and development of entrepreneurial skills, among others.

4.4 Promoting Science and Technology Capacity Building

As Ghana intends to promote and nurture innovative development as its goal, a system will be developed to attract, retrain, motivate and retain indigenous scientific, technical and technological skills and know-how. Deserving

scientists, engineers, and technologists will be given special recognition through awards. Remuneration for S&T practitioners would be packaged to minimize the brain drain.

New approaches to education and training shall be developed to equip researchers to work more effectively in an innovative manner. This will require new curricula and training programmes that are comprehensive, holistic and flexible rather than narrowly discipline-based ones. Education and training in an innovative and competitive society should not wrap people within constraining specializations, but enable them to participate and adopt a problem-solving approach to social and economic issues within and across disciplinary boundaries.

4.5 Strengthening National Engineering Design and Production Capacity

Accelerating the mastery of known technologies is of prime importance in the industrialization programme. Government will facilitate the establishment of centre(s) for engineering and manufacturing, pilot and demonstration plants in selected institutes and departments to promote the development of indigenous capacity and capability in these and other fields. An all-embracing capacity for industrial design will be established in support of quality presentation at all levels of product development and manufacture. The Ministry will also spearhead the establishment of technology incubators and industrial parks to enhance the commercialization of local technologies.

4.6 Strengthening the Protection of Intellectual and Innovative Property Rights

One of the forward movers of science and technology development is the official recognition of innovation and the need to protect the rights of such innovation for the benefit of society. In this respect, Government will encourage and promote S&T development through the protection and use of intellectual and innovative property rights. This will be achieved by strengthening the system for protecting intellectual property rights,

facilitating the use of industrial and other property rights for the development of S&T, and establishing and strengthening intellectual and industrial property rights as well as information management systems. The Ministry will take appropriate steps to ensure that innovative ideas in the informal sector when identified are protected.

4.7 Promoting Participation of Women in Science and Technology

Traditionally, women have not been encouraged to embrace the learning of science at all levels of the educational system. This has created a lopsided proportion of women involved in the learning, teaching and practice of science, engineering, technology and related fields as compared to their male counterparts.

To improve the ratio toward equilibrium, Government will take appropriate measures to institute programmes which encourage girls to specialize in science, mathematics and engineering at the secondary and higher echelons of the education system. The MEST will design special incentive packages for female science students as instruments of motivation.

The Ministry will also promote innovation in women micro and small enterprises (MSEs), especially in the rural areas. Special programmes will be designed to encourage rural women engaged in micro and small-scale production to adopt new and appropriate technologies conducive to their fields of operation.

4.8 Promoting International and Local Cooperation and Linkages

The international scene is linked in such a way that exchanges, partnerships, networking and cooperation have become the norm for keeping abreast of the pace of innovation in all sectors of the economy. Given the scope for international cooperation in S&T at the regional and sub-regional levels, the Government will adopt all necessary measures to consolidate and widen bilateral and multilateral programmes to the benefit of its S&T plans,

especially the flow of scientific and technological information in the national innovation system. The MEST will lead in engaging development partners and other international actors in developing Ghana's national innovation system.

4.9 Promoting a Science and Technology Culture

Science and technology culture may be loosely defined as the sum total of society's concept and attitude to S&T as expressed in its beliefs, traditional customs and daily occupations. The Ghanaian society as a whole has not embraced S&T and its benefits to any appreciable extent, especially in the conduct of their lives. The lack of S&T culture limits the application of STI in industry, and limits the benefits from modern medicine. This is evidenced by the prevalence of the use of primitive tools in agriculture, fishing, blacksmithing, construction and other technology-intensive occupations. At the social level, explanation of natural phenomena is often sought in superstition.

To reverse this trend and the slow acceptance of S&T, Government will harness all available resources to create public awareness of the benefits of S&T, and to seek solutions to socio-cultural and economic problems within the domain of S&T. In health, agriculture, industry, trade, recreation and others, the citizenry will be made to recognize the indispensability of S&T as tools to better their lives.

