STUDY ON THE STATE OF S&T DEVELOPMENT IN ASEAN

TABLE OF CONTENTS

SINGAPORE

BRUNEI DARUSSALAM

COUNTRY FIGURE

Population: 0.4 millions

GDP (USD billions): 10.5

GDP per capita (USD): 26,325

GDP (PPP) as share (%) of world total: 0.03

Brunei Darussalam, meaning 'The Abode of Peace', is a country that many may know as an oil-rich sultanate on the third largest island in the world. Brunei Darussalam is located on the northern shore of Borneo Island, bordered by the South China Sea and the Malaysian state of Sarawak. Geographically, Brunei Darussalam is comprised of two parts, with a total area of 5,765 sq km. It is divided into 4 districts, and the capital city is Bandar Seri Begawan. Brunei has a tropical climate with temperatures ranging year-round from between 25 to 32 degrees Celsius. The population of Brunei Darussalam stands at about 400,000—67% Malay, 15% Chinese, 6% tribes indigenous to Borneo including the Iban, Dusun and Murut tribes, and 12% others. The national language is Malay (Bahasa Melayu) but English is widely spoken and is the principal language of business. The majority of the population is concentrated in and around the capital city of Brunei Muara District, which houses government institutions and the economic sectors of the country which are not oil and gas related. The Belait district lies in the northwest, and is the hub of the country's oil and gas activity, which is Brunei's primary source of wealth. Brunei is the third-largest oil producer in Southeast Asia. Gross Domestic Product is $20.38 billion in 2010, GDP per capita (PPP) is $51,600 and PPP as share (%) of the world total is 0.03

OVERVIEW on the State of S&T Development

There are several institutions responsible for science and technology development in Brunei, namely the Science, Technology, Research and International Cooperation under the Ministry of Development which is responsible for science and technology policy and Brunei Research Council under Department of Economic Planning (JPKE) of Prime Minister Office (PMO) which is responsible for funding. Research and development activities and programs are mainly conducted within national universities under coordination of Higher Education Division of Ministry of Education (MoE) and research institutions related to fisheries, agriculture and forestry under the Ministry of Industry and

Primary sources (MIPR). University of Brunei Darussalam and Institute of Technology Brunei (ITB) are two most prominent universities in Brunei to conduct research activities. Some research activities are also conducted within the Institute Health Science of University Brunei Darussalam in conjunction with the Raja Isteri Pengiran Anak Saleha (RIPAS) Hospital under the Ministry of Health. Research activities done by private companies and other non-governmental institutions are very limited.

In addition to research activities, there are very active activities on science and technology education and training coordinated mainly by the Ministry of Education. Several higher educational institutions are established to provide post-secondary and tertiary educations, including University of Brunei Darrussalam (UBD) established in 1985, Institute of Technology Brunei (ITB) in 1986 (later upgraded to a university status in October 2008by His Majesty the Sultan and Yang dipertuan of Negara Brunei Darusslam), technical and engineering colleges, vocational schools, and Pengiran Anak Puteri Rashidah Sa'adatul Bolkiah College of Nursing in 1986, Wasan Vocational School established in 2005 for technical and vocational and higher education, and University of Sultan Sharif Ali Islamic (UNISSA) in 2007. To promote science education for young students, Science, Technology and Environment Partnership (STEP) Centre has been set up in 1997 under the Ministry of Education. STEP centre aims at provide support in ensuring the availability of opportunities in the development of science, technology and environment education to enhance the development of skilled human resource for business and industrial sectors, in support to the realization of the WAWASAN Brunei 2035 in diversifying the country's economy.

1. S&T Policy and Development Strategy

The Science and Technology, Research and International Division (previously known as Research and Development Unit) under the Ministry of Development has a role to set up science and technology policy in Brunei. The Science and technology policy in Brunei is documented in the Science and Technology Guidelines that outlines the priority agenda of researches. Halal foods, downstream oil and gas industries, ICT are among the priorities and research clusters promoted and funded by Brunei Government. The science and technology guidelines is referred by the Brunei Research Council (BRC) in reviewing all proposals applying for funding from the government.

In addition to the science and technology policy that regulates the research activities, science education and technology skill training is regulated by Brunei's Education Policy. Through the institution of systematic and structured reforms, with respect to education policy, structure, curriculum, assessment

and qualifications, and professional development; Brunei aspires to transform its education landscape in support of the nation's drive to realize its Brunei Vision 2035 (Wawasan Brunei 2035).

In 1993, the 9-Year Education Policy was replaced with 12-Year Education Policy, comprising of 7 years in pre-school and primary, three years in lower secondary, and two years in upper secondary or vocational/technical education. In 2003, the new Education Order was inaugurated aimed to achieve a status of an effective, efficient and equitable system of education that was both consonant with the national philosophy of Malay Islamic Monarchy as well as the needs of a modern, technological and ICT era. In 2007, the Compulsory Education Order 2007 was enacted, mandating that every Brunei residing in the country to receive compulsory education for at least nine years. The success of educational policy changes through years was seen in Brunei's progressive improvements in its literacy rates from only 69% in 1971 progressively increased to 80.3% in 1981, 89.2% in 1991 and 94.7% in 2001.

In the following years, changes in the school curriculum were focused on the needs of the country, especially in producing human resources who have the capabilities and skills in areas such as science and technology. Rapid advancement in science and technology has brought about an awareness of the importance of science and mathematics education at all levels of schooling. Science became a compulsory subject in 1988 at secondary level of schooling. In 1992, science was upgraded to the status of a subject on its own in upper primary. With the implementation of "National Education System for the 21st Century" or "Sistem Pendidikan Negara Abad ke-21" (SPN21) in 2009, this status is extended to lower primary. New subjects such as computer science and design and technology were introduced at the secondary level in 1993 and 2002 respectively.

To ensure the quality of education, the Brunei Examination Board was introduced in 1974 to administer public examinations at key levels, including assessment and qualifications at the end of upper secondary level for Brunei Cambridge General Certification of Education (BC GCE) 'O' and 'A' Levels in collaboration with Cambridge University, UK. The high standard of math and science education in Brunei is revealed in the ranking of the quality of math and science education which positioned at second place after Singapore in the ASEAN country and 27th worldwide (Singapore is ranked at 1st place). However, the high standard imposed by BC GCE 'A' level' for university entrance may be considered to cause relatively low tertiary education enrollment rate even in ASEAN standard, which is only 16% below Singapore (60%), Thailand (44.7%), Malaysia (32.1%), Philippines (28.7%) and Indonesia (21.3%).

2. Infrastructure for S&T

Science and Technology, Research and International Division (STI), Ministry of Development

Science and Technology, Research and International Division under Ministry of Development hold the responsibility for overseeing the nation's science and technology efforts. The Division responsible in coordinating science activities locally, regionally and internationally and also support R&D by funding research projects and science and technology activities.

In realizing the importance of science and technology, the National Committee on Science) and Technology (NSTC was formed in 1994 and chair by the Minister of Development. The mission of the committee is to promote and encourage the development of science and technology in the interest of national development

Brunei Research Council

In order to set the policy direction in research and development (R&D) and innovation, His Majesty's Government has established the Brunei Research Council (BRC) under the ambit of the Prime Minister's Office. The Council is presently located at the Department of Economic Planning and Development which function as it Secretariat. The Council is responsible to formulate and determine national policies on research and guidelines for promoting, facilitating, coordinating and regulating the conduct of research activities in Brunei Darussalam. The Council has been active in identifying priority science and technology clusters to help Brunei Darussalam to develop its niche amongst other already well-established players in the global arena.

University-Based Research Institutes

University of Brunei Darussalam (UBD)

UBD's new curriculum under the GenNEXT (student-centric approach to education and lays the foundation for life-long learning) is an ambitious attempt to prepare students for the constantly changing work environment brought about by the new media and technologies. UBD seeks to build a research culture among its students and staffs in order to produce good researches on par with international standards to achieve its vision as a "First Class International Universities."

Research Centres in UBD

Sultan Omar Ali Saifuddien (SOAS) Centre for Islamic Studies

The centre aims to generate Islamic experts and scholars capable of exploring contemporary issues in the context of Islam and appreciating and understanding Islam in the daily lives from the political, economic and social perspectives.

Kuala Belalong Field Studies Centre

Set up by UBD in 1991, it is located deep in the Temburong District's unspoiled jungle as an international focus for biodiversity research into the threatened rainforests of Borneo.

Institute of ASIAN Studies

The institute focuses on research in historical, cultural and social issues in Asia and has four subsidiary units namely: East Asian Research Group, ASEAN Research Group, South Asian Research Group and Borneo Research Group.

UBD-IBM Centre

Universiti Brunei Darussalam acquires an IBM Blue Gene supercomputer—the first of its kind in the ASEAN region.

e-Government Innovation Centre (eG.InC)

Collaboration between Universiti Brunei Darusssalam, the Prime Minister's Office and KAIST (Korean Advanced Institute for Science and Technology) serves as a research think tank for Brunei e-Government to propose a comprehensive recommendation for an integrated strategic direction towards Brunei e-Government, develop an e-Governance model to overcome current obstacles, and conduct a study on national innovation systems, with particular emphasis on building human capacities and promoting public service deliverables. The eG.InC will facilitate the collaboration (including trainings and workshops) of the Government agencies and industries to supports the successful implementation of e-government. The key research area in eG.Inc in collaboration with experts from KAIST covers the following area:

- Governance. Legislation, policy and standards
- Agile enterprise infrastructure
- National authentication and online security
- E-government roadmaps
- E-government portals and channels strategy and consultancy
- E-government evaluation and monitoring
- Business process reengineering for government services

Institute of Technology Brunei (ITB)

ITB offers Higher National Diplomas and undergraduate degree programs in the fields of Engineering, Business and Computing. Programs are offered in the areas of Business, Computing and Information Systems, Civil Engineering, Mechanical Engineering, Electrical & Electronics Engineering, Petroleum and Chemical Engineering. Since 1986, ITB has focused on meeting the national manpower needs by enrolling a high percentage of local Bruneian students. However, a small percentage of international students have been and are currently enrolled in ITB programs. Through its international outreach activities, Queens University Belfast (United Kingdom), the University of New South Wales (Australia), Shell International Exploration & Production (Singapore), Brunei Shell Petroleum and Brunei Liquified Natural Gas are now among those universities and industries affiliated as partners of ITB currently collaborating in education and R&D activities.

ITB also provides expert services locally and internationally. These services are for the development of the Vocational and Technical Education sector, SEAMEO VOCTECH Regional Centre, Capacity Building programs for CLMV Countries, ISESCO and UNESCO. Consultancy services for Industries and Communities such as Materials Testing & Certification, Professional Development Program for Brunei Engineers, Short Courses, Product Development, Industry-tailored academic programs such as Part-Time programs, Industry-tailored research projects such as market surveys and others, as per the needs of industry, are also available utilizing the existing expertise and facilities.

Most research activities in ITB are coordinated under the Post Graduate Studies and Research Office (PGSR). The office aims to strengthen the University's role as a Centre for quality education, research and innovation. To ensure the relevance of research at the University, PGSR maintains a strong and vibrant link between academic research and industry. Thus, PGSR supports the university in its aims to achieve recognition in research and creative work across a broad spectrum of disciplines and fields, and to contribute to intellectual, economic and social development, both nationally and internationally. ITB's research mission is to pursue excellence in research and creative work across a targeted spectrum of disciplines and fields, and to maintain a strong and vibrant link between the University and industry. With a view to focusing and enhancing research in areas of strategic importance to industry and the country, six research clusters have been identified, including

- Electrical Power & Energy

  This cluster brings together interdisciplinary researchers in order to effectively approach and provide solutions for issues in this area, including energy efficiency in built environment and conservation, renewable energy and power systems, and power electronics and drives.

- Product & Manufacturing

  The research under this cluster also covers micro and nano-engineering and seeks to create new engineering knowledge and products on the micro and nano-scale. Areas of interest include modeling and design, mechatronics, new development and innovation, industrial and systems engineering, and defense technology.

- Electronics and Communication

  This research cluster is driven by the ever increasing demand for high system capacity and quality of service and focuses on the state-of-the-art technologies and application trends. It covers radio resource management and spectrum sharing, wireless IP, antenna design, nano-electronics, robotic and other intelligent system design. The areas of interest include embedded systems, robotics, radio, navigation and power system modeling, RFID applications, and photonic components, devices and systems.

- Computing & Information Systems

  The research here is closely tied with applications, such as identifying and studying new frameworks, models and methodologies. It focuses on the ever-changing computing landscape and covers diverse areas such as logic systems and their computational properties, optimization of performance in hardware/software systems, software modeling and analysis, data and knowledge engineering and web services. The areas of interest are database management systems, multimedia systems, IT/IS adoption management, IT/IS strategic planning, and cloud computing

- Business and Industrial Management

  As part of a Technology University, the research here is to address practical issues in the fields of business, economics, finance and human resources management with links to technology. Research here could be within a discipline or interdisciplinary. The areas of interest include economics and technology, business enterprise, energy economics, finance and banking, human resource development and management and project management

- Civil, Environmental and Sustainability Engineering

  This cluster focuses on research with the goal of promoting engineered systems that are compatible with sustaining natural systems. The research is mostly driven by the concern for the environment and sustainability which now influences a wide range of engineering decisions.

The Road Safety Centre established under this cluster is devoted to road safety research in addition to providing evidence-based advice on a range of road safety issues and policies. The areas of interest are irrigated agriculture, water resources development, construction and sustainability, structures, road safety and management, geotechnics and construction materials.

Research Institutes under the Ministry of Industry and Primary Resources (MIPR)

Aquaculture Research And Development Division

Aquaculture Research and Development Division of is a part of the Department of Fisheries, under the Ministry of Industry and Primary Resources. The main role of the Aquaculture Research and Development Division, AQRD is to do the research and development of the aquaculture technology especially on fish/shrimp culture and fry production, verification on the new culture technology as well as the new species, monitoring the aquaculture areas aiming to increase the productivity of aquaculture industry in Negara Brunei Darussalam. The main functions of AQRD are:

- Verifying, improving and extending the aquaculture technologies to operators.
- Identifying, controlling and managing the aquaculture industry areas.
- Ensuring good quality and continuous supply of fish/shrimp fry.

In order for the division to function effectively, it has three sections whose responsibilities are directed to ensure the full realization of the division's role, i.e. Marine and Brackishwater Aquaculture Research Section, Marine and Brackishwater Aquaculture Development Section, Freshwater and Ornamental Fish.

Agro-Technology Research and Development Division

Agro-technology research and development division is established in the Department of Agriculture, under the Ministry of Industry and Primary Resources aimed:

- To facilitate and assist agricultural entrepreneurs to deliver halal, quality, safe, environmental friendly and market oriented agricultural and agri-food products;
- To generate strategic and innovative technologies in relevant areas of agro-technology to promote sustainable development of the agriculture and agri-food industries;
- To support the development of local agriculture and agri-food industries by providing advisory, consultancy, technical services and technology transfer in relevant areas of agro-technology to the industries;

- To upgrade expertise and capabilities in relevant sectors of agro-technology to support enhancement of further development of the agriculture and agri-food industries; and
- To assist in enforcement of regulations, guide-lines and standards in the agricultural and agri-food industries.

The main activities of the units under the Agro-technology Development Division are:

- Post Harvest & Food Technology – Development of post harvest handling and management systems for local fruits and vegetables, processing and product development, research on food packaging, development of food quality and safety management system, provide quality control, food analysis and advisory services and technology transfer.
- Farming Technology – Adoption and transfer of relevant farming technology to enhance the productivity of vegetable farms through hydroponics' technology and netted structure cultivation.
- Biotechnology – Study of mass propagation of horticultural plant using tissue culture technique, collection and trial activities on mushroom culture, production of mushroom spawns to farmers, ex-situ conservation of indigenous medicinal plants species, analysis of medicinal plants content and provide advisory services and technology transfer.
- Soil and Plant Nutrient – Studies on soil fertility and crop nutrition, support and advisory services on analysis of soil, leaves, fertilizer and water samples, provide training on compost production and fertilizer application, and collection of agro-meteorological data.
- Agrochemical Technology – Routine pesticide residue analysis and research in fresh agricultural products mainly vegetables and fruits to regulate food safety which involves regular sampling and monitoring a whole range of crops produce locally as well as control of imported agricultural products and inorganic fertilizer importation.

STEP Centre

The Science, Technology and Environment partnership (STEP) centre, Ministry of Education had started its operation at the beginning of 1999. The centre provides opportunities for students at all levels of education, teachers and school community to participate in programs and activities on STE and other related fields. As a value-added education sector, it supports the MoE in educating the students through its formal and informal programs and activities. As a results, this can increase the number of the capable students who opt to enroll in the science stream. In addition, with more knowledge, good understanding

and practical experiences, these students will be able to improve their achievement in related subjects, such as science and mathematics.

The centre facilitate and supports the implementation of the MoE's policies and strategy plan, and any other relevant national and international goals and objectives related to the fields of STE including mathematics and science education. The centre will also be supporting the MoE to achieve the goals and objectives of international organizations, including ASEAN, UNESCO, Islamic Educational Scientific and Cultural Organization (ISESCO) and the Commonwealth.

The centre also establish and enhance partnerships at national, regional and international levels in developing and organizing educational programmes and activities on STE and related fields. The "partnership" means programmes and activities organized in collaboration/cooperation/close communication between the education sectors and other ministries, departments, business and industrial sectors; and related non-government organization, at national, regional and international levels. At national level, STEP Centre hopes to become the hub for STE education. Internationally, in line with the MDGs, member nations are encouraged to develop global partnerships for development.

3. Human Resources Involved in R&D

The total number of R&D personnel of Brunei is 244 (headcount, data 2004, including 99 women researchers, equivalent to 0.102 R&D personnel per 1000 population. No newer data is available, and no specific definition on the R&D personnel. The R&D personnel are mostly affiliated with the University of Brunei Darussalam and Institute of Technology Brunei.

4. Expenditure for R&D

The R&D budget of Brunei is controlled by the Department of Economic Planning and Development (JPKE) under the Prime Minister Office, and partly by the Science and Technology, Research and International Division under the Ministry of Development. The total R&D expenditure (GERD, budget base) is 63 millions Bruneian Dollar for Development term 2007—2012, equivalent to 0.12% of GDP in yearly basis. According to Science and Technology Indicators survey by the Science andTechnology, Research and International Division in2004, 91.1% of research funding is coming from the government, , and less than 0.1% from industries.

5. S&T Outputs

Patents and publications are still not developed and documented well in Brunei. Based on 2004 Science and Technology Indicators, there are 17 SCI journal articles and 2 applications to US PTO. Most publication and patent are from the University of Brunei Darussalam and Institute of Technology Brunei.

First round S&T contribution per faculty are Faculty of Science (FOS) $594.060,97, PAPRSB Institute of Health Sciences (IHS) $1.543.433,50, and Faculty of Arts and Social Sciences (FASS) $59.304,00 . The second round are Faculty of Science (FOS) $16.670.540,00, PAPRSB Institute of Health Sciences (IHS) $48.974,80, Faculty of Arts and Social Sciences (FASS) $607.671,12, Sultan Hassanal Bolkiah Institute of Education (SHBIE) $387.499,00, and Faculty of Business, Economics and Policies Studies (FBEPS) $180.583,20. No newer data is available.

6. S&T Utilization Programs including Indicators of Utilization

Brunei Agro-Technology Park

The park is a major 263-hectare site development close to the capital Bandar Seri Begawan. The Park will attract research and innovative technology applicants with a particular focus on life sciences-based activities in agriculture, fisheries and forestry. The park will also be as an industrial site for manufacturing, storage, transportation, research and development and other Halal related support services.

Halal Science Centre

The establishment of a Halal Science Centre is in line with Brunei Darussalam's aspire to develop its ability to provide accreditation services for Brunei Halal Certification process and Brunei Halal brand project. This initiative will streamline Brunei's current capabilities in research and development and also in analytical services together with world-class technologies and expertise to achieve the ultimate aspiration. At the initial stage, laboratory works will be concentrated on primary food ingredients for examples, cooking oil, preservatives and others basic food ingredients. And on a later stage, the centre will be able to examine and analyze various food ingredients and will also venture out to analyze non-food products.

Innovation and Enterprise Office (IEO) in UBD

There some efforts for promoting innovation and entrepreneurship in UBD through innovation and Enterprise Office. The office provides information, advice, and the commercialization of intellectual property rights. The office also facilitates researchers, entrepreneurs and organizations in obtaining intellectual property rights, including patents, trademarks, copyrights and trade secrets.

7. Areas of Strength in S&T

Biodiversity, energy, halal food and food security/agro-technology, climate change, Asian studies, and Islamic banking and finance are among areas of strength in science and technology in Brunei.

- Biodiversity

  The forest of Brunei Darussalam are among the most diverse forest in the world, and it is among top 10 nations having a very high percentage of forested land area (58%). Recent studies have shown the presence of approximately 160,000 individual trees belonging to 1,000 different species in just 25-ha forest dynamic plot. The number of new plant, animal and microbial species discovered from the sultanate in recent past have swelled significantly.

  A project, namely SG INGEI Sg. Ingei Project, initiated by Heart of Borneo (HOB) CoOuncil and supported by government agencies in Brunei has been started in 2010 for 2 years. The Faunal Biodiversity Survey of the Sungaei Ingei Conservation Forest is endorsed by the Brunei Heart of Borneo Council, funded by Standard Chartered bank, supported by the World Wildlife Fund and led by the Biodiversity Research team of UBD.

  UBD recently also launched the "Global Earth Observatory Project" with the Centre of Tropical Rainforest Science of Harvard University in partnership with the Smithsonian Tropical Research Institute of Panama. A 25-Ha research plot in Kuala Belalong was established to allow long-term monitoring and assessment on the impacts and vulnerabilities of climate change on forest biodiversity and health of forest ecosystems necessary to create predictive models and make policy decisions that will guide and secure improvements to the ecosystems and the planet. The extensive projects is fully funded by HSBC Brunei in line with the HSBC group's focus on understanding the effects of climate change.

- Energy

  Brunei Darussalam's oil and gas industry forms the heart of the country's economy currently, but the national economy policy continues to diversify its economy for long-term sustainable development. Brunei, especially UBD has an extensive research program on energy, particularly renewable and alternative energy. The program encourage a multi-track approach in tackling energy issues, collaborating with regional universities to facilitate joint energy research,

including policy, energy technology verification, energy technology development as well as new and alternative energy.

- Food Security/Agrotechnology

  Food security is one of the foremost goals of the Ministry of Industry and Primary Resources (MIPR). The government aims to achieve 60% self-sufficiency in rice production by 2015. UBD can help to carry out research in this important area.

- Climate change modeling

  The collaboration between UBD and IBM will provide UBD researchers the opportunity to work with the world-class researchers from IBM's global research laboratories on projects that will analyze and assess the current and future impact of climate change in the ASEAN region.

- Asian studies

  Strategically-located in the hub of Asia, Brunei Darussalam has access to a wealth of resources and knowledge that enables UBD to set up research programs and research clusters focusing on historical, economic, cultural and social issues in the region. Through its linkages with other major centres of Asian Studies, UBD provides a vibrant and dynamic research environment for international scholars and Bruneian academics to engage in joint research projects, thereby generating world class research on Asian studies.

- Islamic Banking and Finance

  Islamic banking and finance has grown in global importance and is becoming an integral part of the banking and finance sector. The level of penetration of Islamic finance in Brunei Darussalam is the highest in the region, at approximately 40%. Studies on Islamic products and services based on the observance of sharia principles will further strengthen the monetary and financial system, and improve measures against unforeseen difficulties such as the financial crisis, thereby ensuring national stability and prosperity.