Chapter 5

MECHANISMS FOR FINANCING STI DEVELOPMENT

The success of a programme for integrating science, technology and innovation into the country's development agenda depends on establishing appropriate arrangements for financing the STI development and delivery system. It is important that all sectors of the economy, especially the private sector, realize the importance of S&T and provide adequate resources to support S&T activities. The necessary systems should also be put in place to ensure that such resources are used optimally, and that duplication of activities is avoided as much as possible.

5.1 Government Efforts in Financing Science and Technology

To ensure that funds are always available to meet the demands of innovation for the benefit of society, Government will do the following:

i. Take stock of all existing funding lines established to support development in S&T and industry with the aim of streamlining them to achieve economies in their operations.

ii. Strengthen and modify the National Science and Technology Foundation to incorporate support for innovation in its sphere of operations.

iii. Encourage the private sector to support the funding for R&D activities, especially to cater for the needs of the micro, small and medium enterprises (MSMEs) which can be nurtured to become the cutting edge for commercializing novel products or processes (i.e., products of innovation). Typically, the MSMEs have limited resources for financing internal R&D and for transferring technology to or from national and international technology vendors.

iv. Accelerate the allocation of a minimum of 1% of the Gross Domestic Product (GDP) to support the S&T sector.

v. Institute an attractive tax incentive mechanism for contributors to the instituted funds or directly to R&D activities, but in a way that would not erode the national tax base.

vi. Encourage the formation of a venture capital (high risk) fund that administers authority for commercializing new technologies from scientific and technological institutions.

vii. Encourage public procurement of products and services from S&T institutions to facilitate their promotion.

In all these funding mechanisms, Government will solicit the effective participation and contribution of the private sector as an indispensable partner in managing S&T for the socio-economic development of the country.

5.2 Private Sector Contribution

The private sector will be encouraged to contribute to the financing of STI application and development in Ghana through various schemes. A key strategy will be the initiation of Public-Private Partnerships (PPPs) in applying and developing STI. The private sector will be engaged as interested partners in STI programmes. This is particularly feasible in commercializing R&D activities. For substantial innovations, independent companies may be floated to fully commercialise the R&D outputs.

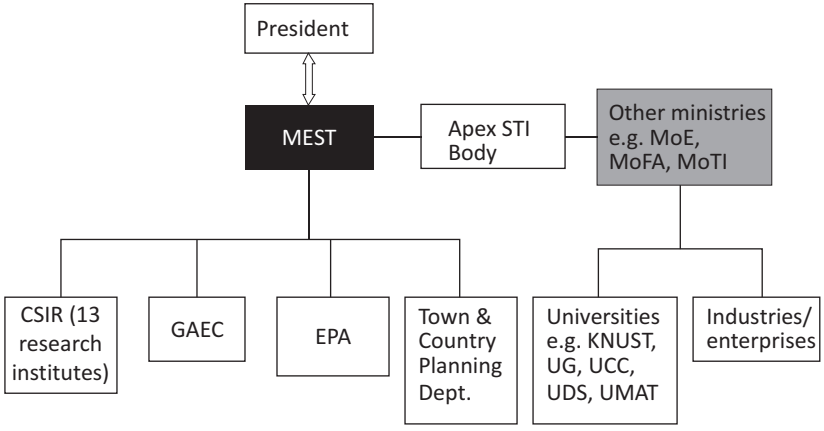
5.3 Other Stakeholders' Contribution

Other stakeholder institutions can make contribution to the financing of STI in the country. For example, the Ghana Education Trust Fund (GETFund) can contribute a percentage of the total inflow to STI programmes, particularly in the area of high-level scientific human resource development. Some of its contribution can be channelled toward increasing the quantum of the Science, Technology and Research Fund (STREFUND) that has been set up to promote R&D in the national innovation system.

The research institutions are also important sources for generating resources for STI application. These institutions will be encouraged to enhance their respective Internally Generated Funds (IGFs). The sector Ministry will institute some matching grants scheme to provide incentives for those R&D institutions showing high performance in this regard.