8. Capability for S&T Human Resource Development in Higher Education

Brunei Darussalam has long recognized the importance of Science and Technology. Brunei education system plays a key role in building human resource needs in Science and Technology. It produces Scientists and Technologists among others in oil and gas producing sector, Ministry of Industry

and Primary Resources (Agriculture, Fishery and Forestry), health and education. Science has been introduced in lower secondary schools, and continues to be offered as National Diploma, Higher National Diploma and, both under- and postgraduate degree programs. The degree programs in Science and Technology offered by the Higher Institutions usually depend on the needs of the country for example, Universiti Brunei Darussalam introduced Bachelor in Science Education in the 1987 because Brunei Darussalam did not have enough science teachers at that time. By 2010, Universiti Brunei Darussalam has 366 academic staff, including 229 (63%) local and 137 (37%) expatriate. This number comprising 9 Associate Professor, 49 Senior Lecturer, 140 Lecturer, and 31 Tutor for local staff. 12 Profesor, 28 Associate Professor, 69 Senior Lecturer, 25 Lecturer, 2 Tutor and 1 Assistant Lecturer for contract staff.

9. Major Contributors to GDP

Brunei is the richest country in Asia with Gross Domestic Product (GDP) per capita is $ 54,100. At over USD 31,000 Brunei's per capita (GDP) is among the top 25 in the world (2011 IMF data). Brunei's gross domestic product (GDP) soared with the petroleum price increases of the 1970s to a peak of $5.7 billion in 1980. It declined slightly in each of the next 5 years, then fell by almost 30% in 1986. This drop was caused by a combination of sharply lower petroleum prices in world markets and voluntary production cuts in Brunei. The GDP recovered somewhat since 1986, growing by 12% in 1987, 1% in 1988, and 9% in 1989. In recent years, GDP growth was 3.5% in 1996, 4.0% in 1997, 1.0% in 1998, and an estimated 2.5% in 1999. However, the 1999 GDP was still only about $4.5 billion, well below the 1980 peak.

Main contributors to Brunei's GDP are agriculture 0.7%, industry 73.3 %, and services 26% (CIA, 2010). Brunei has a small well-to-do economy that encompasses a mixture of foreign and domestic entrepreneurship, government regulation, welfare measures, and village tradition. Crude oil and natural gas production account for just over half of GDP and more than 90% of exports. Per capita GDP is among the highest in Asia, and substantial income from overseas investment supplements income from domestic production. The government provides for all medical services and free education through the university level and subsidizes rice and housing. A new monetary authority was established in January 2011 with responsibilities that include monetary policy, monitoring of financial institutions, and currency trading activities.

10. Brunei Major Exports

Exports commodities in Brunei included crude oil, natural gas, and garments with total amount $10.67 billion (CIA, 2008). Brunei's main exports and the country's economic mainstay include petroleum, liquefied gas and its products . The government is attempting to promote economic diversification like clothing manufacture, banking, tourism, and construction industries.

11. Major Trading/Economic Partners in ASEAN

Brunei's exports partner are Japan 46.8%, South Korea 13.7%, Indonesia 9%, Australia 8.9%, India 6.9%, and New Zealand 4.6% (CIA, 2009). Oil and natural gas account for almost all exports. Since only a few products other than petroleum are produced locally, a wide variety of items must be imported. Brunei statistics show Singapore as the largest point of origin of imports, accounting for 25% in 1997. Japan and Malaysia were the second-largest suppliers.

CAMBODIA

1. S&T Policy and Development Strategy

Cambodia has no comprehensive Science and Technology policy. Many elements for promoting innovation are, however, implicitly present in the National Strategic Development Plan (2006-2010 and 2009-2013). The establishment of some institutions also reflect the areas where science and technology can be used to improve productivity. The Council for Agriculture and Rural Development, for example, which was established in 1998 cites the goal of improving agricultural productivity, diversification and the creation of non-agricultural rural private enterprises. The National Training Board, on the other hand, was created in 2005 to prepare policy and the national training plan for technical/vocational education. A National Information and Communication Technology Development Council was also established in 2003 to formulate policies for Information Technology (IT) promotion and development. In 2006 the Law on Patents, Utility Model Certificates and Industrial Designs was passed indicating a desire to harness innovations for economic development. The areas where S&T can be used for improved productivity can also be the key products which they have identified to have export potential. Their National Export strategy identifies products that could be developed into successful exports. This strategy also articulate the steps that could be taken to reinforce the competitiveness of garments, fruits and vegetables, organic rice, silk and silk products and fresh water fish, all of which have high export potential. Aside from garments and agricultural products, tourism and construction are expected to play major roles in the economy in the coming years.

In terms of broad areas the national development priorities for S&T are agriculture, engineering and technology, and the natural sciences.

Cambodia would also like to focus technology development and application efforts to small and medium enterprises (SME's). They have more than 31,000 SME's in the manufacturing sector and they have identified 4 pillars for technology transfer to SME's. These are: upgrading of standards and product quality, linkages between industry and the research and development sectors, promotion of technologies to SME's and provision of skilled labor.

2. Infrastructure for S&T

Cambodia has a Council of Ministers which prepare the National Strategy Development Plan (NSDP). The current plan is for the period 2009-2013. There is also a National Committee for Science and Technology. The ministries involved in S&T affairs or programs are the following:

- Ministry of Industry, Mines and Energy (MIME)
- Ministry of Education, Youth and Sport (MOEYS)
- Ministry of Agriculture, Forestry and Fisheries (MAFF)
- Ministry of Health (MOH)

- Ministry of Public Works and Transport (MPWT)
- Ministry of Post and Telecommunications (MPTC)
- Ministry of Land Management, Urban Planning and Construction
- Ministry of Environment (MOE)
- Ministry of Labour and Vocational Training (MOLVT) (Technical Education)
- Ministry of Commerce (MOC) and Cambodian Investment Board (CIB)
- Ministry of Economy and Finance (MEF)

There are 11 ministries which supervise 33 public universities. The biggest number is under the Ministry of Education. The Ministry of Agriculture supervises the royal University of Agriculture. The Ministry of Health supervises the medical universities. The Ministry of Posts and Telecommunications supervises the Institute of Technology of Cambodia (ICT)

The Ministry of Commerce takes care of technology transfer and the Ministry of Industry, Mines and Energy (MIME) has under it the General Department of Industry where the Department of Industrial Techniques and S&T office and the Department of Intellectual Property, Creativity and Innovation Center can be found.

The Industrial Laboratory Center of Cambodia (ILCC) which takes care of standards and testing through its 4 divisions (Microbiology, Water Testing, Food Testing, and Non Food Testing) is also under the Department of Industrial Techniques of MIME. The National Metrology Center is also under MIME's General Department of Industry.

The National Committee for Science and Technology which was created in 1999 coordinates and facilitates the activities and tasks related to ASEAN initiatives in S&T.

3. Human Resources in S&T

Inspite of the presence of the Institute of Technology of Cambodia (ITC), the Royal University of Agriculture, the medical universities, the universities under the Ministry of Education, and the rest of the 33 public universities there is a general perception that there is limited supply of highly trained scientist and engineers. The capacity of the higher education institutions (HEI's) has not caught up with demand even as there is strong support from Government and international development partners.

4. Expenditures/Funding for S&T R&D

Unofficial estimates of R&D expenditures as a percentage of GDP from the Ministry of Education is placed at .05%. The contributors to this R&D expenditure figures are:

- Government Organization - 25%
- Universities - 12%
- Business Sector - 12%
- International/NGO donors - 51%

The funds used by the different ministries for S&T activities particularly for human resource development and for the performance of various services are sourced from their respective budget allocations. R&D is funded mostly by international or foreign funding organizations. There is no clear funding program for R&D from Government. The private sector, on the other hand, is not yet in a good position to channel funds for R&D.

5. S&T Outputs

It is estimated that 396 scientific papers have been published with Cambodian authors/co-authors. About 94% of this involve co-authorship with researchers from other countries. This is an unofficial estimate from the Ministry of Education.

Since the Law on Patents, Utility Model Certificates and Industrial Designs was passed in 2006, 27 application for patents and 42 applications for industrial designs have been received by the Office of Patents. No application for utility model certificates have been received so far. All 27 patent applications have been filed by foreigners. Almost all of the applications for industrial design (40 out of 42) were also filed by foreigners. To date no patent application has been approved yet while in the case of industrial designs, 40 have already been registered. The patent applications are mostly in the fields of Mechanical, Electronics and Chemistry. Patent approvals are already expected before the year 2011 ends. Most Cambodian researchers are already aware of the patenting system in Cambodia.

While no complete statistics on researches completed in a year is available the following sample indicators were obtained from three (3) leading research institutions:

- Royal university of Agriculture (RUA) - 10 projects on-going
- Cambodian Agricultural Research and Development Institute (CARDI) - 30 projects on-going
- Institute of Technology of Cambodia (ICT) - 20 projects on-going

The research outputs produced at RUA are in the area of post harvest processing, animal science, agronomy, soil science, plant pathology, fishery breeding, reforestation and community development.

The research achievements of CARDI, on the other hand, are in terms of 3,217 crop accessions (2,595 for rice), 38 rice varieties released, 49% of rice fields covered by their rice varieties released, 4 mungbean varieties and other outputs. All of these were done within their first decade of existence.

Examples of R&D Projects in ITC are in biomass, biofuels, renewable energy and environment.

6. S&T Utilization Programs Including Indicators of Utilization

In the absence of a centralized S&T office to monitor different S&T activities particularly S&T utilization programs there is no comprehensive report that can be given regarding this. The case of CARDI, however, looks like a best practice model for the utilization of outputs from R&D in S&T. CARDI, in addition to its Division for Agricultural Research and Increased Productivity, operates a Division on Agricultural Research on Diversification and Extension, as well as a Planning Collaboration and Business Office. Since CARDI's goal is to improve the living standards of all Cambodians, especially farmers, thru agricultural research, its ultimate measure of performance is in terms of its research outputs which are utilized by farmers whether these are accession samples, new crop varieties, new fertilizers, new pest control systems, new post harvest methods or new soil maps. CARDI monitors the percentage of fields or farms which they are able to cover in their extension work.

7. Areas of Strength, S&T Niches

Based on existing infrastructure, human resources, actual production performance and potential it appears that Cambodia's S&T niches, now or in the future, will include agriculture, mines and minerals, and possibly construction.

8. S&T HRD Capability/Capacity

While Cambodia can boast of some higher educational institutions with very good standards like ITC, RUA, University of Science for Health, Royal Academy of Cambodia and Royal Pham Penh University these universities need to beef up its capacity in terms of research capability, and faculty development.

Some sample indicators show the following:

RUA	:	140 fulltime faculty (11 PhD holders) Graduated 5 PhD's so far
ITC	:	157 fulltime faculty (20% have PhD) (in addition 150 young faculty and researchers are on training abroad)

9. Major Contributors to GDP

Cambodia's major contributors to GDP are agriculture, garments, tourism and construction.

10. Major Exports

Cambodia's major exports are garments, tourism, fruits and vegetables, fresh water fish, organic rice and silk and silk products.

INDONESIA

STATUS OF S&T DEVELOPMENT IN INDONESIA

1. S & T Policy and Development Strategy

The important role of science and technology for development is stipulated in the amendment of Indonesian Constitution of 1945. As the highest national consensus, the 1945 Constitution asserts that the mastery and application of science and technology is one of the Indonesian citizen's rights that must be fulfilled by the state. The assertion is contained in Article 28C Paragraph (1) of the 1945 Constitution which reads, "Everyone has the right to develop themselves through the fulfillment of basic needs, is entitled to education and to benefit from science and technology, arts and culture, for improving the quality of life and for the welfare of the people".

To meet the demands of rights of each citizen to science and technology, chapter XIII of the 1945 Constitution on Education and Culture Article 31 paragraph (5) determines that "the Government is to advance science and technology for the advancement of civilization and welfare of mankind while upholding religious values and national unity." Thus it can be said that science is a human right and the government is obliged to advance the science and technology.

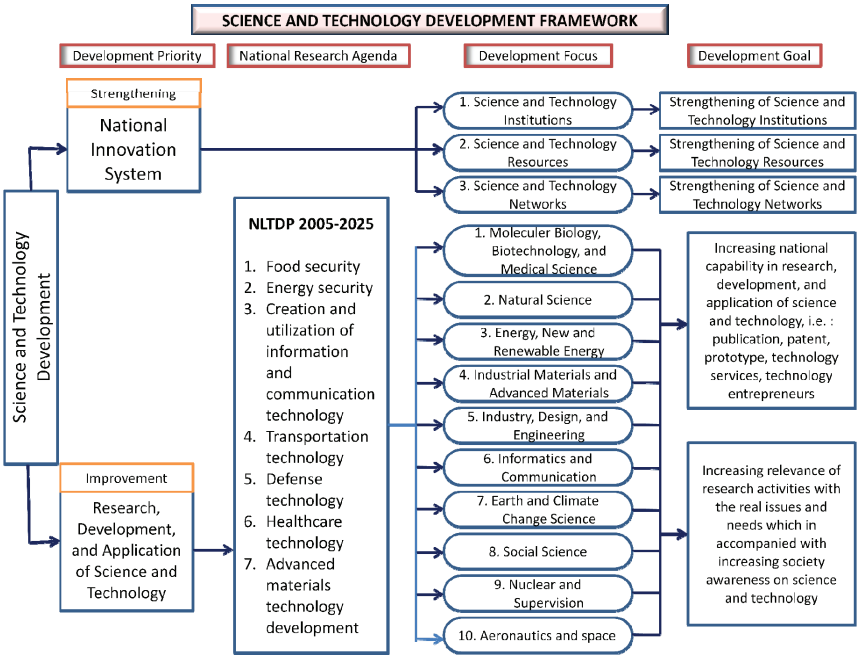
This Constitutional foundation is a firm foundation for science and technology development policies and national development in Indonesia. The promulgation of Law no. 18 of 2002 on the National System of Research, Development and Application of Science and Technology has been based on the constitution. The purpose of the law is to strengthen the national science and technology capacity for accelerating the achievement of the national development goals through improvement of the national competitiveness.

1.1 Vision and Mission of S&T Development

Science and technology development plans 2010-2014 are formulated in the S&T National Development Strategies (Jakstranas IPTEK) that was promulgated by the Minister of Research and Technology. National development of science and technology are planned and carried out in accordance with long- and medium-term of national development planning. The vision of national S&T development is "Science for the welfare and progress of civilization." The vision implies that science and technology development is essentially aimed at improving the economy and will ultimately improve the welfare and living standards of the nation, and aims to create a quality life of the nation economically, socially and culturally.

1.2 Indonesian S&T Development Strategic Framework

The National Mid-term Development Planning (NMDP 2010-2014) and National Research Agenda (NRA) promulgated by The Minister of Research and Technology have identified the expected direction of science and technology development in the context of Indonesian development. In principle, Science and technology development efforts are directed towards two main goals: strengthening of national innovation system and improving the quality of R&D and S&T application (see Figure 1).



Source: National Medium-term Development Planning 2010-2014

Figure 1: Indonesian S&T Development Framework

The second area of development is aiming at improving the quality of Research and Development in seven focus areas: food security, energy security, ICT, transportation technology, defense technology, health and medicine, and advance material technology. Research priority in this seven foci has been determined and elaborated in the National Research Agenda 2010-2014, promulgated by the Minister of Research and Technology.

Recently (May 2011), Government of Indonesia has launched a new policy direction aiming at accelerating the Indonesian economic development. The policy direction, which is called the Master Plan for Acceleration and Expansion of Indonesia Economic Development 2011 – 2025, has explicitly stated that S&T and Human capital development is one of the three pillars for the acceleration program. The other two pillars are "Economic Potential Development through Economic Corridors" and "Strengthening the National Connectivity".

The efforts to increase productivity towards the creation of competitive advantage can be achieved with the innovation based human resource capacity development. The legacy of natural resource-based economy, which is labor intensive, needs to be gradually improved towards skilled labor intensive and eventually to human capital intensive. The improvement of human capital mastering science and technology is highly needed when Indonesia enters into the innovation-driven economies stage.

To realize the increase of productivity, it is recommended that Indonesia applies presidential's innovation initiative 1-747 as a key driver in the transformation to innovation-

based economic system by strengthening the education system (human capital) and technological innovation capacity. Under the presidential innovation initiative 1-747 one percent of the GDP will be earmarked towards this strategy. This proportion should be increased gradually to 3% of GDP by 2025. Research and development funding portion as mentioned above, comes from the Government and the businesses. The transformation will be carried out through 7 improvement steps of innovation ecosystems, while the process will be carried out using 4 acceleration economic development instruments as a model for the strengthening of key stakeholders in innovation including tertiary institutions and community colleges. Therefore, it is expected that the 7 innovation targets in 2025 in the field of Human Resources and Science & Technology will be achieved in order to ensure sustainable economic growth. In line with the economic progress of the factor-driven economy towards innovation driven economy, it is expected over time the role of government in funding R & D will decrease and the role of private sector in funding R & D will increase.

Innovation Implementation Initiatives in MP3EI

The following are some initiatives of innovation implementation that will support the success of MP3EI:

a. Cluster Development in Support of 6 (six) Economic Corridors Development of 6 (six) economic corridor should be accompanied by innovation cluster strengthening as the center of excellence in order to improve the ability for innovation to enhance competitiveness. The development of the Center of Excellence is expected to integrate with industrial clusters.
b. Revitalization of PUSPIPTEK as Science & Technology (S & T) Park. Revitalize PUSPIPTEK as an S & T Park to deliver innovation-based SMI/SME in the various strategic areas, which are able to optimize interaction and utilization of university, research and development institutions, and business resources so that it is able to produce innovative products. To maintain the continuity of the management of the S & T Park, it is necessary to carry out the following steps:
    - ✓ Making PUSPIPTEK as a professionally managed Public Service Agency (Badan Layanan Umum/BLU), in order to create links between businesses and research.
    - ✓ Making PUSPIPTEK as a leading center of high-tech research.
c. Establishment of Regional Innovation Cluster for Equitable Growth. MP3EI encourages and empowers efforts by the communities, business entities, and local governments that already has initiatives to develop innovation potentials on regional prime products and programs, such as:
    - ✓ Agroindustry Innovation Zone Development Model, in North Gresik, East Java Province.
    - ✓ Integrated Downstream Innovation Program Development Model, to develop palm oil, cocoa, and fisheries.
    - ✓ Non Renewable and Renewable Energy Based Innovation Zone Development Model, in East Kalimantan Province
d. Innovation Stakeholders Strengthening.
   A key factor for the successful implementation of MP3EI depends on smart and effective effort of innovation stakeholders consisting of academicians/researchers, business/industry, community, legislators, and government. Some of the following ideas have to be executed in the smart planning and utilization of the nation's potential in order to build a developed and dignified Indonesia. Those ideas are:

- ✓ Creating human resources that have the competence, high level of integrity through a combined curriculum of science & technology, social value, and humanities education.
- ✓ Optimize the deployment of existing highly educated workforce, particularly those with master and doctoral degrees, and overtime increase the number of Ph.D holders in science and technology to 7,000 – 10,000 by 2014.
- ✓ Establish international standard laboratories both in basic and applied science in universities, vocational and non vocational research and development institutes, and at private research centers.
- ✓ International cooperation that encourages the understanding and application of science and technology and the utilization of best practices that have been developed in various countries.

The Strengthening of Operation of National Innovation System

Development of innovation product of an invention involves 3 main stakeholders in national innovation systems, namely: (a) the government as regulator, facilitator and catalyst, (b) business/industry as the users of the invention, and (c) research institutions and universities as incubators of the invention. The Collaboration of these three main stakeholders is very important and necessary for the development of innovative products. In order to develop innovation, the Government will provide:

a. Fiscal incentives to businesses (private and state-owned) that are developing innovation, and to foreign companies that are using technology that was developed by Indonesia or transferring technology that was developed by foreign countries to Indonesia.
b. Research funds will be granted to the innovation developer with the following conditions: (a) the innovative products have to meet the needs and interest of the industry; (b) the innovative products have been proven to have ability to improve the productivity of the industries concerned. This requirement becomes important for the development of national innovation. The private sector is requested to become a major driver of innovation by providing information regarding state of the art technological invention needs, which have high market value.

1.3 Government Policy Framework for S&T Development

The implementation of national science and technology development refers to the Law No.18 of 2002 on the National System of Research, Development and Application of Science and Law No. 17 of 2007 on the National Long Term Development Plan (RPJPN) 2005-2025. Related regulations concerning with science and technology development in Indonesia are:

Presidential Regulation No. 5 2010 concerning the National Mid-term Development Planning (NMDP) 2010-2014

Presidential Instruction No. 4 2003 on the Strategic Policy Formulation and Implementation of National Science and Technology Development

Government Regulation no. 20 2005 on Intellectual Property and Technology Transfer by Universities and Research and Development Institutes

Government Regulation no. 41 2006 on Research and Development permit for Foreign Institutions;

Government Regulation no. 35 2007 on the Allocation of a portion of business revenues for Engineering Capability Improvement, Innovation and Diffusion of Technology;

Government Regulation no. 48 2009 on the Implementation of High Risk and Dangerous Research and Development and Application of Science and Technology activities.

National science and technology development policies outlined in the Strategic Policy for National Development of science and technology (Jakstranas Science) year 2010-2014 are as follows:

a. To increase capacity and capability of all science and technology resources in order to increase R & D productivity that is useful for the national production sector;
b. To increase institutional capacity of R & D institutes and their supporting institutions to support the transfer R&D products to commercial products (the strengthening of national innovation systems);
c. To develop and strengthen institutional and researcher networks at national and international level to support R & D productivity and utilization of national R & D results;
d. To improve creativity and productivity of the national R & D to meet the needs of technology of the production sector and to improve competitiveness of national products and culture of innovation;
e. To increase the utilization of national science and technology for economic growth and creation of new jobs, and for the growing public awareness of the importance of science and technology;
f. To give priority to the seven (7) S&T priority development area as listed in National Long-term Development Planning 2005–2025 and National Medium-term Development Planning 2010-2014.

1.4 R&D Priority Agenda

Referring to the National Long Term Development Plan 2005-2025 and to maintain continuity with what has been done in the previous five-year period, science and technology development aimed to support the following areas: Food Security, Energy, Transportation Technology and Management, Information and Communication Technology, Defense and Security Technology, Health and Medicine, and Advanced Materials.

2. Infratructure for S&T

Institutional Arrangement for R&D

There are a number of institutions play important roles in science and technology development in Indonesia, the most central one is Ministry of Research and Technology which has a role in the formulation of research and technology policies, as well as coordination and synchronization of policy implementation of research and technology; the National Development Planning Agency in formulating science and technology policy in The *National Medium-Term Development Plan* (RPJMN) and responsible for program and budget allocation planning, and the Ministry of Finance. There are also bodies related to science and technology policy namely National Research Council of Indonesia which has duty to assist Ministry of Research and Technology in the formulation of research and technology policies and Indonesian Academy of Science AIPI which has function in reviewing, monitoring, assessing, set direction, and solve problem relating to the development and utilization of science and technology. Regulation of Indonesian Academy of Science AIPI is Act No. 8 of 1990.

Government R&D Institutes

Non-Ministerial R&D Institutes under the Ministry of Research and Technology

1. Indonesian Institute of Science (LIPI)

2. The Agency for The Assesment and Application of Technology (BPPT)
3. National Institute of Aeronautics and Space (LAPAN)
4. National Coordination Agency for Survey and Mapping (Bakosurtanal)
5. The National Nuclear Energy of Indonesia (BATAN)
6. National Standardization Agency of Indonesia (BSN)
7. Nuclear energy Regulatory Agency of Indonesia (Bapeten)
8. Eijkman Institute for molecular biology and biotechnology.
9. Center of Meteorology Climatology and Geophysics (BMKG)

Ministerial R&D Institutes

Ministerial R&D institute is the unit of work in the ministry responsible for research and development to support the program of ministry. There are 18 ministerial R&D institute including Ministry of foreign Affair, Ministry of Internal Affair, Ministry of Defense, Ministry of Law and Human Rights, Ministry of Energy and Mineral Resources, Ministry of Industry, Ministry of Trade, Ministry of Agriculture, Ministry of Forestry, Ministry of Transportation, Ministry of Marine Affairs and Fisheries, Ministry of Manpower and Transmigration, Ministry of Public Works, Ministry of health, Ministry of National Education, Ministry of Social Affairs, Ministry of Religious Affairs, Ministry of Communication and Informatics

Regional Research and Development Agency

Regional Research and Development Agency is a unit under regional government resposible for research and development to support the program of regional government. There are 69 Regional Research and Development Agencies all over the country.

2.1. University-based R&D Institute

University-based research insititute is available in every state university and some private universities. There are 50 university-based R&D institute owned by state university: Bogor Agricultural University, Bandung Institute of Technology, Sebelas Maret Institute of Technology, Surabaya, Airlangga University, Andalas University, Bengkulu University, Brawijaya University, Cenderawasih University, Diponegoro University, Gadjah Mada University, Haluoleo University, Hasanudin University, Indonesia University, Jambi University, Jember University, Jenderal Sudirman University, Khairun University, Lambung Mangkurat University, Lampung University, Malikussaleh University, Mataram University, Mulawarman University, Gorontalo University, Jakarta State University, Makasar State University, Malang State University, Manado State University, Medan State University, Padang State University, Papua State University, Semarang State University, Surabaya State University, Yogyakarta State University, Nusa Cendana State University, Padjadjaran University, Palangkaraya University, Pattimura University, Ganesha University of Education, Indonesia University of Education, Riau University, Sam Ratulangi University, Sebelas Maret University, Sriwijaya University, Sultan Ageng Tirtayasa University, Sumatera Utara University, Syiah Kuala University, Tadulako University, Tanjungpura University Trunojoyo University and Udayana University

The most prominent university based researches are the University of Indonesia with nutrition dietetics, public health, gastroenterology hepatology, Endocrinology Metabolism, Physics Nuclear, Infectious Diseases, Engineering Electrical Electronic, Materials Science Multidisciplinary, Obstetrics Gynecology, Pharmacology Pharmacy and Physics Applied.

Bandung Institute of Technology is strong in the research fields of Engineering Electrical Electronic, Physics Applied, Computer Science Artificial Intelligence, Computer Science Theory Methods, Materials Science Multidisciplinary, Physics Condensed Matter and Telecommunications.

Gadjah Mada University is strong in the research fields of Pharmacology Pharmacy, Plant Sciences, Public Environmental Occupational Health, Anthropology, Evolutionary Biology Oncology, Food Science Technology, Biotechnology Applied Microbiology, Physics Applied Microbiology, Engineering Chemical, Immunology and Materials Science Multidisciplinary.

Bogor Agricultural University is strong in the research fields of Zoology, Plant Sciences, Ecology, Food Science Technology, Biotechnology Applied Microbiology, Genetics Heredity, Microbiology and Agronomy.

Private Non-Profit Institutions which play significant role in R&D

1) The Foundation of Telecommunication and Informatics Research-Jakarta
2) Indonesian Society for Non-Destructive Testing-Jakarta for policy-oriented studies on domestic and international issues.
3) Institute for Social and Economic Research, Education and Information (LP3ES)-Jakarta for policy research and academic publishing related to strategic issues.
4) Laboratory of Development and Environment (Lablink)-Bandung that has activities of research and consultation in the field of environment and development.
5) Indonesian Center for Biodiversity and Biotechnology (ICBB)-Bogor with mission to develop people awareness of biodiversity and biotechnology.
6) Center for International Forestry Research (CIFOR)-Bogor for research and management of forests in less-developed country.
7) Bremen Overseas Research and Development Association (BORDA)-Yogyakarta for research in the fields of poverty alleviation, sustainable protection of natural resources and the strengthening the social structure.
8) Research Triangle Institute (RTI)-Jakarta for research in the areas of health and pharmaceutical, education and training, surveys and statistics, advance technology, international development, economic and social policy, energy and the environment and laboratory testing and chemical analysis.
9) International Center for Research in Agroforesty (ICRAF)-Bogor for research activities to alleviate tropical deforestation, land depletion and rural poverty through the development and promotion of improved agroforesty system.
10) International Rice Research Institute (IRRI)-Bogor for research and training organization to improve the well-being of poor rice farmers and consumers, as well as the environment.

Research Consortia

1) Indonesian Ganoderma Consortium of collective interest of practitioners of palm industry to overcome the quick spreading Ganoderma disease. The members of consortium consist of industry, research institute and Ministry of Agriculture.
2) Indonesian Biotechnology Consortium for research activities in development and application of knowledge and technology in biotechnology. The members of Indonesian Biotechnology Consortium are research institutes, universities and industries.

3) North Sulawesi Mitra Bahari Consortium of collaboration between government and non-government organizations to optimize the role of various stakeholders in maritime activities

Science and Techno Parks

1) The Centre of Science and Technology Research (Puspiptek-Serpong)
2) Cibinong Science Center (CSC-LIPI)
3) Bogor Botanical Garden (LIPI)
4) Agro Techno Park aa a pilot area of cultivation and processing technology for agriculture. There are 5 agro techno park in Indonesia: Palembang, Bahorok, Minahasa Utara, 50 Kota West Sumatera and Jimbaran Bali
5) Solo Techno Park for center of education and technology that promotes regional development
6) Jababeka Education Park to provide a vibrant and creative academic environment to the children and the young residing in Kota Jababeka and surroundings.
7) National Parks as conservation area which has native ecosystem, managed with zone system used for research, science, education, culture and tourism.

3. Human Resources Involved in R&D

Table 1. illustrates the headcount of overall human resource in R&D, which includes researcers, technicians, and support staffs. The R&D Personnel are dominated by Researcher (65% of the total R&D Personnel) by mostly master degree made up to 51% of the total R&D researchers. Government sector contributed the highest number of R&D Personnel with 27.261 headcount (43% of the total number of R&D Personnel). The total number of FTE of researchers constitutes university sector 7,335 persons (34.7%), industrial sector 7,588 persons (35.9%) and government sector 6,224 persons (29.4%).

Table 1. National Headcount of R&D Personnel, 2009

Type of R&D Personnel	Manufacturing Industry Sector	Government Sector	Higher Education Sector*	Total
Researchers	7,588	11,114	22,228	40,930
PhD	19	1,353	5,458	6,830
Master	-	4,025	16,770	20,795
Bachelor	4,374	5,736	-	10,110
Non-Degree	3,195	-	-	3,195
Technicians	2,135	7,572	1,484	11,191
Other Supporting Staff	1,144	8,575	1,334	11,053
Total	10,867	27,261	25,046	63,174

*State Universities

Source: R&D survey in University sector (2009), Industry sector (2010), and Government sector (2006)

4. Expenditure for R&D

The total expenditure on R&D (GERD) based on survey conducted by Indonesian Institute of Science (University Sector Survey, 2009; Industry Sector Survey, 2010; Government Sector Survey, 2006) amounted at IDR 4.7 Trillion (USD 522 million) or about 0,08% of GDP which is constituted from higher education sector (38%), government sector (50%) and private sector (18%).

5. S&T Outputs

The total number of patent application in 2010 is 253 by residents, and 4140 by foreigners, while the total patents granted in the same year is 115 to residents, and 2278 to foreigners. There are an increase rate of 4.3% per year in the number of applications by residents during the past decade, and 126% increase rate in the number of patent granted to residents, and 5.7% increase rate in the number of applications by non-residents and 10.1% increase rate in the number of patents granted to non-residents.

The total number of publication by Indonesian authors in International peer-reviewed journals in 2010 is 1000 articles, a sharp increase from 520 per year in 2001. There is an increase rate of 7.8% per year in the number of journal publication during the last decade. High increase rates averaged at 14.4% per year are accounted during the last 3 years. The total of citations in 2010 is 11150, averaged at 11.15 citations per paper (ESI, 2010).

6. S&T Utilization program

6.1 Government Program to Private Sector

The program is coordinated by the Ministry of Research and Technology (KRT). The program includes 22 incentive schemes covering from incentives to strengthening linkages between R&D institutes, industries and universities, incentives for science and technology diffusion to industry, incentives to promote science and technology based industry, design and creativity awards, incentives for standardization and intellectual property rights promotion. Currently research incentives provided by Ministry of Research and Technology is directed towards strengthening the R&D capacity of research institutes for basic and applied researches, incentives for centre of excellence promotion, incentives for industrial research consortia and incentives for building national innovation system to strengthen linkages between industry, government and universities. Programs for rural and regional development are intensively also promoted for enhance technology absorption by regional small medium enterprises and societal development such as installation of small scale power plant to supply electricity in remote area.

Other S&T utilization programs include:

Early Disaster-Warning System

This system is an integrated information system for monitoring, forecasting and modeling characteristics of the marine environment.

Completion of the IGOS

Program Indonesia, Go Open Source! (IGOS), has become a national movement to improve the strengthening of OSS based information technology system. IGOS has been declared since 2004 and involve several ministries. After formed a roadmap 2005-2009, in 2009 a number of things have been achieved.

Utilization of Wimax

Inline with increasingly needs of a fast, economical and broad range IT. WiMAX (Worldwide Interoperability for Microwave Access) can be a solution for Indonesia as an archipelago. BPPT in cooperation with the Ministry of Communications an Information developing WiMAX in BWA telecommunications netwaork that integrates 62 central government agencies and 472 districts throughout Indonesia.

e-ID Card for Convenience and Safety
The use of electronic ID Cards (e-ID) is feasibible for people. Number of distributed ID Cards can be an accurate indication of population for person aged 17 years. The Goverment has developed an e-ID card for the realization of single identity numbert. This breakthrough can prevent and minimize dual identity card or circulation of fake ID cards. Also in terms of the security, e-ID card designed with authentication methods and maximum data security. Embedded chip in the card has authentication, encryption and digital signatures.

Digital Library Portal
This program was launched on November, 11th 2010 by Ministry of Science and Technology. This portal is aimed to serve the needs of limited access for researchers in Indonesia to international journals. Ministry of Research and Technology made a breakthrough by taking subscriptions (subscription) collectively for international scientific journals and manage an online library network system (digital libraries) so that the international scientific journals can be accessed by researchers from the laboratory respectively.

Nawala: Clean and Safety Internet
Nawala Nusantara is a free service that used by Internet users who need a strainer negative sites.

Information Village
Information village program is the government's commitment to ensure equal distribution of information, mainly in remote areas, lagging, and outer border, which in 2014 reached 500 locations

7. Areas of Strength in S&T (including medicine, health)

Public health, plant sciences, environmental sciences, ecology, geosciences multidiciplinary, tropical medicine, microbiology, pharmacology pharmacy, infectious diseases, zoology, immunology biology, biochemistry molecular biology, chemistry medicinal and agronomy are among the research fields which are relatively strong in Indonesia based on the total number of publication in international journals. The publication in the fields of molecular biology and genetics, microbiology, immunology, space science, environment and ecology, and clinical medicine are mostly cited from Indonesian authored publication with average citation indexes of over 11 citations per paper. The area of agriculture, medical sciences and technological sciences are the fields with biggest number of researchers in Indonesia, accounted for 22% of the total Indonesian researchers.

8. Capability for S&T Human Resource Development in Higher Education Institutions

There are 472 Universities both private and state owned that are offering graduate degree programs in Science, Technology, Engineering and Mathematics. In 2010 there are 174,977 diploma graduates in science, technology and engineering, 434,551 bachelor graduates, 43,729 masters and 1,765 PhDs.

9. Major Contributors to GDP

The major contributions to GDP in 2009 is Agriculture IDR 858,25 trillion (17.13%), mining and primary resources IDR 591,53 trillion (11.8%), Manufacturing IDR 1.480,91 trillion (29.55%) and Services IDR 2.080,95 trillion (41.52%).

10. Major Exports

The major export commodities of Indonesia are Food Products and Beverages, Textiles, Rubber and Plastic Products, Refined Petroleum Products, Wood and Product, computer office machinery, electronics and communications and motor vehicles, metal products and ship building in manufacturing sector, coal and copper ores in mineral resource sector and cocoa, coffee and shrimp in agricultural sector.

10. Major Trading / Economic Partners in ASEAN

Indonesia's major trading partners are Japan, South Korea, Thailand, Singapore, Malaysia, India, USA and Germany.

LAO PDR

LAO People's Democratic Republic

Country Figure

Total Area: 236,800 km2 (83rd), 2 % of Water
Population: 2009 estimate 6,800,000 (104th in the world), Density 26.7/km2 (177th)
GDP (nominal) 2010 estimate $6.341 billion
GDP Per capita $984
GDP (PPP) 2010 estimate $15.693 billion (130th)

Lao People's Democratic Republic, is a landlocked country in Southeast Asia, bordered by Burma and the People's Republic of China to the northwest, Vietnam to the east, Cambodia to the south and Thailand to the west. The country area is Its population was estimated to be 6.8 million in 2009.
Laos traces its history to the Kingdom which existed from the 14th to the 18th century when it split into three separate kingdoms. In 1893, it became a French protectorate, with the three kingdoms, Kingdom of Luang Phrabang, Kingdom of Vientiane and Kingdom of Champasak, uniting to form what is now known as Laos. It briefly gained independence in 1945 after Japanese occupation, but returned to French rule until it was granted autonomy in 1949. Laos became independent in 1954, with a constitutional monarchy under Sisavang Vong. Shortly after independence, a long civil war ended the monarchy, when the Communist Pathet Lao movement came to power in 1975.
Laos is a single-party socialist republic. The capital city is Vientiane. Other large cities include Luang Prabang, Savannakhet and Pakse. The official language is Lao. Most people are Lao with a significant proportion of indigenous religion as well. It is a rising power in providing electricity to neighboring countries such as Thailand, China and Vietnam and the economy is accelerating rapidly with the demands for its metals. It is a member of the Asia Pacific Trade Agreement (APTA), Association of Southeast Asian Nations (ASEAN), East Asia Summit and La Francophonie. Laos applied for membership of the World Trade Organization (WTO) in 1997.

Overview on Science and Technology Development

Faced with the situation of economic competitiveness in the region, the government of Lao has made a great effort to build up socio-economy, acquire modern technology and knowledge to support its national development to be equivalent with other countries. The government of Lao has integrated S&T activities into its national development plan and socio-economic development policy, and increased investment in human resource development and the priority action program.

The S&T investment has been considered as one of the main factor for economic growth through technological changes in the production process. Considerable efforts for investment on S&T up to 2020 have been planned to reach the goal of economic structural change in the direction of industrialization and modernization, including setting up new Ministry of Science and Technology and allocating 1% of GDP for R&D in 2011.

1. S&T Policy and Development Strategy

The government of Lao is currently implementing the 7th Five Year National Socio-Development Plan for the period of 2011-2015. The plan is to determine direction aimed at ensuring that the country achieves its key development goals, such as:

A. To enhance and strengthen stability,
B. To maintain an economic growth at least 8% each year; ensure stability and balance in macroeconomic system; build foundation for industrialized and modernized transformation and sustainable development.
C. To achieve Millennium Development Goal of the United Nation in 2015 and lift the country from least developed country status by 2020
D. To integrate the country's economy to Greater Mekong Sub-region, ASEAN and international in a dynamic manner.

The development plan for 2010-2011 targets GDP increases of 8-8.5% and achieving GDP per capita of 1,130 USD. In the economic sector it targets of achieving rice production of 3.38 million tons, electricity production of 9,087.75 million KWH, exports to the term of US$1,229.73 million. In the social sector the development plan targets to reduce poverty rate to 24% of total population and poor household rate to 19% of total households by the end of 2011, ensuring rate of literacy of age 15 and above to reach 83% and literacy rate , rate of people using latrine facilities to reach 54%, literacy rate between those aged 15-40 to reach 90%, providing clean water to 80% of people, providing training and skill labor development to 44,136 people and creating new jobs for 55,365 people, and targeting the number of culturally preserved villages to total 125. To attain the target of at least 8% economic growth, the government of Lao will invest 32% GDP, of which the state investment comprises 10.87% of GDP. Starting 2010, the government will allocate 30% of budget to economic sector, 35% to social sector and 35% to roads and infrastructures.

Science and Technology policy is yet to establish in Lao. The Ministry of Science and Technology is newly established in June 2011, and still under re-organization from originally the National Agency of Science and Technology before fully functioning as become the institution to outline the science and technology policy. At the moment, the Agricultural Development Strategy 2011-2020 is the most relevant policy in Lao related to the science and technology policy as agriculture and natural resource (ANR) sector is still the main thrust for the science and technology development. The strategic direction for the ANR is to ensure a successful gradual transition from subsistence into commercial smallholder production. This can be achieved by applying innovative technologies for the systematic and continuous production of high-value agri-food products for local value-added agro-processing and for domestic, regional, and world markets.

The major themes of the ANR sector strategy include a strong focus on modernizing agricultural production and creating value-added food and agricultural products aimed at reducing rural poverty, maintaining food security, and applying results-based management to the natural resources that are the foundation for sustainable agricultural and rural development and resiliency to climate change. Lowland agriculture production will be focused with the application of technologies to improve and maintain the quality of soils and guide the use of agricultural chemicals; use appropriate technology and equipment for mechanized production; and, apply climate change mitigation and adaptation measures.

2. Infrastructure of S&T

There are two main government institutions in charge for science and technology (S&T) development in Lao People's Democratic Republic: the Ministry of Science and Technology (MOST) for the nation and the Provincial Department for Science and Technology (PDST) for the provinces. There are also a National Science Council (NSC), various ministries, universities and research institutes. All research institutes are available only at MOST (originally National Authority for Science and Technology, NAST) and under some of the ministries, especially Ministry of Agriculture and Forestry (MAF).

Ministry of Science and Technology (MOST)

The Ministry of Science and Technology in June 2011 was formed and established in June 2011 from originally the National Authority for Science and Technology (NAST), under the Prime Minister's Office. MOST is a central organization under the government structure, whose role is to serve as secretary and assist the Government of Lao to organize and administer science and technology, intellectual property, standardization and metrology throughout the country. MOST is headed by Minister of Science and Technology, consists of four administrative section, five technical management section and three technical research and service section. Before reorganized into MOST, NAST has accomplished some projects including establishing research institutes and information centres on S&T centrally and in some provinces; creating some legislations relating to the management and promotion of science, technology and innovation (STI), such as the law on IP, the law on standardization and the policy on information and communication technology (ICT), and completed Phase I of the implementation of an "e-government project" (set up national and local centres for e-governance, installed linkage networks by using fibre optics and WiMax system, and installed ICT equipment to train government staff on information technology).

Provincial Department for Science and Technology (PDST)

PDST, a governmental institution at local level, acts as a secretary to the provincial governor and a leader of NAST and directly manages on S&T, IP, standardization and metrology in the provinces. It is a young institution and has low capacities and limited budget. PDST is yet to carry out its functions actively.

National Science Council (NSC)

NSC was established in 2002 as a technical institution, under the Prime Minister's Office. NSC's main functions are to provide advice on social and natural research activities, and to consider and certify results of research carried out in the country. NSC is also chaired by a Minister in the Prime Minister's Office, who is the Chairperson of NAST. Members of NSC are drawn from different public and private sector entities. The Council is yet to start active functions.

Research Institutes under MOST and Line Ministries

MOST and different Line ministries have established institutes, centres and councils relating to the research, development, application and management of S&T for serving their own activities. Many activities, including pilot projects, have been undertaken by these ministries and some important results achieved. Under MOST there are three research institutes: Biotechnology and Ecology Research Institute, Renewable Energy and New Material Research Institute, and Technology Computer and Electronics Science Research Institute. The most leading research institutes under Line Ministries in Lao are the National Agriculture and Forestry Research Institute (NAFRI) under MAF with total staff of around 300 persons, the National Research Institute of Medicine Plant under the Ministry of Health (MOH) with total staff of less than 50 persons and the National Economic Research Institute under the Ministry of Planning and Investment (MOPI) with total staff of less than 30 persons.

National Universities

The country has five universities: National University of Lao in capital city of Vientiane which is the leading university in the country, Suphanouvong University in Luangprabang, Champasack University, Savannakhet University and the University of Public Health. National University of Laos is founded in 1996, and has important role in developing human resources in Lao, producing a number of scientists,

technologists and researchers. Other universities are just established very recently, still in the process of developing infrastructures and human resources.

Business Units

The industrial units in Lao People's Democratic Republic fall into four categories: state-run enterprises; private enterprises; joint enterprises; and collective enterprises. Most business units are involved in technology application, rather than S&T research. Computer is a basic technology that most business units are employing. Application of modern technologies, which are mostly imported, is very limited among business units that have low s investment, such as small and medium enterprises (SMEs).

3. Human Resources Involved in R&D

There is very limited resource on the statistical data on human resources involved in R&D in Lao PDR. The latest available data is based on survey conducted by the Department of Science and Technology under former NAST in 2002 to 169 institutions comprising of business enterprises, government institutions, higher education and private non-profit organizations. According to the survey, there are 1,946 persons (headcount) human resources devoted to R&D distributed to higher education (58%), government research institutions (31%) and business enterprises (11%). The human resources devoted to R&D (FTE) is total 550 persons, comprising of 55% of higher education, 31% of government research institutions and 14% of business enterprises. The numbers of researchers among the human resources devoted to R&D are 490 persons based on headcount, distributed to higher education (55%), government research institutions (31%) and business enterprises (14%), and 120 persons based on FTE, distributed to higher education (42%), government research institutions (33%) and business enterprises (25%).

4. Expenditure for R&D

The total R&D expenditure based on National R&D Survey (2002) is 6,560 million KIP (US$ 649,800), shared by government research institutions (51%), higher education sector (12%), and business enterprises (37%).

Different survey data by the Agricultural Science and Technology Indicators (ASTI) on agricultural research expenditure and number of researchers in 2003 is presented in Table 1.

Table 1—Composition of agricultural research expenditure and total researchers, 2003

	Spending KIP (millions)	Spending Intl dollars (millions)	Researchers (fte's)	Spending (%)	Researchers (%)	Number of Agencies in sample
Public Agencies/ Government						
NAFRI	16,501.50	10.1	105	89.9	83.7	1
NUoL	1,723.30	1.1	18.4	9.4	14.7	2
Subtotal	18,224.80	11.1	123.4	99.2	98.4	3
Private enterprises	140.2	0.1	2	0.8	1.6	1
Total	**18,365.00**	**11.1**	**125.4**	**100**	**100**	**4**

5. S&T Outputs

Lao is yet to establish record on science and technology outputs, including international publications as well as patent granted.

6. S&T Utilization Programs including Indicators of Utilization

There are some activities of S&T utilization programs conducted by the NAST including:

- Research activities, and dissemination of results of research and information to the public.
- Technical training and workshops to upgrade knowledge of governmental officials at both local and national level.
- Implementation of an "e-government project" in national and local centres for e-governance, installing linkage networks by using fibre optics and WiMax system, and ICT equipment to train government staff on information technology.
- Implementation of Lao National Biosafety Framework, coordinated by MOST and involving 7 ministerial institutions including NAFRI and Department of Agriculture (MAF), Department of Food and Drugs (MOPH), Cabinet Office of Lao Woman Union, Department of Law (MOJ), Department of Environment (MOENR); the project is lasting for 4 years, funded by TEF, costing for 1 million US$ and 0.5 million US$ of in-kind support from Lao Government.

7. Areas of Strength in S&T

Given the importance of the agricultural sector to the Lao economy, agricultural research and development (R&D) plays an important development role for the country. We identified four agencies involved in agricultural R&D.2 In 2003, these agencies employed a combined total of 125 full-time equivalent (fte) researchers and spent close to 18 billion Lao kip in 2000 constant prices, the equivalent of 11 million international dollars in 2000 constant prices (Table 1).3 The National Agriculture and Forestry Research Institute (NAFRI) is the only government agency involved in agricultural R&D in Laos. In 2003, this institute accounted for roughly 84 percent of the country's total agricultural researchers and 90 percent of expenditures. NAFRI was established in 1999 through the amalgamation of existing agriculture, livestock, fisheries, and forestry research centers, with the tasks of designing, implementing, and coordinating all agriculture and forestry research in Laos.4 The institute is mandated to play a major role in the National Growth and Poverty Eradication Strategy (NGPES)5 through the provision of improved technologies and information for crop, livestock, forestry, and aquatic resource production with the aim of improving productivity. The institute has an additional eight research centers: the Agriculture Research Centre (ARC), the Coffee Research Centre (CRC), the Forestry Research Centre (FRC), the Horticulture Research Centre (HRC), the Livestock Research Centre (LRC), the Living Aquatic Resources Research Centre (LARReC), the Northern Agriculture and Forestry Research Centre (NAFReC), and the Soil Survey and Land Classification Centre (SSLC).