APPENDIX 1

THE STI ORGANISATIONAL FRAMEWORK IN GHANA



APPENDIX II

SCIENCE AND TECHNOLOGY SUPPORT AND PROMOTION INSTITUTIONS

The understated Government ministries and agencies, private sector institutions and non-governmental organizations perform policy formulation, planning, programming, coordination, monitoring, evaluation, and implementation functions relating principally to their areas of competence in the area of science and technology. The Ministry of Environment, Science and Technology will seek to open science desks in the major ministries.

MAJOR MINISTRIES

National Development Planning Commission
Ministry of Environment, Science and Technology
Ministry of Finance
Ministry of Food and Agriculture
Ministry of Foreign Affairs
Ministry of Employment and Social Welfare
Ministry of Mines and Energy
Ministry of Works and Housing
Ministry of Health
Ministry of Education
Ministry of Roads and Transport
Ministry of Lands and Forestry
Ministry of Trade and Industry
Ministry of Communications
Ministry of Local Government and Rural Development
Ministry of Justice
Ministry of Defence

Ministry of Parliamentary Affairs/Parliamentary Committee on Environment, Science and Technology

MAJOR GOVERNMENT AGENCIES

Architectural and Engineering Services Ltd
Centre for Scientific Research into Plant Medicine (CSRPM)
Cocoa Research Institute of Ghana (CRIG)
Council for Scientific and Industrial Research (CSIR)
Customs, Excise and Preventive Service (CEPS)
Department of Rural Housing and Cottage Industries
Development and Application of Intermediate Technology (DAPIT)
Electricity Company of Ghana (ECG)
Environmental Protection Agency (EPA)
Fisheries Commission
Food and Drugs Board
Forestry Commission
Geological Survey Department
Ghana Atomic Energy Commission (GAEC)
Ghana Broadcasting Corporation (GBC)
Ghana Export Promotion Council (GEPC)
Ghana Highway Authority (GHA)
Ghana Institute of Management and Public Administration (GIMPA)
Ghana Investment Promotion Centre (GIPC)
Ghana Regional Appropriate Technology Industrial Service (GRATIS)
Ghana Standards Board (GSB)
Ghana Statistical Service (GSS)
Meteorological Service Department
Minerals Commission
National Board for Small Scale Industries (NBSSI)
Pharmacy Council
Polytechnics of Ghana

- Accra Polytechnic
- Kumasi Polytechnic

- Takoradi Polytechnic
- Cape Coast Polytechnic
- Ho Polytechnic
- Tamale Polytechnic
- Sunyani Polytechnic
- Koforidua Polytechnic
- Wa Polytechnic
- Bolgatanga Polytechnic

Public Works Department (PWD)
Rural Enterprises Project
State Enterprises Commission (SEC)
Technical Institutes of Ghana
Town and Country Planning Department (TCPD)
Universities of Ghana

- University of Ghana
- Kwame Nkrumah University of Science and Technology
- University of Cape Coast
- University for Development Studies
- University of Education, Winneba
- University of Mines at Tarkwa
- Other private universities

Volta River Authority (VRA)
Water Resources Commission

NON-GOVERNMENTAL AGENCIES AND INSTITUTIONS

Association of Ghana Industries
Association of Small Scale Industries
Centre for Policy Analysis
Ghana Academy of Arts and Sciences
Ghana Association of Science Teachers
Ghana Biochemical Society
Ghana Chamber of Mines

Ghana Chemical Society
Ghana Geological Society
Ghana Institution of Biology
Ghana Institute of Planners
Ghana Institution of Engineers
Ghana Institution of Physics
Ghana Institution of Surveyors
Ghana Journalist Association
Ghana Medical Association
Ghana National Association of Garages
Ghana National Chamber of Commerce
Ghana Registered Nurses Association
Ghana Science Association
Institute of Economic Affairs
Mathematical Association of Ghana
National Union of Environmental Non-Governmental Organisations
Pharmaceutical Society of Ghana
Private Enterprise Foundation
Research Staff Association (of the CSIR)
Trades Union Congress
Women in Science and Technology
Ghana Institute of Architects
University Teachers Association of Ghana (UTAG)