During 1998-2003, total agricultural researcher numbers in Laos rose steadily, while agricultural R&D expenditures contracted by half in constant prices during 1999–2003. The principal agricultural research agency, the National Agriculture and Forestry Research Institute (NAFRI) accounted for 90 percent of Laos' agricultural R&D spending in 2003. NAFRI employed only a few scientists holding PhD degrees. However, researcher qualification levels are expected to rise because a large number of NAFRI researchers are currently undertaking PhD and MSc training abroad. Since its establishment in 1999, NAFRI has depended almost exclusively on donor support, with the result that its donor-driven research does not always contribute to Laos' overall agricultural R&D needs. Private sector involvement in agricultural R&D is limited.

The higher-education sector plays a limited role in the Lao agricultural research system, accounting for just 15 percent of the country's total fte research staff and an estimated 9 percent of agricultural R&D spending. We identified two faculties involved in agricultural R&D under the Vientiane-based National University of Laos (NUoL). The Faculty of Forestry (FoF) is the larger of the two, employing 12 fte

researchers in 2003. FoF's research activities concentrate mainly on silvicultural issues and to a limited extent agroforestry and community forest issues. Most research activities are performed by individual staff members as part of collaborative programs initiated by other agencies. The faculty is currently setting up a formal research program for the next five years. NUoL's Faculty of Agriculture (FoA) employed seven fte researchers in 2003. These researchers were spread across three formal research programs: cropping systems and crop management, livestock and fisheries, and agroeconomics and agroprocessing.

8. Capability for S&T Human Resource Development in Higher Education

National University of Laos is the only higher education institution to offer post-graduate programs. The university has important role in developing human resources in Lao, producing a number of scientists, technologists and researchers in the fields of Agriculture & Food, Applied Science & Technologies, Biology & Nature, Computers & Communication, Earth & Ocean Science, Energy & Energy Conservation, Environment, Health & Medicine, Math, Physics & Chemistry and Science Education.

Other universities are just established very recently, still in the process of developing infrastructures and human resources.

9. Major Contributors to GDP

The estimated GPD in 2010 is $6.341 billion, with agriculture sector accounted 29%, industry sector 26.5% and services 39%.

Subsistence agriculture still accounts for half of the GDP and provides 80 percent of employment. Only 4.01 percent of the country is arable land, and 0.34 percent used as permanent crop land,[28] the lowest percentage in the Greater Mekong Subregion.[29] Rice dominates agriculture, with about 80 percent of the arable land area used for growing rice.[30] Approximately 77 percent of Lao farm households are self-sufficient in rice

The economy receives development aid from the IMF, ADB and other international sources, and foreign direct investment for development of the society, industry, hydropower and mining, most notably copper and gold. Tourism is the fastest-growing industry in the country. Economic development in Laos has been hampered by brain drain, with a skilled emigration rate of 37.4 percent in 2000.[35]

Laos is rich in mineral resources but imports petroleum and gas. Metallurgy is an important industry, and the government hopes to attract foreign investment to develop the substantial deposits of coal, gold, bauxite, tin, copper and other valuable metals. In addition, the country's plentiful water resources and mountainous terrain enable it to produce and export large quantities of hydroelectric energy. Of the potential capacity of approximately 18,000 megawatts, around 8,000 megawatts have been committed for exporting to Thailand and Vietnam.[36]

The country's most widely recognised product may well be Beerlao which is exported to a number of countries including neighbours Cambodia and Vietnam. It is produced by the Lao Brewery Company.

10. Lao Major Exports

Lao's major export commodities are mining products (copper and gold) which account for more than 50% of total Lao exports, hydropower electricity that makes up 26% of the total export, industrial products such as beer and processed coffee and agricultural products such rice and coffee beans as well as tourism goods.

11. Major Trading/Economic Partners in ASEAN

Thailand, Vietnam and Cambodia are the major economic partners in ASEAN.

MALAYSIA

Country Figure (2010)

Area (sq.km)	: 330,803
Population (million)	: 28.2
Unemployment rate (%)	: 3.4
Literacy Rate (%)	: 95.1
GDP (current prices) RM Million	: 765,966
Real GDP Growth Rate (%)	: 7.2
GNI per capita (RM)	: 26,219
Inflation (% p.a)	: 1.4
Exports (RM Million)	: 639,428
Imports (RM Million)	: 529,194.60
Exchange rate (RM/USD)	: 3.221

Malaysia is a federal constitutional monarchy in Southeast Asia. It consists of thirteen states and three federal territories, separated by the South China Sea into two regions, Peninsular Malaysia and Malaysian Borneo. Land borders are shared with Thailand, Indonesia, and Brunei, and maritime borders are with Singapore, Vietnam, and the Philippines. The capital city is Kuala Lumpur, while the federal government administration offices are centralized in Putrajaya. The country is multi-ethnic and multi-cultural. Islam is the state religion, although freedom of religion is protected by a secular constitution.

The economy has fuelled by the success of industrial manufacturing sector in the past decades from traditionally based on its natural resources, and currently is expanding in the sectors of science, tourism, commerce and medical tourism. International trade, facilitated by the adjacent Strait of Malacca shipping route, and manufacturing are key sectors of the country's economy. Malaysia is an exporter of natural and agricultural resources, the most valuable exported resource being petroleum. At one time, it was the largest producer of tin, rubber and palm oil in the world. In 2010 the GDP per capita (PPP) of Malaysia became the 3rd largest economy in ASEAN and 29th largest economy in the world.

OVERVIEW on the State of S&T Development

In 1957 to late 1970, Malaysia applied Agriculture based economy with land and labour as basic inputs. In 1980s to mid 1990s, resource-led economy with heavy invesment on infrasructure combined with collateralised risk free capital and cheap labour became the base concept to fuel economic sector. In the late 1990s to 2020, innovation-led Economy model is being proposed to spur the economy, transforming Malaysia into a high income economy for sustainable wealth generation, employment creation, and societal well being.

Science and technology development is administered under the Ministry of Science, Technology and Innovation (MOSTI). MOSTI sets some policies to enhance the model and establishes some organizations under it to maintain its innovation programs to reach vision 2020.

1. S&T Policy and Development Strategy

Malaysia has employed the first National Science and Technology Policy (NSTP) in 1986. Curently the second NSTP set up in 2002 is employed. The 7 key strategic thrusts for S&T development under the Second NSTP are:

- Strengthening research and technological capacity and capability
- Promoting commercialization of research outputs
- Developing human resource capacity and capability
- Promoting a culture for science, innovation and techno-entrepreneurship.
- Strengthening institutional framework and management for S&T and monitoring of S&T policy implementation.
- Ensuring widespread diffusion and application of technology leading to enhanced market driven R&D to adapt and improve technologies.
- Building competence for specialization in key emerging technologies.

The Third NSTP and S&T Act are still in preparation. The new NSTP will propel the nation towards achieving a sustainable high income Knowledge-based economy by 2020. Malaysia is aiming at moving towards a high income economy by 2020 by ing a progressive scientific and innovative society. Vision 2020 highlighted STI as one of its strategic priorities: "to establish a scientific and progressive society, a society that is forward looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future".

Malaysia is at crucial phase of development in its efforts to transform the nation into an advanced and high-income economy. The Government is embarked on a national transformation program premised on four pillars, namely One Malaysia: People First, Performance Now, the Government Transformation Program, the Economic Transformation Program, and the Tenth Malaysia Plan.

The New Economic Model (NEM) constitutes aspirations of a united and advanced nation. The Goals to be achieved are high incomes, inclusiveness, and sustainability. It targeted income per capita of US$ 15,000-$20,000 by 2020. Inclusiveness is aimed to enable all communities to fully benefit from the wealth of the country, while sustainability is to meet present needs without compromising generations. The ultimate goal of NEM is improving the people's quality of life.

Economic Transformation Programme (ETP) runs the programmes with 12 National Key Economic Areas (NKEAs) and NEM 8 Strategic Reform Initiative (SRIs). The 12 NKEAs constitutes tourism, business serviced, oil and gas, electrical and electronic, education services, private healthcare, ICT, palm oil products, agriculture, greater Kuala Lumpur, financial services, and wholesale and retail. 8 NEM SRIs comprises of: 1) re-energising the private sector, 2) developing a quality workforce and reducing dependency on foreign labour, 3) creating a competitive domestic economy, 4) strengthening the public sector, 5) Transparent and market friendly affirmative action, 6) building the knowledge base infrastructure, 7) enhancing the sources of growth, and 8) ensuring sustainability of growth.

S&T Laws and Other National Policy Pronouncements

Every five years Malaysia renews the country's master plan (MP) of national development, namely Malaysia's five year Development Plans and key plans/policies. National S&T Policy is the 4th MP performed in 1985. In 1990 the Malaysia government arranged vision 2020 and was followed by Privatization Master Plan, National Multimedia Plan (1995), establishment of national Innovation

Council (NIC) (2004), National Innovation Model (2007) and some others policies that enhance vision 2020, namely:

1. The National Biotechnology Policy
   The National Biotechnology Policy which was launched in 2005 envisions that biotechnology will be a new economic engine for Malaysia, enhancing the nation's prosperity and well-being.
2. Outline Perspective Plans (OPP)
   OPP were prepared to set the broad thrusts and strategies in the national development agenda over a long term. OPP1 was a 20-year plan (1971-1990). The next two OPPs were prepared for a 10 year time frame. The OPP2 was prepared for the period 1991-2000 and the OPP3 for 2001-2010. The next tier is medium-term planning, where 5-year development plans are formulated to operationalize the OPPs. It set out the macroeconomic growth targets as well as the size and resource allocation for the public sector development programme. Currently, the Tenth Malaysia Plan (10^{th} Malaysia Plan), covering the period 2011-2015, is in operation.
3. Industrial Master Plan (IMP)
   The Industrial Master Plan was formulated to guide the development of the manufacturing sector in Malaysia. IMP provided a framework for ensuring a more diversified and integrated manufacturing sector and establishing the foundation for its sustained growth. Threes IMP have been formulated namely IMP1 (1986-1995), IMP2 (1996- 2005) and IMP3 (2006-2020).
4. National Science and Research Council (NSRC)
   In 2011, a National Science and Research Council (NSRC) was established to strategize and prioritize R&D focus areas to meet the challenge of becoming a knowledge based economy by 2020, as well as encouraging interdisciplinary research. NSRC replaced the National Research and Science Development Council which was established in 1975. NSRC is chaired by the Science Adviser to the Prime Minister, and the members comprised the Secretary Generals of ministries actively involved in R&D and experts from academia and private sector. The ministries involved are the Ministry of Science, Technology and Innovation, Higher Education Ministry, Agriculture and Agro-based Industry Ministry, Health Ministry, Natural Resources and Environment Ministry, and Plantation Industries and Commodities Ministry.

Innovation System Framework

Ministry of Science, Technology and Environment (MOSTE) was renamed to Ministry of Science, Technology and Innovation (MOSTI) in 2004. National Innovation Council (NIC) was established in 2004 to propel the national agenda forward and enhanced the country's National Innovation System. The Council is chaired by the Prime Minister and MOSTI is the secretariat of NIC. Introduction of National Innovation Model in 2007 which have two approaches namely market driven and technology driven innovations.

Agensi Inovasi Malaysia (AIM) under the Prime Minister's Department was established in 2011 to be the driving force behind Malaysia's push towards establishing an innovation economy.

A reform of institutional structure will be undertaken during the 10th Malaysia Plan (2011-2015) to improve innovation outcomes.

2. Infrastructure for S&T

S&T Institutions

- The key actors in Malaysia's STI system are government and government linked organizations.
- Ministry of Science, Technology & Innovation (MOSTI) spearheads the development of STI and oversees more than 20 departments, agencies & companies clustered into 5 focus areas: biotechnology, ICT policy, industry, sea to space, and science & technology core.
- Ministry of Higher Education (MOHE) aims to turn Malaysia into a hub of excellence for higher education and also to develop at least 20 Centres of Excellence internationally recognized in terms of research outputs, copyrights, publications and research collaborations and to commercialize at least 10% of research outputs.
- Other Ministries include Ministry of Natural Resources and Environment (MNRE), Ministry of Energy, Green Technology and Water (MEGTW), Ministry of Agriculture (MOA), Ministry of Health (MOH), Ministry of Plantation Industries and Commodities (MPIC).

Government Research Institutes

- MOSTI – *Malaysian Institute of Microelectronic System (MIMOS)*
  - *SIRIM Berhad*
  - MIMOS Berhad
  - *Malaysian Centre for Remote Sensing (MACRES)*
  - *Nuclear Malaysia*
  - *Malaysia Genome Institute (GENOMalaysia)*
  - *Malaysian Institute of Pharmaceuticals and Nutraceuticals (IPHARM)*
  - *Agro-Biotechnology Institute Malaysia (ABI)*
  - *Technology Parks Malaysia Corporation (TPM)*
- MNRE
  - National Hydraulic Research Institute of Malaysia *(NAHRIM)*
  - *Forest Research Institute of Malaysia (FRIM)*
  - *Mineral Research Centre (MRC)*
- MEGTW
  -*Malaysia Green Technology Corporation*
- MOA
  - Veterinary Research Institute (VRI)
  - Fisheries Research Institute (FRI)
  - Malaysian Agricultural Research Development Institute (MARDI)
- MOH
  - Institute Medical Research (IMR)
- MPIC
  - Malaysia Rubber Board (MRB)
  - Malaysia Palm Oil Board (MPOB)
  - Malaysian Cocoa Board (MCB)
  - The Fibre and Biocomposite Development Centre (FIDEC)

- MOD
  - Science and Technology Research Institute for Defence (STRIDE)

Government R&D Funding Agencies

Under the 10th Malaysia Plan (2011-2015), the Government will support R&D and commercialization across the value chain under a number of initiatives, as shown in Figure 7. A number of RD&C funds/grants are made available including Cradle fund, Science fund, Pre-commercialization fund, Fundamental Research Grant Scheme, Commercialization of R&D Fund, Business Growth Fund, Technology Acquisition Fund, and Venture capital fund. Under this arrangement, funding will come from Ministry of Finance (MOF), MOSTI, Ministry of Higher Education (MOHE), Malaysian Technology Development Corporation (MTDC).

For commodity related research such as oil palm and rubber, research activities are also funded using cess fund. Cess fund is tax imposed on palm oil and palm kernel oil produced in Malaysia used mainly to fund research on oil palm. Cess fund is also collected on rubber and rubber products produced in Malaysia.

University-based R&D – Public University

Malaysia has 20 public universities namely Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Sains Malaysia (USM), Universiti Teknologi Malaysia (UTM), Universiti Teknologi MARA (UiTM), Universiti Utara Malaysia (UUM), Universiti Islam Antarabangsa Malaysia (UIAM), Universiti Malaysia Sarawak (UNIMAS), Universiti Malaysia Sabah (UMS), Universiti Pendidikan Sultan Idris (UPSI), Universiti Malaysia Terengganu (UMT), Universiti Teknologi Husein Onn (UTHM), Universiti Teknologi Melaka (UTeM), Universiti Malaysia Pahang (UMP), Universiti Malaysia Perlis (UniMAP), Universiti Sains Islam Malaysia (USIM), Universit Darul Iman (UDM), Universiti Pertahanan Negara Malaysia (UPNM), Universiti Malaysia Kelantan (UMK).

Five universities have been given the status as “Research University” and they are UKM, UM, UPM, USM, and UTM. Research University is the public universities that have been accredited by the Cabinet on 11 October 2006 to become a hub of excellence for education and research. Characteristics of Research Universities include :

- Research-focused field of study
- Competitive Entry
- Quality Lecturer
- Ratio of graduate and postgraduate 50:50

Malayasia also has 18 Private Universities namely Multimedia University (MMU), Universiti Teknologi Petronas (UTP), Universiti Tenaga Nasional (UNITEN), Universiti Tun Abdul Razak (UNITAR), Malaysia University of Science & Technology (MUST), Kuala Lumpur Infrastructure University College (KLIUC), Curtin University of Technology Sarawak (CURTIN), Universiti Industri Selangor (UNISEL), International Medical University (IMU), Monash University Malaysia (MONASH), Universiti Tuanku Abdul Rahman (UTAR), University of Nottingham Malaysia Campus (NOTTINGHAM), Universiti Kuala Lumpur (UniKL), Swinburne University of Technology, Sarawak Campus (SUTS), Management and

Science University (MSU), Sunway University College (SUNWAY), TATi University College (TATi), Taylor's University (TAYLORS)

Private Non-Profit Institutions which plays significant role in R&D

- Malaysia Toray Science Foundation (MTSF)
  - S&T Award
  - S&T Research Grant
  - Science Education Award
- National Cancer Council (MAKNA)
  - MAKNA Research Award in collaboration with ASM
  - Research Collaboration with UPM, HUSM, HUKM, IMR
- Cancer Research Initiatives Foundation (CARIF)
  - Breast Cancer Research, Oral Cancer Research, Nasopharyngeal Cancer Research, and Drug Discovery
- Dr. Ranjeet Bhagwan Singh Medical Research Trust Fund
  - Memorial lecture and international Fellowship
- Sime Darby Foundation
  - Climate change research with UKM
  - Stability of Altered Forest Ecosystem (SAFE) research project with Royal Society United Kingdom and Sabah Foundation

Linkages (Academia-Industry Linkages)

The Academia – Industry Consultative Council (AICC) under the Ministry of Higher Education (MOHE) was established to foster better ties between the world of academia and industry; with the shared view of formulating mutually beneficial understanding and cooperation between the participating stakeholders.

Under the National Higher Education Strategic Plan, 2007, efforts will be made to strengthen the AICC covering the academia and industry linkages including:

- Activity related to spin-offs and start-ups and commercialization of intellectual property
- Student industrial attachment
- Curriculum development, research collaboration and attachment of lecturer with industry
- Research lab
- Expert to provide latest industrial information
- Sharing of industry experience with academia
- Joint efforts between academia and industry in R&D and innovation

The Malaysian government is vigorously promoting and advocating academia-industry engagement including through the establishment of industry and community partnership offices at five research universities with government funding provided under the Higher Education Strategic Plan , with the objective of creating a sustainable ecosystem for academia-industry and community collaboration.

Following are some of the initiatives undertaken at the "research universities" to strengthen academia-industry linkages.

University	Initiatives
UKM	Deputy Vice Chancellor (Industry & Community Partnership
	Industry Liaison Office. This office acts as the matchmaker in facilitating the industry engagement and partnerships ; a) in enhancement of industry perception of the quality of UKM graduates; and b) in collaborative R & D, consultancy and commercialization with research groups from faculties, institutes and centres. Together with the Faculties, Institutes and UKM Holdings, the office facilitates the bridging process between the industry and UKM.
USM	Deputy Vice Chancellor (Industry & Community Network
	Division of Industry & Community Network (DICN) focuses on Industry Liaison, Industry Advisory Panel and Research Consultancy
	The aim of DICN is to develop an eco-system of sustainable collaboration between USM and industry/community that benefits all parties
UPM	Deputy Vice Chancellor (Industry & Community Partnership)
	Industrial Network Division, Industrial Relations Unit and The aim of this Division is to enhance and coordinate the linkages between UPM and Industry and Community towards strengthening quality of education and teaching as well as R&D and extension
UM	Deputy Vice Chancellor (Research & Innovation)
	UM Centre of Innovation & Commercialization, UM Consultancy Unit and Centre for Industrial Training & Relations
UTM	Deputy Vice Chancellor (Research & Innovation)
	Consultancy Services, Training Services, Partnership & Collaborations and Opportunities for Investments

Technology Financing Companies

- Malaysia Technology Development Corporation (MTDC)
  MTDC was set up by government of Malaysia in 1992 to spearhead the development of technology businesses in Malaysia. Its initial role was to concentrate on the promotion and commercialisation of local research and invests in new ventures that can bring in new technologies from abroad.

  MTDC has now evolved to become an Integrated Venture Capital Solutions Provider – successfully managing grants, venture capital funds, technology centres and nuturing technology companies. Under the 10th Malaysia Plan, the role of MTDC had been expanded to create an effective ecosystem for commercialisation of homegrown technologies – to groom a new generation of Technopreneurs through comprehensive nurturing services that support them all the way from laboratory ideas to full commercialisation.

- Malaysia Venture Capital Management Berhad (MAVCAP)

  MAVCAP was incorporated in 2001 by the Malaysian Government and is the nation's largest venture capital (VC) firm which focuses on investments in the local information, communications and technology sector (ICT). MAVCAP was established to realize the Government's vision to develop the VC industry and encourage entrepreneurship in the technology sector.

  MAVCAP is wholly owned by the Minister of Finance Incorporated, the Company was allocated RM970 million under its management. The firm provides an alternative source of high-risk financing for start-ups, seed capital and early stage ventures in the ICT sector and high-growth industries.

- Malaysia Debt Ventures Berhad (MDV)

  MDV was established in 2002, MDV is a Venture Financing Organisation, providing contract/project financing facilities to early and growth stage companies within MDV's ICT, Biotechnology, and Green Technology and other emerging technologies. On 3rd May 2011, MDV has officially launched its new Green Technology Financing Programme.

- Modal Perdana

  Modal Perdana was incorporated on May 16, 2001 by the Government of Malaysia, Modal Perdana administers and manages the Venture Capital for Technology Acquisition (VCTA) fund. The vision is to become a global venture capital company that focuses on technology transfer development to support Malaysia's Economic Innovation Model.

3. Human Resources Involved in R&D

The total number of R&D personnel (headcount) in 2008 is 29,945 as compared to 24,588 in 2006. The total number of Researchers (headcount) in 2008 is 24,991 as compared to 19,021 in 2006. The total number of R&D personnel (FTE) in 2008 is 15,221.7 as compared to 13,415.8 in 2006. The total number of Researchers (FTE) in 2008 is 12,541.6 as compared to 9,684.23 in 2006. (Table 1).

Table 1 shows the headcount of overall human resource in R&D, which includes researchers, technicians and support staff from the period of 1998 to 2008. The figure indicates a rising trend from 1998 to 2004, but decreasing slightly in 2006 to 24,588 to almost equivalent to the number recorded in 2002. In 2008, the number increase to 29,945. The same trends is also recorded for the total no. of researchers (*Full Time Equivalent*) for the same period.

4. Expenditure for R&D

Total R&D Expenditure (GERD) in 2008 is USD 1,586 million an increase as compared to RM 3,646.7 million (USD 1,215 million) in 2006. R&D Expenditure (GERD) as a percentage of GDP in 2008 is 0.72 as compared to 0.64 in 2006. In 2006, private sector contribution to GERD constitutes 85% percent while the Government only contributes about 15% percent. The national GERD increased consistently from 1992 to 2008. However the ratio of GERD per GDP only increased consistently from 1996 to 2002. The ratio decreased slightly in 2004 and increased again in 2008.

5. S&T Outputs

Patents Applied for and Patents Granted

- Total number of patens applications in 2010 were 6,464 as compared to 5,737 applications in 2009.
- In 2010, 5,189 applications were from residents and 1,275 were from non-residents.
- The total number of patents granted in 2010 for residents were 204 as compared to 1,973 for non-residents.
- Patents applied from 2001 to 2010 were totaled at 52,437 and 31,014 patents were granted in the same period.
- The total number of applications 2001-2005 were 27,661, dropping about 10% to 24,776 for the year 2006-2010.
- For the period of 2001-2010, there were much more applications from non-resident compared to Malaysians. Only 12.6 % of the applications were from Malaysians.
- Total number of patents granted for the period of 2001-2010 were 31,014. Of the total, only 4 % were granted to Malaysians, while the remaining 96% were granted to non residents.

Malaysian Authored Publications

The total number of Malaysian authored S&T publications as indexed in Scopus from the earliest date of 1909 to February 2009 was 54,124, about half of which or totally 22,276 are published between 2001 to February 2009. The number of citations received by Malaysian authored publications was 127,914 for the same period. This indicates that on average, Malaysian authors have received 2.4 citations per publication throughout the publishing period. The pattern of Malaysian authored publications in Malaysia from 2001 to 2008 shows significant increase of 43% in 2004, while from 2005-2008 the growth rate tends to decrease .

6. S&T Utilization Programs including Indicators of Utilization

Incubators

The National Incubator Network Association (NINA) was formally established in 2004 to serve as a common platform for knowledge sharing on incubation/business acceleration among all the incubators in Malaysia and for forging collaborative efforts among incubators for their mutual benefits.

- UPM-MTDC Technology Centre

  UPM-MTDC Technology Centre was established on November 16, 1996 and is a joint-venture project between Universiti Putra Malaysia and MTDC. It is the first of a series of MTDC technology incubation centres established within universities' campus in Malaysia. The centre is strategically located within the vicinity of the Multimedia Super Corridor and was the second area awarded with Cybercity status after Cyberjaya.

- UKM-MTDC Technology Centre

UKM-MTDC Technology Centre is a joint venture between Universiti Kebangsaan Malaysia (UKM) and MTDC. The centre is planned to attract companies mainly involved in biotechnology. The centre is located on a 6-acre piece of land within the UKM campus in Bangi. It will have enough space to accommodate 12-15 tenants. The centre is expected to become a new growth centre for industrial linkages between universities, industries and the private sectors.

- UTM-MTDC Technology Centre

  The UTM-MTDC Technology Centre was established in December 2001 and is a joint venture project between Universiti Teknologi Malaysia (UTM) and MTDC. The centre is planned to attract companies mainly involved in advanced engineering and life sciences. The Centre is located on a 4.24 acre land within the Technovation Park area with a total built up area of 31,200 sq/ft.

- SIRIM Berhad
  The incubation centres under SIRIM Berhad are strategically located in SIRIM's regional offices nationwide. Among others, SIRIM offer technology incubation facilities in spin casting, investment casting, ceramics and cosmetics and natural products.
- MSC Malaysia Technology Commercialisation Centre (Formerly known as MSC Malaysia Central Incubator) focusing on ICT and multimedia, located in Cyberjaya

Incubation Centres are also available at Technology Park Malaysia, Kulim Hi Tech Park and USM (Kompleks EUREKA).

Science/Technology Parks

- Technology Park Malaysia (TPM)

  TPM has to date achieved a turnover of RM6.3 billion, created employment opportunities to over 9,000 professionals and has helped increase the nation's economical Gross Domestic Product (GDP) by 1.2%. TPM provides a unique comprehensive balance of technology, support and R&D capabilities including Rental of incubator premises, Technology and business incubation programmes and Technology commercialization assistance and support.

- Kulim Hi-Tech Park

  The park is envisioned to be the 'Science City of The Future', an integrated science park targeting technology-related industries primarily in the fields of advanced electronics, mechanical electronics, telecommunications, semiconductors, optoelectronics, biotechnology, advanced materials, research and development and emerging technologies. As Malaysia's first and fully integrated high-tech park, KHTP incorporates the following functions - industrial, research & development facilities, amenities, medical and educational institutions and recreational facilities.

- Senai Hi-Tech Park – Iskandar Malaysia (SHTP)

  SHTP was Launched in May 2010 and partially operational in March this year. 3 focus areas are the high-tech manufacturing activities, the research and development (R&D) activities

and the professional services and human capital development. SHTP would target companies in hi-tech manufacturing activities – hi-end electrical and electronics, semiconductor, photonics, optoelectronics, nanotechnology, alternative energy sources and green technology. MOSTI will establish a Malaysia Nano Centre worth RM 200 million in SHTP to further developed nanotechnology development in the country

- Cyberjaya – situated about 50 km south of Kuala Lumpur, the ICT-focused cluster located within Multimedia Super Corridor (MSC) which has attracted Dell, HP, Motorola and Ericsson.

7. Areas of Strength in S&T

Malaysia's area of strength in S&T are based on patents granted on field of technology classified according to the International Patent Classification (IPC), on number of researchers on field of research, and on scientific publications**.** In the recent years, the trend of patents granted based on IPC is increasing. Malaysian Science & Technology Indicators report 2008 shows that Engineering Science field contributes the largest number of researcher (more than 2000 persons), followed by medical and health science (1500 persons), social science (1500 persons), ICT (about 1300 persons), applied S&T (about 1100) and agriculture science (about 800 persons).

8. Capability for S&T Human Resource Development in Higher Education

Both public and private universities offer graduate degree programs in Science, Technology, Engineering and Mathematics (STEM). There are 20 public universities and all of them offers graduate degree programs in STEM. Out of 20 private universities that have the highest students enrollment, only 16 of them offers graduate degree programs in STEM. Total number of students in 2010 at Public Universities with Graduate Degree Programs in Science, Technology, Engineering and Mathematics are 23,309 Master students and 8338 PhD students.

9. Major Contributors to GDP

Major contributors to GDP (2010) include agriculture (81,400RM, 10.4%), mining & quarrying (96,131RM, 12.3%), manufacturing (200,028RM, 25.6%), construction (24,773RM, 3.2%) and services (377,715RM, 48.4%).

10. Malaysia Major Exports

Total Malaysia's exports in 2010 amounted to RM 639,428 million. The major exports are electrical & electronic products, palm oil & palm oil based products, timber and timber based products, liquefied natural gas, crude petroleum, petroleum products, articles of apparel & clothing accessories, natural rubber and other manufactured goods & articles. The highest value-added comes from electrical and electronic products at RM 249,797 million which constitues almost 40% of the total export.

11. Major Trading/Economic Partners in ASEAN

Malaysia's trade with ASEAN (excluding Singapore) continues to expand strongly, accounting for 13.8% of Malaysia's total trade. Singapore was Malaysia's second largest trade partner,

accounting for 12.4% of total trade. Malaysia's top five export destinations in ASEAN in 2010 were Singapore, Thailand, Indonesia, Vietnam, and the Philippines. The top five import sources of Malaysia within ASEAN in 2010 were Singapore, Thailand, Indonesia, Philippines and Vietnam.

Malaysia's exports to ASEAN countries for the period of January-July 2010 amounted to RM 94,974 million as compared to the total imports of RM 81,600 million, registering a trade surplus of RM 13, 688 million.

MYANMAR

1. S&T Policy and Development Strategy

The Science and Technology Development Law of Myanmar was enacted on 7th June, 1994 with the following objectives:

- to carry out development of Science and Technology for promotion of industrial production contributory towards the National Economic Development Plans.
- to carry out Research and Development for the increased extraction and utilization of domestic raw materials and the promotion of industrial production enterprises based on modern Science and Technology.
- to effect Technology Transfer for the promotion of production processes and the improvement of the quality goods.
- to nurture luminaries required for the development of Science and Technology and for Research and Development and to improve their qualifications.
- to communicate and co-operate with domestic and foreign research institutes and organizations for the development of Science and Technology and Research and Development.
- to honour and grant appropriate benefits to outstanding luminaries and inventors in the field of Science and Technology.

The Ministry of Science and Technology was established in 1996 with the following objectives:

- To carry out research and development programmes for national economic development
- To strengthen the national economy utilizing the national resources
- To enhance production in agricultural and industrial sector through technology transfer and distribution of knowledge gained from research and development work
- To produce and nurture human resources for advanced science and technology
- To carry out tasks such as laboratory analysis, quality control and standardization of industrial raw materials and finished products
- To conduct applied research on the utilization of atomic energy

The current National Science and Technology Plan envisions the following role and objectives for Science and Technology:

- Import Substitution
- Defense Support
- Development of New and Renewable Energy Source
- Rural Development Support particularly Poverty Alleviation
- Health Service Support
- National Industrial Sector Upgrading
- Development of Value Adding Materials/Technologies

The major strategies are Human Resource Development (HRD) for S&T and Research and Development (R&D).

The current R&D priority areas are Biotechnology, Materials Science, Nanotechnology, Renewable Energy, Engine Production, Hydropower Turbine Production, Nuclear Energy, CNC Machines, and Unmanned Aerial Vehicle.

There are no S&T Laws in existence or being crafted. However, there is already a draft Intellectual Property Law which, hopefully, can be passed within a year or two.

2. Infrastructure for S&T

The agency mainly responsible for S&T is the Ministry of Science and Technology (MOST) which was created in 1996. There are five (5) original departments in MOST namely:

- Department of Technical & Vocational Education (DTVE)
- Department of Advanced Science and Technology (DAST)
- Myanma Scientific & Technological Research Development (MSTRD)
- Atomic Energy Department
- Department of Science Promotion and Cooperation

The Department of Biotechnological Research was added in 2010.

DTVE supervises 27 technological universities, 25 computer universities, one aerospace and aeronautical engineering university, 4 government technical colleges, 14 government technical institutes, 43 government technical high schools and 4 technical training schools. DAST, on the other hand, supervises 5 technological universities which include two that offers only MS and PhD programs. These are Yangon Technological University (YTU) and Mandalay Technological University (MTU).

There are other Ministries involved in R&D for S&T. These are:

Ministry of Education for the natural and physical sciences since it supervises the universities not under MOST, Ministry of Agriculture, Ministry of Health and Ministry of Transportation.

Ministry of Agriculture for R&D and HRD in agriculture. It supervises two (2) universities namely Yezin Agricultural University and _____

Ministry of Health for R&D and HRD in health. It supervises four (4) medical universities which offer MBBS (their equivalent of MD), MS & PhD in health sciences.

Ministry of Transportation for HRD in marine engineering through the Maritime University which it supervises.

Each of the above mentioned ministries have allocations for HRD and R&D in S&T in their respective budgets. All of these institutions/agencies are public/government organization. The involvement of the private sector in S&T R&D is minimal.

All higher educational institutions are government owned.

3. Human Resources Involved in S&T R&D.

Only the organizations cited in #2 (Infrastructure for S&T) have human resources doing S&T R&D.

As an example, the largest R&D organizations are the MSTRD, Atomic Energy Department and Department of Biotechnological Research which belong to MOST. MSTRD is the largest with 300 personnel of which 50 are researchers.

The universities provide the other group of researchers. These researchers come from the faculty of the universities the numbers of which are shown below:

MOST-DAST:	5 Technological Universities
MOST-DTVE:	27 Technological Universities 25 Computer Universities
Ministry of Education:	50 Universities which include those offering academic programs in the natural and physical sciences.
Ministry of Agriculture:	2 Agricultural Universities
Ministry of Health:	4 Medical Universities
Ministry of Transportation:	1 Maritime University

The largest pool of university researchers come from Yangon Technological University (YTU) and Mandalay Technological University (MTU). These two universities offer MS & PhD in the different Engineering and Technology fields.

The total number of students (?) under the supervision of the MOST is currently at 273,027.

4. Expenditures for S&T R&D

The budget and expenditures for R&D in S&T are accounted for by the government institutions mentioned in #2 (Infrastructure for S&T)

This is no single office yet compiling all statistics on human resources and expenditures for R&D although MOST has a Database Division which compile statistics only for MOST.

5. S&T Outputs

While there are some products/technologies developed in the government research departments, commercialization is limited since there is no Intellectual Property Protection System yet in Myanmar. It is hoped that the Intellectual Property Law of Myanmar will be adopted soon. Examples of products/technologies developed by the Myanmar Standards and Industrial Research Department (MSIRD) are anti-malaria herbal medicine which will now go through clinical trials, composite material using waste plastics for housing construction, ceramic insulators for electric transformers and jars made from clay which can be used to purify water. The Biotechnological Research Department under the MOST has come out recently with biofertilizers and these are now produced in 3 factories owned by MOST. Whatever commercial production there is from technologies generated from government R&D are 'commercialized' by government itself through its agencies and universities.

Since there are no Myanmar patents issued yet. There are a some professors/researchers who have applied for patents abroad.

The publications coming out from R&D are those which were presented in two international conferences sponsored by Myanmar between 1997 and 2008. These two conferences generated 803 scientific papers which were then published as proceedings. During the same period 997 scientific papers have been presented abroad by Myanmar researchers bringing in a total of 1800 papers since 1997. The average number of citation of S&T publications per year is 229.

No real technology commercialization through industry adoptors or through start-up enterprises can be cited. Fund constraints for scaling up from laboratory scale to pilot plant scale has been cited also as a deterrent to commercialization/utilization of technologies/products generated from R&D in addition to the absence of an IP Protection system.

6. S&T Utilization Programs Including Indicators of Utilization.

There are as yet no national programs designed to facilitate and ensure the utilization of generated or required technologies, results of R&D and innovations. Perhaps the closest to this is the setting up of biofertilizer factories which can supply its products to farmer/users. Biopesticides and biofungicides developed through research have also been utilized. MOST Officials indicated that the different government ministries have the responsibility for ensuring the adoption or utilization of technologies generated through R&D. Examples of those are the technologies in plant tissue culture and in cattle breed upgrading which have been taken care by the Ministry of Agriculture.

7. Areas of Strength, S&T Niches

Engineering can be considered an area of high potential considering the number of higher educational institutions (HEI's) or universities which are dedicated to engineering disciplines.

There are 32 technological universities in Myanmar, all under MOST, which offer a wide range of engineering disciplines to include petroleum engineering, textile engineering and ceramics engineering. Two of these technological universities offer MS and PhD programs in 13 engineering field or disciplines. The biggest number of PhD students go to Civil Engineering and Electrical Power Engineering. There are also 25 computer universities, also all under MOST, with two universities – the University of Computer Studies Yangon and the University of Computer Studies Mandalay offering MS and PhD in Computer Studies. Computer Science or Information Technology can be considered an area of high potential.

If exports can be considered as basis for areas of strength, Myanmar is an exporter of rice, forest products particularly teakwood and other hardwood, fish, prawn, livestock and meat, natural gas, rubber and gemstones (jade) and garments. These are mostly in the agriculture-forestry-natural resources sector.

The other areas where Myanmar is trying to build S&T capability are in biotechnology, nanotechnology, nuclear technology, renewable energy and materials science.

8. S&T HRD Capability/Capacity

Myanmar has a very well structured system for developing advanced human resources in Science and Technology. In engineering for instance while there are 32 technological universities all over the country, only five (5) of them are under the supervision of the

Department of Advanced Science and Technology in MOST and only two (2) out of the five are designated to offer MS and PhD programs. These two have stopped offering undergraduate courses starting 2003 based on a government policy that they should offer MS and PhD courses only.

The five (5) technological universities under MOST-DAST are:

- Yangon Technological University (YTU)
- Mandalay Technological University (MTU)
- Pyay Technological University (PTU)
- West Yangon Technological University (WYTU)
- Myanmar Aerospace Engineering University (MAEU)

YTU and MTU are the only ones offering MS & PhD in engineering.

The other universities offering MS and PhD in the sciences are:

- Four (4) Medical Universities
- Two (2) Agricultural Universities
- Two (2) Universities under the Ministry of Education

At least four (4) universities under the Ministry of Education offers MS and PhD in the natural and physical sciences. These are the University of Yangon, University of Mandalay, University of Taun Gyi and the University of Mawla Mye In. There are more than fifty (50) universities under the Ministry of Education.

There are thirteen (13) engineering fields where MS and PhD is offered in both YTU and MTU. These are:

1. Civil Engineering
2. Mechanical Engineering
3. Chemical Engineering
4. Electrical Power Engineering
5. Electronics and Communication Engineering
6. Mining Engineering
7. Metallurgical Engineering
8. Mechatronics
9. Textile Engineering
10. Petroleum Engineering
11. Aeronautical Engineering
12. Information Technology
13. Nuclear Technology

They also offer PhD degrees in Architecture, Biotechnology, Engineering, Math, Physics and Chemistry, as well as Remote Sensing.

During the last 5 years YTU graduated an average of 37 PhD's per year and MTU an average of 99 PhD's a year. During this period also YTU graduated an average of 98 MS while MTU graduated an average of 140 MS per year. Starting 2011-2012 however, YTU will be increasing its target admission to raise enrolment to 1200 by 2016. Their current enrolment is only 157 for both MS and PhD. MTU has more students and graduate because their MS and PhD offerings

are in two(2) categories. One category is for regular students in government service. These are the scholars of MOST and other government agencies and they comprise about 90% of the student population of MTU. Most of them are the faculty members in the technological universities under MOST.

Research output from the technological universities is still low. Even YTU for instance implement only 20 new research projects a year. These include the researches carried out by MS and PhD students.

The laboratory facilities in the graduate technological universities are not up to date.

9. Major Contributors to GDP

The major contributors to GDP are Agriculture, Livestock and Fishery, Processing and Manufacturing, Construction, Mining, Forestry, Transportation and Trade.

10. Major Export

The major exports are Natural Gas, Jade, Bean, Garment, Fish, Teak, Rubber, Hard Wood, Rice

11. Major Trading Partners in ASEAN

The major trading partners of Myanmar in ASEAN are Thai, Singapore, Malaysia and Indonesia.

PHILIPPINES

1. S&T Development Policy and Strategy

Recent developments will significantly shape S&T development policy and strategy in the country. They are as follows:

- **Philippine Development Plan (PDP) 2011-2016**

  Chapter 3 of PDP entitled, "Competitive Industry and Services Sectors", enunciates that science, technology and innovation are "crucial factors for productivity, competitiveness, job creation, sustainable development and poverty alleviation"." To increase productivity and efficiency, the government shall give priority to the development of areas that have the highest growth potentials and generate the most jobs. These include: tourism; business process outsourcing (BPO); mining; agri-business and forest-based industries; logistics; shipbuilding; housing; electronics; infrastructure; and other industries with high growth potential."

  PDP also states that "the government shall continue to implement the national innovation strategy called Filipinnovation. This will enable the country to achieve (a) a competitive and multidisciplinary work force competent in producing value-added knowledge-based services of global standards; (b) competitive local firms driven by or borne out of constant innovations brought about by increased R&D; and (c) a public policy environment that ensures continuous innovation not only through executive, legislative and judicial initiatives but through local government programs. It will promote the usage of Information and Communications Technology (ICT) in enterprises. Filipinnovation focuses on: (a) strengthening human capital investments for STI; (b) stimulating STI; (c) enhancing management of the STI system; and (d) upgrading the Filipino mindset in S&T. Since the strategy/policy imperatives are interconnected, it shall be coordinated and harmonized to create necessary conditions to deepen and consolidate STI capacity."

- **Cabinet Cluster System and STI**

  To enhance horizontal governance, the Cabinet, the highest policy-making body of the Executive branch of government, has been organized thematically into Cabinet Clusters corresponding to the five (5) key result areas adopted by the Aquino Administration. These are: 1) Transparent, accountable, and participatory governance; 2) Poverty reduction and empowerment of the poor and vulnerable; 3) Rapid, inclusive, and sustained economic growth; 4) Just and lasting peace and the rule of the law; and 5) Integrity of the environment and climate change adaptation and mitigation. The Department of Science and Technology (DOST) has been designated as regular member of the Economic Development Cluster and the Climate Change Cluster.

- **DOST Five-Point Action Agenda**

  To focus its STI interventions, the DOST has adopted a 5-Point Action Agenda. These include: 1) Using S&T to address pressing national concerns and problems; 2) Developing appropriate technologies to create growth in the countryside and alleviate poverty; 3) Harnessing technology

to improve industry competitiveness; 4) Using S&T to enhance the delivery of government and social services; and 5) Developing emerging technologies to boost national competitiveness. As a strategy, DOST will adopt the program management approach to address said identified priority areas.

- **Congressional Commission on Science, Technology and Engineering (COMSTE)**

  The COMSTE, a body created jointly by the Senate and the House of Representatives, undertakes a national review and assessment of the science, engineering, and technology research and development system of the country with a view to: (a) enhancing the system's internal capability to satisfactorily implement the constitutional provisions on science and technology; (b) providing the system with the necessary funding requirement and other infrastructure support; (c) strengthening the linkages will all sectors concerned with science, and technology and engineering R&D; and (d) assisting the science and technology and engineering sector in achieving its goals and targets through policies and approaches that are consistent with the nation's development perspectives.

  Its recent initiatives focus on the creation of innovation clusters in the country to be spearheaded by the DOST. Among its proposed innovation clusters are on Algae Research and Commercialization; Cloud Computing in Cebu, Disaster Science and Management; Non-Adversarial Mining in Mindanao; Remote Sensing and Decision Support for Agriculture; and High Value Added Electronic Products.

2. Human Resources Involved in S&T

- The country's R&D workers in terms of headcount numbered some 9,325 (116 per million population) in 2002 and increased to 14,649 (165 per million population) in 2007. However, scientists and engineers engaged in R&D increased from 7,203 (90 per million population) in 2002 to 11,490 (130 per million population) in 2007.
- By sector of performance, the distribution of R&D personnel has been changing. While the bulk (42 %) of R&D workers is with the higher education sector, the share of the business enterprise has grown from 20% in 2002 to 35% in 2007.

Sector of Performance	2002	2007
All Sectors	9,325 (100%)	14,649 (100%)
Government	32.8 %	21.8%
Higher Education	43.9%	41.7%
Public HEIs	33.6%	28.1%
Private HEIs	10.3%	13.4%
Private Non-Profit	2.6%	1.4%
Business Enterprise	20.8%	35.1%

3. Infrastructure for S&T

- There are a plethora of institutions engaged in R&D. While the DOST has been mandated under the law to coordinate R&D efforts in the country, there are actually 52 government R&D institutions in 9 Departments. Only eleven of these are under the direct supervision of the DOST.
- In the higher education sector, the University of the Philippines (UP) System has 95 R&D institutes in 6 campuses all over the country. Also, there are 131 R&D institutes under the 117 state universities and colleges.
- The University of the Philippines Diliman Campus has built the Science Complex which has been envisioned to support other universities.
- Also, under the leadership of the UP College of Engineering, a consortium of 8 universities nationwide has been organized under the Engineering R&D for Technology (ERDT), a program that is being funded by the DOST.
- Multi-disciplinary approach to R&D has yet to take root in the country.

4. Funding for S&T

- GERD in 2002 amounted to 5.77 billion pesos which was 0.15 % of GDP. In 2007, GERD was pegged at 7.56 billion pesos or 0.11 % of GDP. National R&D spending has not been keeping up with economic growth.
- In 2002, the private sector accounted for the bulk (72%) of GERD and the government, 28%. In 2007, the private sector contributed 65% while the government, 35%.
- By sector of performance, the Higher Education Sector has increased its share in R&D spending from 13 % in 2002 to 23 % in 2007.

Sector of Performance	2002	2007
All Sectors	5.77 B (100%)	7.56 B (100%)
Government	16.9%	17.7%
Higher Education	13.2%	23.3%
Public HEIs	11.1%	17.6%
Private HEIs	2.1%	5.7%
Private Non-Profit	2.1%	2.1%
Business Enterprise	67.8%	56.9%

5. S&T Utilization Program

- The concept of Technology Business Incubators has been gaining ground. In the last three years, three four additional TBI facilities have been established through different partnership arrangements, DOST-ASTI-PEZA Open TBI in UP Diliman (government-led); Entrepreneurship Center at NEC of UP College of Engineering (academe-led); Tacloban IT center (Local Government-led) and the UPLB-based TBI (academe-led). TBIs are also being established in Cebu and Davao.
- The Philippine Technology Transfer Law has been enacted giving the R&D institutes the default ownership of the intellectual property arising from publicly funded R&D.
- The proposed Innovation Clusters are calculated to enhance S&T utilization all over the country.

6. **S&T Outputs**

- in 2000, there were 574 patents granted and these increased to 1,679 in 2009.
- In terms of patents applications filed in 2000,1,082 were from foreigners and 8 from nationals. Comparatively, in 2009, there were 1,082 from foreigners and 22 from nationals.
- As cited in the draft OECD Study, "OECD Review of Innovation in Southeast Asia: Innovation Performance and Linkages", the Philippines in 2000 had 17 PCT applications which grew to 32 in 2008.
- In terms of co-publications (as cited in the draft OECD Study, "OECD Review of Innovation in Southeast Asia: Innovation Performance and Linkages"), the number of co-publications by Filipinos with counterparts in other ASEAN countries have increased.

Number of Co-publications by Filipinos With Citizens from Other ASEAN Countries

Country	2000-2004	2005-2009
Indonesia	51	110
Malaysia	50	142
Singapore	50	144
Thailand	91	176
Vietnam	35	89

7. Areas of Strength in S&T/R&D

- Disaster Science and Management
- Climate Change
- Aquaculture
- Biodiversity

8. Major Contributions to GDP

These sectors identified in PDP would contribute significantly to inclusive growth and employment generation:

- Business Process Outsourcing (including knowledge process outsourcing)
- Tourism
- Electronics
- Mining
- Housing
- Agribusiness/Forest-based Industries (banana, pineapple, mango, papaya, and okra; preserved fruits; beverages; and processed marine products)
- Logistics
- Shipbuilding
- Infrastructure

9. Major Exports

- Electronic Products
- IT-enabled Services
- Automotive parts (Ignition Wiring Set & Other Wiring Sets Used in Vehicles, Aircrafts and Ships)
- Articles of Apparel & Clothing Accessories
- Coconut Oil
- Tuna
- Banana

10. Major Trading/Economic Partners in ASEAN

- Singapore
- Thailand
- Malaysia

SINGAPORE

Singapore's Input on Focus Areas under "Status of S&T Development in ASEAN"

1. S&T Policy and Development Strategy

1.1 National S&T Plans

Singapore's long term vision is to be a research-intensive, innovative and entrepreneurial economy.

Singapore has been investing significantly in R&D since the launch of the first National Technology Plan in 1991 with the aim of enhancing our economic competitiveness. There has been significant progress, with Singapore's research intensity growing rapidly. The four national science and technology plans were:

National Technology Plan (1991-1995) S$2 billion
Science & Technology Plan (1996-2000) S$4 billion
Science & Technology Plan 2005 (2001-2005) S$6 billion
Science & Technology Plan 2010 (2006-2010) S$13.9 billion.

To further boost research, innovation and enterprise (RIE), the Singapore Government will invest S$16.1 billion over 2011-2015. This is a 20% increase over 2006-2010. At 1% of the national GDP, it is on par with advanced countries. This demonstrates Singapore's sustained commitment to both basic and mission-oriented research in our public sector research institutions.

RIE2015 has five key thrusts.

First, a greater proportion of R&D will be focused on economic outcomes, so as to reap the returns from our investments. This means greater support for private sector R&D and partnerships between public sector and private sector R&D. Our aim is to leverage public sector research capabilities to catalyse more efficient private sector R&D, thereby raising business expenditure on R&D towards 2.5% of GDP by 2015.

Second, there will be greater emphasis on competitive funding as a means to select the best ideas. This will direct resources to the best research and researchers for further support and development.

Third, greater synergies between researchers across the public and private sectors will be fostered. Greater funding support will be provided to multidisciplinary, breakthrough science.

Fourth, there will be continued emphasis on basic science and knowledge as the basis for future innovations.

Fifth, we will strengthen support for commercialisation so as to spur the development of new products and services for economic and societal benefit.

Lastly, we will continue to focus on talent attraction and development, positioning Singapore as a choice location for researchers.

RIE2015 will support Singapore's long term vision is to be a research-intensive, innovative and entrepreneurial economy. We seek to be a hotbed of creativity, where innovators are inspired, and ideas realised. "Innovate in Singapore"

Research Priority Areas

Electronics

Singapore has strong capabilities in data storage and semiconductors, which have contributed to the growth and development of the electronics sector.
In **Data Storage**, Singapore has built up expertise in areas such as spintronics, media and interfaces, mechatronics and recording channels, optical materials and systems, and network storage technologies. Singapore will also increase its focus on solid state memory and data centre integrated technologies.
In **Semiconductors**, Singapore has built up strong capabilities in areas such as integrated circuit design and sub-systems, IC design, packaging, CMOS (Complementary Metal-oxide semiconductor) and MEMS (Microelectromechanical systems). In the coming years, Singapore research institutes will focus on "More-than-Moore" capabilities – system integration rather than transistor density. This will create new opportunities in diagnostics, memory devices, MEMS, sensors and actuators.

Biomedical Sciences

Singapore has strengths across the entire biomedical sciences spectrum, in areas such as bioprocess technology, human immunology, eye diseases, stem cell and cancer biology.
Singapore will continue to build up a base of clinician scientists and strengthen core capabilities in translational and clinical research to convert laboratory discoveries into new drugs, devices and diagnostics. Key therapeutic areas include cancer, neurosciences, eye diseases, cardiovascular and metabolic disorders and infectious diseases.
Nutrition and medical technology are new areas of emphasis. The former will focus on obesity and diabetes management, health and high value foods, and food manufacturing processes. The latter will draw on Singapore's clinical and engineering expertise to develop new medical devices, equipment, as well as platforms to improve healthcare.

Infocomms & Media

Singapore has built capabilities in interactive and digital media, IT, computational science, communications and multimedia technologies, cloud computing and security.

Research focus in **data analytics** will provide organisations decision-making tools based on data ranging from the spread of infectious diseases, traffic management to consumer behaviour. Consequently, **cloud computing** research is poised to be the way the next generation of IT and network services will be delivered to homes and businesses.

In **interactive and digital media,** Singapore will continue to nurture technology enterprises in virtual world and games, mobile media and rich media and publishing.

Engineering

In Precision Engineering, Singapore research institutes will advance their strong manufacturing capabilities through research in advanced materials, microfluidics, printed electronics, nano-manufacturing of multi-functional products and sustainable manufacturing.
In Transport Engineering, R&D is a key driver for growth in the Aerospace and Marine and Offshore sectors. The SERC Aerospace Consortium engages companies across entire value chain in pre-competitive research in Maintenance Repair & Overhaul (MRO), engine-related technologies, avionics and composite materials. The Aerospace Consortium includes global players such as Boeing, EADS, Pratt & Whitney and Rolls-Royce. In Marine and Offshore sector, Singapore supports research in subsea systems, specialised vessel design (including emerging clean tech and engine technology), composite materials, advanced ruggedised electronics, oil & gas equipment manufacturing and reservoir information & data acquisition.

Cleantech

Singapore has leading expertise in water and solar research, and will develop capabilities in intelligent energy systems and energy efficiency.
Large scale test bed projects such as the Cleantech Park, HDB's Eco-Town and HDB's nationwide solar test bed demonstrate Singapore's differentiation as a "living lab" to co-create, demonstrate and commercialise new-generation solutions.

1.2 National Framework for Innovation and Enterprise

Initiatives under the National Framework for Innovation and Enterprise

Overview of Framework

The National Framework for Innovation and Enterprise (NFIE) will build on the strong R&D foundation established through earlier investments in R&D to develop innovation and enterprise in Singapore. A key focus of the framework is on developing academic entrepreneurship in the IHLs. A sum of S$350 million over five years (2008 – 2012) is allocated to fund the initiatives under NFIE.

NFIE Initiatives

The NFIE initiatives are tabulated below.

Establishing Support for Academic Entrepreneurship in Universities

Establishment of University Enterprise Boards

Innovation Funds for Universities

Creating Enterprise Support Structures

Proof-of-Concept Grants

Technology Incubation Scheme

Early-Stage Venture Funding

Disruptive Innovation (DI) Incubator

Enhancing Technology Transfer

Translational R&D Grants for Polytechnics

National IP Principles for Publicly-funded R&D

Innovation Vouchers Scheme

Industry Proof-of-Concept and Technology Incubation Scheme

Supporting Innovation Policy Studies

Innovation Policy Centre

2. Infrastructure for S&T

2.1 The national Research, Innovation and Enterprise Council

The national Research, Innovation and Enterprise Council (REIC) was formed in 2006.

The mission of the RIEC is:

a. To advise Singapore Cabinet on national research and innovation policies and strategies to drive the transformation of Singapore into a knowledge-based economy, with strong capabilities in research and development (R&D); and
b. To lead the national drive to promote research, innovation and enterprise, by encouraging new initiatives in knowledge creation in science and technology, and to catalyze new areas of economic growth.

RIEC Members

The RIEC is chaired by the Prime Minister. Other members are appointed by the Prime Minister for two year terms. They comprise Cabinet Ministers and distinguished local and foreign members from the business, science and technology community.

2.2 The National Research Foundation

The National Research Foundation (NRF) was set up on 1 January 2006 as a department under the Prime Minister's Office. It was set up to perform the following:

a. To provide secretariat support to the Research, Innovation and Enterprise Council (RIEC), chaired by the Prime Minister;
b. To coordinate the research of different agencies within the larger national framework in order to provide a coherent strategic overview and direction;
c. To develop policies and plans to implement the five strategic thrusts for the national R&D agenda; and
d. To implement national research, innovation and enterprise strategies approved by the RIEC, and to allocate funding to programmes that meet NRF's strategic objectives.

The National R&D Agenda

The National R&D Agenda consists of five strategic thrusts, namely:

1. To intensify national R&D spending to achieve 3% of GDP by 2010;
2. To identify and invest in strategic areas of R&D;
3. To fund a balance of basic and applied research within strategic areas;
4. To provide resources and support to encourage private sector R&D; and
5. To strengthen linkages between public and private sector R&D.

Strategic Thrust 1

Intensify national R&D spending

Our national expenditure on R&D, including the public and private sectors, at 2.36% of GDP in 2005, lags significantly behind other leading innovative countries, such as Finland and Sweden, which spend over 3% of their GDP on R&D.

Therefore, we must intensify our R&D efforts significantly. The NRF aims to achieve a national R&D spending target of at least 3% of GDP by 2010.

Strategic Thrust 2

Focus on areas of economic importance where Singapore can be internationally competitive

As a small country, Singapore has finite resources. Thus, we need to concentrate our resources around a small number of strategic areas to develop a critical mass of research capabilities in industries where we can be economically competitive.

Building on our existing foundation, we need to deepen and broaden our capabilities in current key clusters such as electronics, chemicals, aerospace and logistics, marine engineering, and biomedical sciences, by continuing to invest in R&D and research manpower development. This will enable us to gain a strong lead and maintain our competitive advantage. We will also continually look for new growth areas to sustain our economic growth over the long-term.

Strategic Thrust 3

Provide a balance of investigator-led and mission-oriented research in strategic areas

A vibrant research environment will help us identify emerging growth areas for economic renewal. Within the selected strategic areas, Singapore must be prepared to fund a broad spectrum of research, ranging from basic investigator-led research to applied and mission-oriented research.

Mission-oriented research willcontinue to have a significant role. Such research will be closely integrated with our industry development and investment promotion strategies. They will contribute to our economic objectives by focusing resources to support our key industries and potential new growth areas.

We should also increase support for basic investigator-led research that is broadly aligned with the long-term strategic interests of Singapore. This will help build the foundation for scientific excellence, create new knowledge, develop our own talent and attract talent from overseas to live and work in Singapore.

Strategic Thrust 4

Encourage more private sector R&D

This will be a key priority, as companies are best placed to decide which areas of R&D to invest in, and to align R&D investments with commercial opportunities.

Our economic promotion agencies will therefore have a critical role to facilitate and catalyse private sector investments in research and innovation.

We will review our incentive packages to better attract more global R&D centres and activities to Singapore. This should be supported by a high quality support framework, including a strong base of scientific and research manpower, and sophisticated intellectual property protection regulations.

To achieve the 3% GDP for national R&D spending by 2010, we must leverage better on public sector funding to increase private sector research. We would aim to eventually have two-thirds of R&D spending by the private sector with the balance of R&D spending by the public sector agencies. EDB will play a critical role in rapidly catalysing a research- and innovation-driven economy, and to draw in investment projects that will complement the transformation of the economy.

Strategic Thrust 5

Strengthen nexus between R&D and business

Our institutions must improve on their ability to exploit their research results, and have closer collaboration with industry.

We will review how to strengthen our technology transfer framework, as well as how we can reach out more effectively to local enterprises - for example, by promoting technology innovation in local enterprise through stronger co-funding frameworks between public and private sector. In particular, our polytechnics, which have developed strong applied research and downstream capabilities and industry networks, could be encouraged to link up with industry associations to collaborate on R&D initiatives.

This will help to strengthen innovation and uplift the technological and manpower capabilities of our enterprises.

2.3 Scientific Advisory Board (SAB)

The terms of reference of the SAB are:

a. To highlight critical issues and emerging global trends in basic and investigator-led research where Singapore could fill a gap or meet a need;
b. To identify, with the NRF, new areas of research where Singapore can reap the benefits of cutting edge science and build the foundation for enterprise and industry growth;

c. To review and give advice on the proposals and plans prepared by the NRF;
d. To assist and advise the NRF on the management of R&D, including the allocation of funding and the assessment of research outcomes; and
e. To recommend to the NRF R&D areas that Singapore can focus on to develop new growth areas.

SAB Members

SAB members are appointed by the Chairman of the NRF Board. The SAB is co-chaired by Dr Curtis Carlson, CEO of SRI International and Prof Ulrich Suter, Emeritus Professor of the Swiss Federal Institute of Technology Zurich. It is a multidisciplinary international board with expertise in broad areas of technology. The current term of the SAB is from 1 April 2009 - 31 March 2011.

2.4 Research Centres of Excellence

Research Centres of Excellence (RCEs) are long-term investments, involving careful selection of world-class talent and aimed at developing a virtuous cycle of research excellence in our universities. These Centres will build upon the existing academic strengths and research competencies of the local universities and complement the principally mission-oriented programmes of A*STAR. The NRF and the Ministry of Education (MOE) will co-fund the establishment of a selected number of RCEs.

Vision for RCEs

The vision is for RCEs to conduct world-class investigator-led research with a global impact, focusing on areas aligned with the long-term strategic interests of Singapore. It will serve to attract top academic research talent and retain them in Singapore. At the same time, RCEs will engender interest in research among local students, and encourage more to pursue research careers. RCEs will catalyse the development of local universities into research-intensive universities and will enhance their international standing.

Objectives

RCEs serve three main objectives:

a. Attract, retain and support world-class academic investigators to perform high quality and high impact research in Singapore;
b. Enhance graduate education (and potentially undergraduate education) in the local universities and train quality research manpower for Singapore; and

c. Create new knowledge in selected areas of focus which are of strategic relevance to Singapore.

Organization

Each RCE is co-located within one of the autonomous universities in Singapore, and is headed by a Director who is an academic researcher of the highest quality, with outstanding scientific and leadership credentials. The RCE Director is committed to investigator-led research and is responsible for the hiring, mentoring and advancement of the investigators, as well as development, research performance and administration of the RCE.

The RCEs are integrated sufficiently with the host university and/or other local universities for knowledge exchange with the wider community of faculty and students, thereby ensuring a cross-flow of talent between the university and itself. This is facilitated by principal investigators (PIs) holding joint-faculty appointment (with teaching responsibilities) at the host university or one of the local universities.

RCEs accept postgraduate research students of the host universities or one of the other local universities for research and training in its laboratories.

Approved RCEs

Since 2007, five RCEs have been approved. They are:

Centre for Quantum Technologies,

Cancer Science Institute Singapore ,

Earth Observatory of Singapore,

Mechanobiology Institute and

Singapore Center on Environmental Life Sciences Engineering.

2.5 Government Research Institutes

The Agency for Science, Technology and Research (A*STAR) is a statutory board under the Ministry of Trade and Industry of Singapore. The agency was established in 1991 to foster scientific research and talent for a knowledge-based Singapore. The entities under A*STAR are the Biomedical Research Council (BMRC) and the Science and Engineering Research Council (SERC).

The research institutes and units under BMRC are:

- Bioinformatics Institute (BII)

- Bioprocessing Technology Institute (BTI)
- Experimental Therapeutics Centre (ETC)
- Genome Institute of Singapore (GIS)
- Institute of Bioengineering and Nanotechnology (IBN)
- Institute of Medical Biology (IMB)
- Institute of Molecular and Cell Biology (IMCB)
- Neuroscience Research Partnership (NRP)
- Singapore Bioimaging Consortium (SBIC)
- Singapore Immunology Network (SIgN)
- Singapore Institute for Clinical Sciences (SICS)
- Singapore Stem Cell Consortium (SSCC)

The BMRC Research Institutes focus on building up core biomedical capabilities in the areas of bioprocessing; chemical synthesis; genomics and proteomics; molecular and cell biology; bioengineering and nanotechnology and computational biology. In addition, the Institute of Medical Biology (IMB) and Singapore Institute for Clinical Sciences (SICS) focus on translational and clinical research.

Science and Engineering Council

A*STAR's Science and Engineering Research Council (SERC) promotes public sector research and development in the physical sciences & engineering.

SERC manages seven research institutes and several state-of-the art centres and facilities with core competencies in a wide range of fields including communications, data storage, materials, chemicals, computational sciences, microelectronics, advanced manufacturing and metrology to tackle global technological challenges and create future industries from its headquarters at Fusionopolis, Singapore's iconic hub for science and technology research.

The research institutes and units under SERC are:

- Bioinformatics Institute (BII)
- Bioprocessing Technology Institute (BTI)
- Data Storage Institute (DSI)
- Genome Institute of Singapore (GIS)
- Institute for Infocomm Research (I2R)
- Institute of Bioengineering and Nanotechnology (IBN)
- Institute of Chemical & Engineering Sciences (ICES)
- Institute of High Performance Computing (IHPC)
- Institute of Materials Research and Engineering (IMRE)
- Institute of Microelectronics (IME)
- Singapore Institute of Manufacturing Technology (SIMTech)
- National MetrologyCentre (NMC)

2.5 University-Based Research Institutes

The following list gives the research institutes and centres at the university level (centres at the faculty/school/department level are not included)

National University of Singapore

- Centre for Maritime Studies (CMS)
- Centre for Remote Imaging, Sensing and Processing (CRISP)
- Institute for Mathematical Sciences (IMS)
- Interactive & Digital Media Institute (IDMI)
- Life Sciences Institute (LSI)
- NUS Environmental Research Institute (NERI)
- NUS Nanoscience and Nanotechnology Initiative (NUSNNI)
- Singapore Synchrotron Light Source (SSLS)
- Solar Energy Research Institute of Singapore (SERIS)
- Temasek Laboratories (TL@NUS)
- The Logistics Institute - Asia Pacific (TLI - Asia Pacific)
- Tropical Marine Science Institute (TMSI)

Nanyang Technological Institute

- Institute of Environmental Science and Engineering (IESE)
- Nanyang Environment & Water Research Institute (NEWRI)
- Electromagnetic Effects Research Laboratory (EMERL)
- Energetics Research Institute (E*n*RI)
- Intelligent Systems Centre (IntelliSys)
- Satellite Engineering Centre (SEC)
- Thales@NTU
- Temasek Laboratories@NTU

2.6 Government R&D Funding Agencies

- National Research Fundation
- Agency for Science, Technology and Research
- Singapore Medical Research Council
- Academic Research Council
- Economic Development Board

2.7 Physical Infrastructure of R&D

Infrastructure under A*STAR

Biopolis Phase One, is a 185,000 m² biomedical complex of seven buildings was developed in 2004 at a cost of S$500 million. They are namely: Nanos, Genome, Helios, Chromos, Proteos, Matrix and Centros. Several government agencies (A*STAR), publicly-funded research institutes and research labs of pharmaceutical and biotechnological companies are located there.

Biopolis Phase Two was completed in October 2006, comprising two blocks (37,000 m^2) are named Neuros and Immunos, housed research on neuroscience and immunology respectively.

Biopolis is now expanded to Phase Three and Four.

Fusionpolis

Fusionpolis is an infrastructure and scientific platform to fuse and to synergize the knowledge for different domains; from infocomm, electronics, to engineering.

- Phase 1 of 119,000 sqm completed in 2008, houses I2R, IHPC, and companies like Vestas, Thales, Linden, and Nitto Denko.
- More than 1000 professionals in science and engineering R&D working in award winning facilities (e.g. Genexis Theatre won the President Design Award 2009)
- Phases 2A of 104,000 sqm to house DSI, IME, IMRE, SIMTech expected to complete in 2014
- Phase 2B of 50,000 sqm for Private R&D firms
- To include largest clean room in the region and cater to vibration sensitive labs
- Foster inter-disciplinary collaboration and test-bed new technologies

Campus for Research Excellence And Technological Enterprise (CREATE)
The Campus for Research Excellence And Technological Enterprise (CREATE) is an example of how Singapore has partnered selected elite international research universities and corporate labs to form a complex of world-class research centres which will have intensive research collaboration with Singapore-based universities and research institutions. CREATE offers a multi-national, multi-disciplinary research enterprise unlike anything known till now, strategically located in the heart of Asia, at the nexus of East and West. The Campus as a whole is expected to house some 1,000 young research talent at a steady state, as well as a larger churn of talent coming through Singapore to work with the best minds from all over the world gathered here. Current centres in CREATE include:

i. The Singapore-Massachusets Institute of Technology Alliance for Research and Technology (SMART) Centre;

ii. The Singapore-Swiss Federal Institute of Technology Centre for Global Sustainability (SEC)

iii. Research on Regenerative Medicine Initiative in Cardiac Restoration Therapy between Technion-Israel Institute of Technology, NTU and NUS;

iv. Technical University Munich-CREATE Centre on Electromobility in Megacities;

v. Research on Cellular and Molecular Mechanism of Inflammation between Hebrew University of Jerusalem and NUS;

vi. Berkeley Education Alliance for Research in Singapore (BEARS) between University of California at Berkeley, NTU and NUS and;

vii. Research on Nanomaterials for Energy and Water Management between Ben-Gurion University, Hebrew University of Jerusalem and NTU.

3. Human Resources Involved in R&D

3.1 R&D Manpower (year 2009)

Type of R&D Manpower	Private Sector	Government Sector	Higher Education Sector	Public Research Institutes	Total
Researchers	17,371	2,597	11,476	2,943	34,387
RSEs[#]	15,068	2,496	6,125	2,919	26,608
PhD	1,275	420	3,346	1,710	6,751
Master	3,750	897	1,237	497	6,381
Bachelor	10,043	1,179	1,542	712	13,476
Postgrad students*	-	-	5,295	-	5,295
Non-Degree	2,303	101	56	24	2,484
Technicians	1,689	462	695	717	3,563
Other Supporting Staff	1,820	733	659	226	3,438
Total	20,880	3,792	12,830	3,886	41,388

Total manpower = Total R&D Personnel
Total Researchers = 34,387 and excludes technicians and support staff

3.2 R&D Manpower (2009) in FTE

Type of R&D Manpower	Private Sector	Government Sector	Higher Education Sector	Public Research Institutes	Total
Researchers	16,267.5	1,841.5	9,699.8	2,721.4	30,530.2
RSEs	14,149.2	1,758.9	4,365.6	2,698.2	22,971.9
PhD	1,199.4	331.5	2,053.5	1,594.1	5,178.4
Master	3,529.7	558.2	923.0	449.8	5,460.7
Bachelor	9,420.2	869.2	1,389.2	654.3	12,332.7
Postgrad students*	-	-	5,295.0	-	5,295.0
Non-Degree	2,118.3	82.6	39.2	23.3	2,263.4
Technicians	1,458.2	379.7	240.4	646.5	2,724.9
Other Supporting Staff	1,582.9	591.2	292.5	174.5	2,641.1
Total	19,308.7	2,812.4	10,232.7	3,542.4	35,896.2

3.3 Research Scientists and Engineers in the past ten years (PhD, Masters and Bachelor degree holders)

Private Sector		2000	2005	2006	2007	2008	2009
	PhD	446	973	1025	1242	1246	1275
	Masters	1791	3311	3505	3780	3741	3750
	Bachelor	5760	8933	9363	9899	10362	10043

Public Sector		2000	2005	2006	2007	2008	2009
	PhD	2665	3602	3980	4395	4901	5476
	Masters	1867	2188	2278	2339	2502	2631
	Bachelor	1954	2331	2524	2851	2993	3433

4. Expenditure for R&D

4.1 Gross Expenditure on R&T

Year	2005	2006	2007	2008	2009
GERD	4,582.2	5,009.7	6,339.1	7,128.1	6,042.8
GDP ($m)	208,763.7	230,509.2	266,405.1	273,537.2	265,057.9
GERD/GDP	2.2%	2.2%	2.4%	2.6%	2.3%

4.2 Gross Expenditure, Public (Government) Expenditure and Business (Private Sector) Expenditure as Percentage of GDP)

Year	2005	2006	2007	2008	2009
GERD/GDP	2.2%	2.2%	2.4%	2.6%	2.3%
BERD/GDP	1.5%	1.4%	1.6%	1.9%	1.4%
PUBERD/GDP	0.7%	0.7%	0.8%	0.7%	0.9%

4.3 Funding for Research, Innovation and Enterprise (RIE 2015)

To further boost research, innovation and enterprise (RIE), the Singapore Government will invest S$16.1 billion over 2011-2015. This is a 20% increase over 2006-2010. At 1% of the national GDP, it is on par with advanced countries.

RIE2015 competitive Public R&D funding programmes

	Public Research Institutes	Universities and University-based Research Centres	Academic-Medical Centres and Medical Schools
Fully competitive			
National Innovation Challenge: $1,000m	√	√	√
Competitive Research Programme:$960m	√	√	√
BMS Competitive Funding: $590m	√	√	√
Singapore NRF Research Fellowships: $250m	√	√	√
Energy Efficiency Initiatives: $100m	√	√	√
Competitive amongst a subset of research performers			
Joint Council Office Programmes: $250m	√	-	-
Biomedical Sciences Research Council Industry Alignment Fund: $600m	√	-	-
Science and Engineering Research Council Industry Alignment Fund: $600m	√	√	-
Science and Engineering Research Council Public Sector Grants: $50m	√	√	-
NRF Industry Alignment Fund: $100m	-	√	-
Academic Research Fund Tier 2: $265m	-	√	√
Academic Research Fund Tier 3: $225m	-	√	√
MOH Industry Alignment Fund: $50m	-	√	√
Clinician Programmes: $580m	-	-	√

5. S&T Outputs

5.1 Patents

Patenting Indicators	Private Sector	Government Sector	Higher Education Sector	Public Research Institutes	Total
Patents Applied	1,124	39	170	236	1,569
Patents Awarded	571	6	59	111	747
Patents Owned	4,548	49	646	824	6,067

(Cumulatively as at 31 Dec 2008)

Private

	2000	2005	2006	2007	2008	2009
Patent Applied	717	1167	1561	1415	1227	1124
Patents Awarded	240	726	777	791	586	571
Patents Owned	1045	2703	3752	4664	4444	4548

Public

	2000	2005	2006	2007	2008	2009
Patent Applied	185	358	378	316	354	445
Patents Awarded	45	125	128	167	144	176
Patents Owned	223	772	965	1122	1011	1519

5.2 Revenue from R&D (S$ million)

Revenue Indicators	Private Sector	Government Sector	Higher Education Sector	Public Research Institutes	Total
Licensing Revenue from Patents and New Technologies Developed in Singapore	29.99	0.53	0.93	0.36	31.80
Sales Revenue from Commercialised Products/Processes Attributed to R&D Performed in Singapore	12,292.62	0.01	0.00	7.22	12,299.85

5.3 Peer Reviewed Publications (Year 2010)
Source: SCImago Journal and Country Rank (SJR) Based on Scopus.

Total Publications: 12,269
Number of citations: 987,384
Number of self citations: 146,174

Journal subject area:
Year 2010
SCImago Journal and Country Rank (SJR) Based on Scopus.
Total Publications: 12,352
Number of citations: 987,384
Number of self citations: 146,174

Publications in past 10 years

Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Number	4879	5112	5818	5863	7865	9552	9581	10661	11007	12352

Journal subject areas:
Agricultural and Biological Sciences
Biochemistry, Genetics and Molecular Biology
Chemical Engineering
Chemistry
Computer Science
Decision Sciences
Dentistry
Earth and Planetary Sciences
Energy
Engineering
Environmental Science
Health Professions
Immunology microbiology
Material Science
Mathematics
Medicine
Neuroscience
Nursing
Pharmacology, Toxicology and Pharmaceutics
Physics and Astronomy
Psychology and
Veterinary.

6. S&T Utilization Programmes including Indicators of Utilization

The Singapore government has announced its continued effort to spearhead commercialisation of S&T outputs. It will:

- Provide stronger support for scientists to take their ideas from basic research through to commercialisation
- Strengthen the work of Singapore's technology transfer offices, translational and innovation centres, and enterprise incubators and accelerators.

Singapore institutes, universities and centres have proactively engaged industry at all stages of the research and commercialisation continuum to convert technologies into new products and services.

Industry engagement platforms such as bilateral collaborations, R&D consortia, and Centres of Innovation are complemented by outreach platforms.

Entrepreneurial activities are nurtured through gap and seed funding, technology incubators, mentorship and role models.

6.1 Innovation and Enterprise Centres

The Standards, Productivity and Innovation Board (SPRING Singapore} is a statutory board under the Ministry of Trade and Industry of Singapore. It is the main agency for enterprise development, and it aims to enhance the competitiveness of enterprises to develop a strong base of dynamic and innovative Singapore enterprises. Five centres of innovation have been jointly established by SPRING and Singapore polytechnics and research institutions, these are:

- Centre for Food Innovation & Resource (FIRC)
- Centre of Innovation for Electronics (COIE)
- Environmental and Water Technology Centre of Innovation (EWT –COI)
- Marine and Off-Shore Technology Centre of Innovation (MOT-COI)
- Precision Engineering Centre of Innovation (PE-COI)

In 2011,

- Cloud Innovation Centre

was established at Nanyang Polytechnic with Microsoft Singapore.

- Innovation Centre (Nanyang Technological University)

The set up of the Innovation Centre was in line with the University's goal of providing education and research and transferring technology and expertise from the University to industry. The objective of having incubation units at the University is to provide strategic proximity to the University's spin-off and research collaborative companies.

- NUS Enterprise

NUS Enterprise (ETP) was established as a University-level cluster to provide an enterprise dimension to NUS teaching and research involving the University's students, staff and alumni.

The ETP strategy is to foster the development of an entrepreneurial culture in the NUS community through teaching, training, internship, and the nurturing of startup enterprises. This is done through three main divisions in ETP – NUS Overseas Colleges (NOC), Industry Liaison Office (ILO) and NUS Entrepreneurship Centre (NEC), which are supported by Corporate Services and the Business units – NUS Extension (NEX), NUS Press and NUS Technology Holdings Pte Ltd (NTH). ILO promotes industry collaboration, technology transfer and commercialisation of the University's intellectual assets and expertise.

6.2 Encourage Innovation in Enterpriese

- Innovation Voucher Scheme (SPRING Singapore)

This scheme is to encourage SMEs to engage in technology innovation projects with participating knowledge institutions. Vouchers are worth S$5,000.

- Technology Innovation Programme (SPRING Singapore)

The Technology Innovation Programme (TIP) aims to strengthen the technological innovation capabilities in SMEs. To encourage the development of technology innovation as a competitive strategy for enterprises, SPRING provides vital support and resources to help SMEs.

(SPRING Singapore is the enterprise development agency responsible for helping Singapore enterprises grow. SPRING works with partners to help enterprises in financing, capability and management development, technology and innovation, and accessing new markets.)

- GET-Up (Growing Enterprises through Technology Upgrade, A*STAR-SPRING)

GET-Up is a pro-active integrated approach aimed at boosting the global competitiveness of local technology-intensive enterprises to equip them for the knowledge-based

economy. Since its inception in 2003, over 270 research scientists and engineers have been seconded to local enterprises.

- Technical Assistance and Manpower Assistance Programmes (A*STAR, SPRING and other agencies)

    - Operation and Technology Roadmapping (OTR)

      OTR is to help the local companies improve their technology management.

    - Technology for Enterprise Capability Upgrade (T-U)

      Launched in August 2002 with the aim of helping Singapore enterprises upgrade their R&D capabilities through the secondment of experienced researchers from A*STAR Research Institutes.

    - Technical Advisory Support(TA)

      TA aims to provide a bridge between the in-depth technical advice needed by companies and the expertise available in the A*STAR Research Institutes.

- Financial Assistance Schemes

    - Innovation Development Scheme (IDS)

      IDS encourages and assists Singapore registered companies and organizations to engage in and develop capabilities in the innovation of products, processes, applications and services.

    - Local Enterprise and Technical Assistance Schemes (LETAS)

      LETAS supports generic upgrading projects for SMEs by defraying the cost of consultancy services for the implementation of IT projects.

    - Local Enterprise Finance Scheme (LEFS)

      LEFS is a fixed interest rate financing scheme to help local enterprises to upgrade, strengthen and expand their operations.

- Early Stage Technology Start-Up (NRF)

Singapore will continue to provide broad-based support for early-stage companies, especially in nascent sectors. Initiatives include investing and incubating early stage technology start-ups through the following two schemes.

- Technology Incubation Scheme (TIS)

  Provides co-funding up to 85%, up to a maximum of S$500,000 of total investments for Singapore-based high-tech startups.

- Early Stage Venture Fund (EV)

  EVF is an initiative of National Framework for Innovation and Enterprise (NFIE), driven by the NRF to seed EV to early-stage venture funds with a fund of S$50 million to support Singapore-based early stage technology startups. In 2008 NRF chose to seed the following 6 companies for a total of S$60 million

  1. BioVeda Capital II
  2. NanoStart Asia
  3. Raffles Venture Partners
  4. Tamarix Capital
  5. Upstream-Expara
  6. Walden International

7. Areas of Strength in S&T

7.1 Areas of Strength based on available expertise

Total of Private, Public and Tertiary Researchers in Areas of S&T

The areas of strength in S&T based on the number of researchers are as follows:

Field of Science and Technology	PhD	Masters	Bachelor	Non-Degree
Agricultural & Food Sciences	76	83	224	89
Biomedical & Related Sciences	1,955	870	1,543	153
Basic Medicine	153	43	140	11
Biological Sciences	998	279	548	47
Clinical Medicine	336	302	390	26
Health Sciences	153	105	116	9
Pharmaceutical Sciences & Manufacturing	138	69	149	17
Other Related Biomedical Sciences	177	72	200	43
Engineering & Technology	3,176	4,087	9,256	1,924
Aeronautical Engineering	41	42	77	6
Biomedical Engineering	234	97	133	10
Civil & Architecture Engineering	196	124	113	10
Computer Engineering	206	303	1,313	153
Electrical & Electronics Engineering	862	1,949	4,287	719
Infocommunication & Media Technology	476	544	1,033	284
Marine Engineering	43	79	157	102
Material Sciences & Chemical Engineering	712	319	522	93
Mechanical Engineering	387	608	1,572	528
Metallurgy & Metal Engineering	19	22	49	19
Natural Sciences (excluding Biological Sciences)	1,044	891	1,874	244
Chemical Sciences	363	151	269	61
Computer & Related Sciences	247	576	1,438	179
Earth & Related Environmental Sciences	116	82	89	4
Physical Sciences & Mathematics	318	82	78	0
Other Areas	500	450	579	74
Total	6,751	6,381	13,476	2,484

Basic Medicine
Biological Sciences
Clinical Medicine
Health Sciences
Pharmaceutical Sciences & Manufacturing
Aeronautical Engineering
Biomedical Engineering
Civil & Architecture Engineering
Computer Engineering
Electrical & Electronics Engineering
Infocommunication & Media Technology
Material Sciences & Chemical Engineering
Mechanical Engineering
Chemical Sciences
Computer & Related Sciences
Earth & Related Environmental Sciences
Physical Sciences & Mathematics

The areas of strength in S&T based on the number of researchers are as given in the above list.

7.2 Areas of strength based on peer-reviewed publications

year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Agricultural and Biological Sciences	146	162	193	193	228	273	290	327	378	447
Biochemistry, Genetics and Molecular Biology	333	436	550	683	895	968	1.061	1.104	1.293	1.519
Chemical Engineering	246	295	331	308	408	565	589	602	601	592
Chemistry	319	350	476	422	522	711	763	947	1.040	1.206
Computer Science	549	660	857	798	977	1.300	1.222	1.242	1.195	1.456
Decision Sciences	81	91	73	68	88	145	117	135	116	134
Dentistry	14	28	25	54	21	17	20	21	12	16
Earth and Planetary Sciences	91	94	96	87	93	91	89	111	108	140
Energy	53	48	47	51	63	74	77	111	102	123
Engineering	1.686	1.765	1.924	1.484	1.928	2.378	2.211	2.302	2.289	2.263
Environmental Science	122	147	177	195	212	245	233	247	282	277
Health Professions	17	22	25	23	24	41	37	65	52	53
Immunology and Microbiology	105	116	149	175	197	198	234	260	272	351

Materials Science	687	780	838	683	781	1.070	969	1.115	1.101	1.259
Mathematics	253	289	409	457	475	633	608	616	666	730
Medicine	734	790	1.002	1.103	1.344	1.490	1.548	1.784	1.900	2.058
Multi-disciplinary	15	23	14	31	31	38	50	69	68	84
Neuroscience	64	60	80	72	80	118	104	121	128	133
Nursing	2	6	7	8	8	18	46	39	44	61
Pharmacology, Toxicology and Pharmaceutics	50	69	83	78	141	173	147	206	162	193
Physics and Astronomy	601	585	722	688	772	1.283	1.245	1.257	1.400	1.421
Psychology	19	28	44	22	37	53	59	88	111	131
Veterinary	9	12	4	6	8	3	5	5	8	7

The areas of strength based on peer reviewed publications in year 2010 are as follows:

Agricultural and Biological Sciences
Biochemistry, Genetics and Molecular Biology
Chemical Engineering
Chemistry
Computer Science
Earth and Planetary Sciences
Engineering
Environmental Science
Immunology and Microbiology
Materials Science
Mathematics
Medicine

Pharmacology, Toxicology and Pharmaceutics
Physics and Astronomy

Source: SCIMago based on Scorpus

7.3 Areas of Strength based on Patents Granted

General S&T Area	2008	2009
Human necessities, Agriculture, food stuff, personal or domestic articles	1285	1295
Performing operations; transporting, physical or chemical processes or apparatus in general, hand-cutting tools, vehicles in general	986 1760	960 1681
Chemistry; Metallurgy organic and inorganic chemistry; treatment of water or wastes	47	51
Textile; Paper ;Yarn, treatment of textile, paper making	184 289	134 233
Fixed Construction;Construction of road, railways or bridges, hydraulic engineering	1703	1443
Mechanical Engineering, lighting, heating, weapons, machines or engines in general	1537	1443
Physics;Optics, photography, horology, nuclear physics, nuclear engineering		
Electricity; Basic electric elements, electric communication techniques		

Source: Intellectual Property Office of Singapore (IPOS)

7.4 Areas of Strength based on Centres of Excellence

7.4.1 Prior to 2000, industry-aligned capabilities in research institutes and universities were:

- KRDL – Kent Ridge Digital Lab
- CWC – Centre for Wireless Communication
- IMA – Institute of Molecular Agrobiology
- CRISP – Centre for Remote Imaging, Sensing and Processing
- CSP – Centre for Signal Processing
- ETI – Environmental Technology Institute

7.4 Singapore's major infrastructure in R&D

Biopolis

Biopolis Phase One, is a 185,000 m² biomedical complex of seven buildings was developed in 2004 at a cost of S$500 million. They are namely: Nanos, Genome, Helios, Chromos, Proteos, Matrix and Centros. Several government agencies (A*STAR), publicly-funded research institutes and research labs of pharmaceutical and biotechnological companies are located there.

Biopolis Phase Two was completed in October 2006, comprising two blocks (37,000 m^2) are named Neuros and Immunos, housed research on neuroscience and immunology respectively.

Biopolis is now expanded to Phase Three and Four.

- (Fujitsu opened it's first bio-medical focused research facility in Biopolis - Fujitsu will be working with A*STAR on the development of aptamer technology for diagnostics application and business development trials.)
- Private sector/ corporate labs: Eli Lilly (USA), Novartis (Swiss), Abbott (USA), GSK (UK), Schering-Plough (USA), Takeda (Japan), Pharmalogicals (Japan),
- Education institution Labs: Waseda Bioscience Research Institute in Singapore (WABIOS) – under Waseda University (Japan)
- Educators: Swissnex
- Foreign Govt Offices: Riken (Japan publication), Japan Science and Tech Agency (JST), British High Comm Science and Tech Office
- PharmaLogicals Research Pte Ltd was set up in 2002 as a joint venture between three Japanese companies; Chugai Pharmaceutical Co Ltd (Chugai), Biostar Research Pte Ltd (a subsidiary of Mitsui & Co Ltd) (Biostar) and the Central Institute for Experimental Animals (CIEA). PharmaLogicals research Pte Ltd was set up in 2002 as a joint venture between three Japanese companies; Chugai Pharmaceutical Co Ltd (Chugai), Biostar Research Pte Ltd (a subsidiary of Mitsui & Co Ltd) (Biostar) and the Central Institute for Experimental Animals (CIEA).

Fusionpolis

Fusionpolis an infrastructure and scientific platform to fuse and to synergize the knowledge for different domains; from infocomm, electronics, to engineering.

- Phase 1 of 119,000 sqm completed in 2008, houses I2R, IHPC, and companies like

Vestas, Thales, Linden, and Nitto Denko.

- More than 1000 professionals in science and engineering R&D working in award winning facilities (e.g. Genexis Theatre won the President Design Award 2009)
- Phases 2A of 104,000 sqm to house DSI, IME, IMRE, SIMTech expected to complete in 2014
- Phase 2B of 50,000 sqm for Private R&D firms
- To include largest clean room in the region and cater to vibration sensitive labs
- Foster inter-disciplinary collaboration and test-bed new technologies

7.5 Campus for Research Excellence And Technological Enterprise

Create is expected to house some 1,000 young research talent at a steady state, as well as a larger churn of talent coming through Singapore to work with the best minds from all over the world gathered here. Current centres in CREATE include:

viii. The Singapore-Massachusets Institute of Technology Alliance for Research and Technology (SMART) Centre;

ix. The Singapore-Swiss Federal Institute of Technology Centre for Global Sustainability (SEC)

x. Research on Regenerative Medicine Initiative in Cardiac Restoration Therapy between Technion-Israel Institute of Technology, NTU and NUS;

xi. Technical University Munich-CREATE Centre on Electromobility in Megacities;

xii. Research on Cellular and Molecular Mechanism of Inflammation between Hebrew University of Jerusalem and NUS;

xiii. Berkeley Education Alliance for Research in Singapore (BEARS) between University of California at Berkeley, NTU and NUS and;

xiv. Research on Nanomaterials for Energy and Water Management between Ben-Gurion University, Hebrew University of Jerusalem and NTU

The centres of excellence in this section are consistent with the areas of excellence in S&T R&D stated in sections 7.1 and 7.2.

7.6 NRF Centres of Excellence

Research Centres of Excellence (RCEs) are long-term investments, involving careful selection of world-class talent and aimed at developing a virtuous cycle of research excellence in our universities.

Since 2007, five RCEs have been approved. They are:

Centre for Quantum Technologies,

Cancer Science Institute Singapore ,

Earth Observatory of Singapore,

Mechanobiology Institute and

Singapore Center on Environmental Life Sciences Engineering.

The above NRF centres of excellence in this section are consistent with the areas of excellence in S&T R&D stated in sections 7.1 and 7.2.

7.6 Collaboration with Industry

Singapore's ability to move discoveries out of the lab and into clinical proof-of-concept and validation studies, as well as its diverse population phenotype for clinical trials is also highly attractive to industry and represents a key competitive advantage. The following examples are testimony to this attraction:

- The Roche-Singapore Hub for Translational Medicine (TM) that was jointly established by Roche Pharmaceuticals and Singapore in 2010 to collaborate with the BMRC RIs, hospitals and academic medical centres in Singapore. Roche signed a Master Research Collaboration Agreement (MRCA) with these research entities, and committed a total of S$130m to be spent over the next five years on R&D projects spanning basic research to clinical studies.

- The Academic Centre of Excellence (ACE) – is being established by GSK to stimulate and support research collaborations with RIs and hospitals.

These examples of major collaboration support the area of excellence in medical R&D in Singapore and are in-line with the findings of sections 7.1 and 7.2.

Source for 7.4, 7.5 and 7.6: Science and Technology Plan 2010; Research, Innovation Enterprise 2015 (RIE 2015); R&D Survey of Singapore 2009, A*STAR; National Research Foundation (NRF)

8. Capability for S&T Human Resource Development in Higher Education Institutions

Singapore has five university namely, the National University of Singapore (NUS), Nanyang Technological University (NTU), Singapore Management University (SMU), the Singapore University of Technology and Design (SUTD) and the Singapore Institute of Management University SIM University). Currently, only NUS and NTU offer postgraduate programmes in S&T and medicine. The lists of postgraduates for the past 5 years are provided below.

NTU (Exclude NIE)

	Convocation 2006		Convocation 2007		Convocation 2008		Convocation 2009		Convocation 2010	
	Qualification		**Qualification**		**Qualification**		**Qualification**		**Qualification**	
Field of S&T	PhD	Master	PhD	Master	PhD	Master	PhD	Master	PhD	Master
Agricultural & Food Science	0	0	0	0	0	0	0	0	0	0
Biomedical & Related Sciences	0	0	0	0	0	0	0	0	0	0
Basic Medicine	0	0	0	0	0	0	0	0	0	0
Biological Sciences	1	3	14	1	17	4	17	0	17	5
Clinical Medicine	0	0	0	0	0	0	0	0	0	0
Health Sciences	5	2	7	0	1	1	0	2	1	0
Phrmaceutical Sciences & Mfg	0	0	1	1	0	0	2	2	11	4
Other Related Biomedical Sciences	0	0	0	0	2	1	2	1	0	0
Engineering & Technology										
Aeronautical Engineering	0	0	0	0	0	0	0	2	1	3
Biomedical Engineering	7	1	8	5	9	6	10	3	10	5
Civil & Architecture Engineering	20	7	22	8	19	5	11	5	7	11
Computer Engineering	25	23	44	19	51	15	43	16	24	18
Electrical & Electronics	56	16	67	8	64	25	48	18	39	14

Engineering										
InfoComms & Media Technology	27	10	36	11	20	3	19	11	26	13
Marine Engineering	0	0	0	0	0	0	0	0	0	0
Material Sciences & Chemical Engineering	15	2	30	2	25	7	18	18		8
Mechanical Engineering	41	20	36	4	36	13	25	16	9	11
Metallurgy & Metal Engineering	0	0	1	0	0	0	1	1	0	0
Natural Sciences (excl. Biological Sciences)										
Chemical Sciences	0	0	1	0	0	0	0	0	0	0
Computer & Related Sciences	0	0	1	1	1	0	0	0	1	0
Earth & Related Environment Sciences	0	0	0	0	0	0	0	0	0	0
Physical Sciences & Mathematics	0	0	1	1	2	4	7	6	10	1
Other Areas										
Environmental Engineering	6	3	14	2	12	3	5	4	5	3
Interactive Digital Media Systems	0	2	0	1	2	0	1	1	1	1
Maritime	0	0	2	0	1	0	0	1	0	1
Total	**203**	**89**	**285**	**64**	**262**	**87**	**209**	**107**	**198**	**98**

Postgraduate degrees conferred by NUS

Sch	Dept	Degree Conferred	Degree Conferred /AY	06/07	07/08	08/09	09/10	10/11	Tot
2	FoE	CENTRE FOR DESIGN TECHNOLOGY	MASTER OF TECHNOLOGICAL DESIGN (EMBEDDED SYSTEMS)	22	0	0	0	0	22
3			MASTER OF TECHNOLOGICAL DESIGN (MECHATRONICS)	9	0	0	0	0	9
4			MASTER OF TECHNOLOGICAL DESIGN (RAPID PRODUCT DEVELOPMENT)	10	0	0	0	0	10
5		CENTRE FOR MGT OF SCIENCE & TECHNOLOGY	MASTER OF SCIENCE (INTELLECTUAL PROPERTY MANAGEMENT)	5	0	0	0	0	5
6			MASTER OF SCIENCE (MANAGEMENT OF TECHNOLOGY)	23	0	0	0	0	23
7			MASTER OF SCIENCE (SYSTEMS DESIGN AND MANAGEMENT)	2	0	0	0	0	2
8		CHEMICAL & BIOMOLECULAR ENGINEERING	MASTER OF ENGINEERING	12	12	6	11	17	58
9			MASTER OF SCIENCE (CHEMICAL ENGINEERING)	18	20	10	36	21	105
10			MASTER OF SCIENCE (ENVIRONMENTAL ENGINEERING)	1	0	0	0	0	1
11			MASTER OF SCIENCE(SAFETY, HEALTH & ENVIRONMENTAL TECHNOLOGY)	21	30	35	23	38	147
12			NUS-UIUC JOINT MASTER OF SCIENCE IN CHEMICAL ENGINEERING	3	0	0	0	0	3
13		CIVIL ENGINEERING	MASTER OF ENGINEERING	14	9	4	4	3	34
14			MASTER OF SCIENCE (CIVIL ENGINEERING)	39	52	57	57	34	239
15			MASTER OF SCIENCE	0	5	6	4	4	19

			(GEOTECHNICAL ENGINEERING)						
16			MASTER OF SCIENCE (TRANSPORTATION SYSTEMS AND MANAGEMENT)	8	8	10	17	14	57
17		DIVISION OF BIOENGINEERING	MASTER OF ENGINEERING	1	1	0	2	4	8
18		DIVISION OF ENGINEERING AND TECH MGT	MASTER OF ENGINEERING	0	0	2	0	0	2
19			MASTER OF SCIENCE (INTELLECTUAL PROPERTY MANAGEMENT)	0	11	7	15	9	42
20			MASTER OF SCIENCE (MANAGEMENT OF TECHNOLOGY)	0	62	54	51	60	227
21			MASTER OF SCIENCE (SYSTEMS DESIGN AND MANAGEMENT)	0	7	10	16	12	45
22		DIVISION OF ENVIRONMENTAL SCIENCE & ENGG	MASTER OF ENGINEERING	0	2	3	3	4	12
23			MASTER OF SCIENCE (ENVIRONMENTAL ENGINEERING)	17	13	27	20	15	92
24		ELECTRICAL & COMPUTER ENGINEERING	MASTER OF ENGINEERING	36	34	29	32	28	159
25			MASTER OF SCIENCE (ELECTRICAL ENGINEERING)	87	114	90	119	155	565
26		INDUSTRIAL & SYSTEMS ENGINEERING	MASTER OF ENGINEERING	4	7	9	4	5	29
27			MASTER OF SCIENCE (INDUSTRIAL AND SYSTEMS ENGINEERING)	84	85	100	81	70	420
28		MATERIALS SCIENCE AND ENGINEERING	MASTER OF ENGINEERING	0	2	2	1	3	8
29			MASTER OF SCIENCE (MATERIALS SCIENCE AND ENGINEERING)	1	21	26	11	32	91
30		MECHANICAL ENGINEERING	MASTER OF ENGINEERING	26	32	20	12	15	105
31			MASTER OF SCIENCE (MATERIALS SCIENCE AND	21	14	1	0	0	36

			ENGINEERING)						
32			MASTER OF SCIENCE (MECHANICAL ENGINEERING)	48	38	50	53	49	238
33			MASTER OF SCIENCE (MECHATRONICS)	22	30	24	23	16	115
34		NANOENGINEERING PROGRAMME	MASTER OF ENGINEERING	2	8	8	8	0	26
35		Civil & Environmental Eng	Master of Engineering	0	0	0	0	1	1
36			Master of Science (Civil Engineering)	0	0	0	0	48	48
37			Master of Science (Environmental Engineering)	0	0	0	0	19	19
38			Master of Science (Geotechnical Engineering)	0	0	0	0	6	6
39			Master of Science (Transportation Systems and Management)	0	0	0	0	9	9
40			FoE Total	536	617	590	603	691	3037
41	FoS	BIOLOGICAL SCIENCES	MASTER OF SCIENCE	14	19	15	15	22	85
42		CENTRE FOR FINANCIAL ENGINEERING	MASTER OF SCIENCE IN FINANCIAL ENGINEERING	15	0	0	0	0	15
43		CHEMISTRY	JOINT MASTER OF SCIENCE IN INDUSTRIAL CHEMISTRY	15	15	13	10	0	53
44			MASTER OF SCIENCE	17	16	19	11	18	81
45			MASTER OF SCIENCE (CHEMISTRY)	5	16	18	38	32	109
46		DEAN'S OFFICE (SCIENCE)	NUS-ANU MASTER OF SCIENCE (SCIENCE COMMUNICATION)	0	0	0	1	9	10
47			Master of Science (Industrial Chemistry)	0	0	0	0	27	27
48			Master of Science (Quantitative Finance)	0	0	0	0	16	16
49		MATERIALS SCIENCE	MASTER OF SCIENCE	6	3	0	0	0	9
50		MATHEMATICS	MASTER OF SCIENCE	14	15	6	10	15	60
51			MASTER OF SCIENCE (MATHEMATICS)	6	3	10	5	10	34
52			Master of Science (Quantitative Finance)	0	0	0	0	8	8
53		PHARMACY	MASTER OF PHARMACY	8	1	2	0	0	11

			(CLINICAL PHARMACY)						
54			MASTER OF SCIENCE (PHARMACEUTICAL SCIENCES AND TECHNOLOGY)	0	0	0	3	12	15
55			MASTER OF SCIENCE (PHARMACY)	5	6	4	2	0	17
56		PHYSICS	MASTER OF SCIENCE	9	15	6	5	7	42
57			MASTER OF SCIENCE (APPLIED PHYSICS)	6	1	1	2	11	21
58			MASTER OF SCIENCE (PHYSICS)	2	3	1	0	4	10
59		RISK MANAGEMENT INSTITUTE	MASTER OF SCIENCE IN FINANCIAL ENGINEERING	45	50	60	79	143	377
60		STATISTICS & APPLIED PROBABILITY	MASTER OF SCIENCE	3	8	10	4	4	29
61			MASTER OF SCIENCE (STATISTICS)	14	14	8	31	40	107
62			FoS Total	184	185	173	216	378	1136
63	SoC	COMPUTER SCIENCE	MASTER OF COMPUTING	1	17	6	0	0	24
64			MASTER OF SCIENCE	20	7	8	13	22	70
65		DEAN'S OFFICE (SCHOOL OF COMPUTING)	MASTER OF COMPUTING	55	45	61	87	86	334
66		INFORMATION SYSTEMS	MASTER OF COMPUTING	5	10	5	0	0	20
67			MASTER OF SCIENCE	6	2	0	4	2	14
68			SoC Total	87	81	80	104	110	462
69	YLLSoM	ANAESTHESIA	MASTER OF SCIENCE (CLINICAL SCIENCE)	1	0	0	0		1
70		ANATOMY	MASTER OF SCIENCE	2	3	0	2	1	8
71		BIOCHEMISTRY	MASTER OF SCIENCE	11	12	7	5	3	38
72		COMMUNITY,OCCUPATIONAL & FAMILY MEDICINE	MASTER OF SCIENCE	1	1	0	0	3	5
73			Master of Public Health	0	0	0	0	4	4
74		DIVISION OF GRADUATE MEDICAL STUDIES	MASTER OF CLINICAL INVESTIGATION	0	0	0	7	9	16
75			MASTER OF MEDICINE (ANAESTHESIOLOGY)	18	13	11	13	19	74
76			MASTER OF MEDICINE (DIAGNOSTIC RADIOLOGY)	11	11	14	9	17	62
77			MASTER OF MEDICINE (EMERGENCY MEDICINE)	6	8	7	11	5	37

78			MASTER OF MEDICINE (FAMILY MEDICINE)	15	14	23	14	24	90
79			MASTER OF MEDICINE (INTERNAL MEDICINE)	24	31	33	42	42	172
80			MASTER OF MEDICINE (OBSTETRICS AND GYNAECOLOGY)	2	6	0	5	6	19
81			MASTER OF MEDICINE (OCCUPATIONAL MEDICINE)	2	0	0	0	0	2
82			MASTER OF MEDICINE (OPHTHALMOLOGY)	3	1	17	12	11	44
83			MASTER OF MEDICINE (ORTHOPAEDIC SURGERY)	9	17	15	2	3	46
84			MASTER OF MEDICINE (OTORHINOLARYNGOLOGY)	2	3	6	10	6	27
85			MASTER OF MEDICINE (PAEDIATRIC MEDICINE)	11	6	2	8	10	37
86			MASTER OF MEDICINE (PSYCHIATRY)	3	8	6	5	11	33
87			MASTER OF MEDICINE (PUBLIC HEALTH)	6	0	0	0	0	6
88			MASTER OF MEDICINE (SURGERY)	32	35	11	16	9	103
89			MASTER OF NURSING	0	23	2	0	0	25
90			MASTER OF PUBLIC HEALTH	0	6	21	34	0	61
91			MASTER OF SCIENCE (SPEECH AND LANGUAGE PATHOLOGY)	0	0	18	0	18	36
92		EPIDEMIOLOGY & PUBLIC HEALTH	MASTER OF SCIENCE	0	0	2	1	1	4
93			Master of Public Health	0	0	0	0	15	15
94		GRADUATE PROGRAMME IN BIOENGINEERING-SOM	MASTER OF SCIENCE	18	8	1	1	1	29
95		MEDICINE	MASTER OF SCIENCE	2	1	1	2	1	7
96		MICROBIOLOGY	JOINT M.SC. IN INFECTIOUS DISEASES, VACCINOLOGY AND DRUG DISCOVERY	7	0	5	5	0	17
97			MASTER OF SCIENCE	9	6	5	8	18	46
98		NURSING/ALICE LEE CTR FOR NURSING STUD	MASTER OF NURSING	0	0	0	39	0	39

99		OBSTETRICS & GYNAECOLOGY	MASTER OF SCIENCE	0	0	0	2	1	3
100		OPHTHALMOLOGY	MASTER OF SCIENCE	0	0	1	0	1	2
101		ORTHOPAEDIC SURGERY	MASTER OF SCIENCE	1	0	1	0	1	3
102		OTOLARYNGOLOGY	MASTER OF SCIENCE	1	2	0	0	0	3
103		PAEDIATRICS	MASTER OF SCIENCE	2	2	1	2	2	9
104		PATHOLOGY	MASTER OF SCIENCE	0	1	1	3	1	6
105		PHARMACOLOGY	MASTER OF SCIENCE	4	2	4	2	0	12
106		PHYSIOLOGY	MASTER OF SCIENCE	1	7	4	4	5	21
107		PSYCHOLOGICAL MEDICINE	MASTER OF SCIENCE (CLINICAL SCIENCE)	1	0	0	0	0	1
108			MASTER OF SCIENCE	0	1	0	0	0	1
109		SURGERY	MASTER OF SCIENCE	0	2	0	2	1	5
110			YLLSoM Total	205	230	219	266	249	1169
111	NGS	GRADUATE PROGRAMME IN BIOENGINEERING-NGS	MASTER OF SCIENCE	0	1	0	0	0	1
112			NGS Total	0	1	0	0	0	1
113			Grand Total	1012	1114	1062	1189	1428	5805
114	Notes:								
115	AY10/11 data is accurate as at 03 Jun 2011, and includes students conferred as well as potential graduands in AY10/11 Sem 2 .								

Fac/Sch	Dept	Degree Conferred	AY06/07	AY07/08	AY08/09	AY09/10	AY10/11	Total
FoE	CHEMICAL & BIOMOLECULAR ENGINEERING	DOCTOR OF PHILOSOPHY	37	40	22	23	35	157
		NUS-UIUC JOINT PH.D. PROGRAMME	1	2	1	1	0	5
	CIVIL ENGINEERING	DOCTOR OF PHILOSOPHY	27	22	13	27	16	105
	Civil & Environmental Eng	DOCTOR OF PHILOSOPHY	0	0	0	0	15	15
	DIVISION OF BIOENGINEERING	DOCTOR OF PHILOSOPHY	0	0	5	7	12	24
	DIVISION OF ENGINEERING AND TECH MGT	DOCTOR OF PHILOSOPHY	0	0	0	1	1	2
	DIVISION OF ENVIRONMENTAL SCIENCE & ENGG	DOCTOR OF PHILOSOPHY	0	0	1	2	3	6
	ELECTRICAL & COMPUTER ENGINEERING	DOCTOR OF PHILOSOPHY	42	60	62	64	72	300
		NUS-SUPELEC JOINT PH.D. PROGRAMME	0	2	1	0	0	3
		NUS-TU/E JOINT PH.D. PROGRAMME	2	1	1	3	0	7
	INDUSTRIAL & SYSTEMS ENGINEERING	DOCTOR OF PHILOSOPHY	6	5	7	11	9	38
		NUS-TU/E JOINT PH.D. PROGRAMME	0	0	2	3	0	5
	MATERIALS SCIENCE AND ENGINEERING	DOCTOR OF PHILOSOPHY	0	0	0	2	5	7
	MECHANICAL ENGINEERING	DOCTOR OF PHILOSOPHY	30	50	34	72	42	228
		NUS-TU/E JOINT PH.D. PROGRAMME	0	0	0	1	0	1
		FoE Total	145	182	149	217	210	903
FoS	BIOLOGICAL SCIENCES	DOCTOR OF PHILOSOPHY	43	38	43	37	48	209
	CHEMISTRY	DOCTOR OF PHILOSOPHY	30	32	28	33	47	170

	MATERIALS SCIENCE	DOCTOR OF PHILOSOPHY	3	5	10	1	4	**23**
	MATHEMATICS	DOCTOR OF PHILOSOPHY	7	6	4	5	9	**31**
	PHARMACY	DOCTOR OF PHILOSOPHY	15	16	11	13	30	**85**
		Doctor of Pharmacy	0	0	0	0	5	**5**
	PHYSICS	DOCTOR OF PHILOSOPHY	10	26	14	11	30	**91**
		NUS-ANU JOINT PHD	0	0	0	1	0	**1**
	STATISTICS & APPLIED PROBABILITY	DOCTOR OF PHILOSOPHY	3	2	4	11	6	**26**
		FoS Total	**111**	**125**	**114**	**112**	**179**	**641**
SoC	COMPUTER SCIENCE	DOCTOR OF PHILOSOPHY	41	28	35	20	29	**153**
	INFORMATION SYSTEMS	DOCTOR OF PHILOSOPHY	8	6	9	4	6	**33**
		SoC Total	**49**	**34**	**44**	**24**	**35**	**186**
YLLSoM	ANATOMY	DOCTOR OF PHILOSOPHY	6	6	5	5	6	**28**
	BIOCHEMISTRY	DOCTOR OF MEDICINE	1	0	0	1	0	**2**
		DOCTOR OF PHILOSOPHY	15	14	15	22	5	**71**
	COMMUNITY,OCCUPATIONAL & FAMILY MEDICINE	DOCTOR OF PHILOSOPHY	2	1	0	0	3	**6**
		NUS-KI JOINT PHD	1	0	0	0	0	**1**
	DIAGNOSTIC RADIOLOGY	DOCTOR OF PHILOSOPHY	0	1	0	0	0	**1**
	EPIDEMIOLOGY & PUBLIC HEALTH	DOCTOR OF PHILOSOPHY	0	0	1	3	0	**4**
		NUS-KI JOINT PHD	0	0	0	1	0	**1**
	GRADUATE PROGRAMME IN BIOENGINEERING-SOM	DOCTOR OF PHILOSOPHY	4	5	7	7	7	**30**
	MEDICINE	DOCTOR OF MEDICINE	1	0	0	0	1	**2**
		DOCTOR OF PHILOSOPHY	3	7	2	2	2	**16**
	MICROBIOLOGY	DOCTOR OF PHILOSOPHY	8	13	8	2	11	**42**
	NATIONAL UNIVERSITY MEDICAL INSTITUTES	DOCTOR OF PHILOSOPHY	1	0	0	0	0	**1**
	OBSTETRICS & GYNAECOLOGY	DOCTOR OF MEDICINE	1	0	0	0	1	**2**

		DOCTOR OF PHILOSOPHY	0	3	3	0	1	**7**
	OPHTHALMOLOGY	DOCTOR OF MEDICINE	1	0	0	0	0	**1**
		DOCTOR OF PHILOSOPHY	0	0	0	2	0	**2**
	ORTHOPAEDIC SURGERY	DOCTOR OF MEDICINE	0	0	1	0	0	**1**
		DOCTOR OF PHILOSOPHY	0	1	0	0	1	**2**
	OTOLARYNGOLOGY	DOCTOR OF MEDICINE	1	0	0	0	0	**1**
		DOCTOR OF PHILOSOPHY	2	0	2	10	0	**14**
	PAEDIATRICS	DOCTOR OF PHILOSOPHY	5	9	1	2	4	**21**
	PATHOLOGY	DOCTOR OF PHILOSOPHY	0	0	1	0	5	**6**
	PHARMACOLOGY	DOCTOR OF MEDICINE	0	1	0	0	0	**1**
		DOCTOR OF PHILOSOPHY	10	7	12	8	13	**50**
	PHYSIOLOGY	DOCTOR OF PHILOSOPHY	11	6	8	15	14	**54**
	PSYCHOLOGICAL MEDICINE	DOCTOR OF PHILOSOPHY	0	0	1	1	1	**3**
	SURGERY	DOCTOR OF PHILOSOPHY	2	2	2	1	4	**11**
		YLLSoM Total	**75**	**76**	**69**	**82**	**79**	**381**
Duke GMS	Duke-NUS Grad Medical School	Doctor of Medicine	0	0	0	0	24	**24**
		Duke GMS Total	**0**	**0**	**0**	**0**	**24**	**24**
NGS	GRADUATE PROGRAMME IN BIOENGINEERING-NGS	DOCTOR OF PHILOSOPHY	0	2	0	0	0	**2**
	NGS	DOCTOR OF PHILOSOPHY	0	26	43	18	25	**112**
		NGS Total	**0**	**28**	**43**	**18**	**25**	**114**
		Grand Total	**380**	**445**	**419**	**453**	**552**	**2249**

Notes:
AY10/11 data is accurate as at 03 Jun 2011, and includes students conferred as well as potential graduands in AY10/11 Sem 2 .

9. Major Contributors to GDP

Contributions from economic sectors to GDP at current market prices (S$million).

	2007	2008	2009	**2010p**
GDP AT CURRENT MARKET PRICES	267,253.5	267,951.9	266,659.2	303,652.2
Goods Producing Industries	72,950.2	67,767.0	71,724.2	80,922.2
Manufacturing	61,039.6	52,476.8	54,128.8	63,463.9
Construction	7,901.2	11,296.6	13,675.2	12,961.5
Utilities	3,899.0	3,886.0	3,812.9	4,392.7
Other Goods Industries[1]	110.4	107.6	107.3	104.1
Services Producing Industries	170,462.4	175,311.0	169,796.7	193,215.0
Wholesale & Retail Trade	47,353.3	44,447.7	41,496.7	47,160.2
Transport & Storage	25,102.6	25,511.2	21,343.1	24,448.7
Hotels & Restaurants	5,410.5	6,010.5	5,534.6	6,320.7
Information & Communications	9,061.0	9,713.1	9,885.6	10,380.7
Financial Services	30,396.9	30,568.7	31,078.8	34,155.0
Business Services	29,944.0	34,408.2	35,089.5	40,033.4
Other Services Industries	23,194.1	24,651.6	25,368.4	30,716.3
Ownership of Dwellings	8,321.1	10,641.9	11,231.6	11,781.1
Gross Value Added At Basic Prices	251,733.7	253,719.9	252,752.5	285,918.3
Add: Taxes on Products	15,519.8	14,232.0	13,906.7	17,733.9

Share of contributions from the goods producing sector and service producing sector. The nominal added value is directly to but not exactly equal to contributions at market prices.

STRUCTURE OF ECONOMY (2010)	Nominal Added Value (% of share)
TOTAL	100%
Goods producing industry	28.3
Manufacturing	22.2
Construction	4.5
Utilities	1.5
Other goods industries	0.0
Service producing industry	67.6
Wholesale & retail trade	16.5
Transport and storage	8.6
Hotels and restaurants	2.2
Information and communications	3.6
Financial services	11.9
Business services	14.0
Other service Industries	10.7
Ownership of dwellings	4.1

Source: Economic Survey of Singapore 2010, MTI.

Details of contribution to national economy from each of the main sectors.

SECTOR	Nominal Added Value (% Share)
Manufacturing	100
Electronics	31.4
Chemicals	10.7
Biomedical manufacturing	19.6
Precision engineering	13.4
Transport Engineering	14.7
General Manufacturing industries	10.3
Transport & storage	100
Land transport	17.1
Water transport	42.4
Air transport	23.6
Storage &services allied to transport	14.0
Post and courier activities	2.9
Financial services	100
Banking	48.4
Security dealing activities	4.7
Fund management activities	8.5
Insurance	16.1
Others	22.3

10. Singapore Major Exports

	2007	2008	2009	**2010**
	Million Dollars			
TOTAL	450,627.7	476,762.2	391,118.2	478,840.7
Mineral Fuels	79,723.8	115,478.5	78,398.0	103,511.0
Petroleum Products	61,376.0	87,338.6	59,191.7	76,886.8
Non-oil	370,903.9	361,283.6	312,720.2	375,329.8
Food	4,387.2	4,903.9	4,718.2	5,455.4
Meat, Fish & Dairy Produce	1,107.2	1,131.9	808.7	965.8
Cereals, Fruits & Vegetables	578.9	573.9	533.5	597.2
Coffee & Spices	1,105.8	1,240.4	1,183.6	1,322.5
Beverages & Tobacco	2,725.1	2,923.3	2,824.6	3,256.5
Crude Materials	2,887.9	3,041.6	2,265.6	2,820.0
Rubber	514.4	576.3	293.5	658.7
Wood	145.7	134.5	82.1	81.6
Animal & Vegetable Oils	552.6	888.7	593.0	610.6
Palm Oil	237.5	369.1	282.8	275.0
Chemicals	55,615.3	48,514.1	46,597.9	56,644.3
Medicinal Products	9,482.7	7,007.4	8,377.3	8,332.1
Manufactured Goods	21,889.8	22,331.0	16,835.5	18,904.7
Veneer & Plywood	70.8	53.9	41.2	37.2
Textile Yarn & Fabrics	956.7	806.9	614.1	638.8
Iron & Steel	5,233.3	6,147.8	4,197.9	4,200.2
Machinery & Equipment	247,655.1	242,702.0	203,294.9	244,933.1
Power Generating Machines	4,904.9	7,069.7	5,758.0	5,540.9
Industrial Machines	10,671.9	10,650.9	10,215.6	8,812.4
Radio & Television Receivers & Parts	6,726.3	4,682.2	2,748.3	2,894.1
Electronic Components & Parts	108,152.5	104,273.4	91,138.5	119,327.1
Road Motor Vehicles	5,003.7	5,699.9	4,849.7	5,450.2
Ships, Boats & Oil Rigs	1,697.8	2,949.8	3,435.7	3,161.7
Miscellaneous Manufactures	29,159.1	29,885.4	27,501.7	33,410.0
Clothing	2,679.8	2,196.6	1,516.1	1,455.7
Miscellaneous	6,031.9	6,093.7	8,088.9	9,295.2

Source: Economic Survey of Singapore 2010, Ministry of Trade and Industry, Singapore

EXTERNAL TRADE

TOP 10 EXPORTS	% Share	% Growth
Electronic Valves	24.6	31.2
Refined Petroleum Products	21.2	32.2
Parts for Office & Data Processing Machines	5.3	14.0
Data Processing Machines	2.8	10.6
Telecommunications Equipment	2.6	5.1
Electrical Machinery	1.8	35.0
Electrical Circuit Appratus	1.6	16.0
Specialised Machinery	1.6	112.0
Measuring Instruments	1.4	30.7
Organo-Inorganic Compounds	1.4	-14.9
Total Exports	100.0	22.4

11. Major Trading/Economic Partners in ASEAN

Singapore External Trade with ASEAN Member Countries

Country/Year	2005	2006	2007	2008	2009	2010
Brunei Darussalam	825.7	910.8	1,048.1	1,228.1	1,257.8	1,286.2
(Exports/Imports)	247.7	348.8	211.5	267.6	135.0	178.1
Cambodia	504.8	729.9	660.5	733.7	1,038.4	3,000.3
	167.3	178.3	127.7	164.4	614.1	217.4
Indonesia	36,816.8	39,504.4	44,320.2	50,299.1	37,857.8	44,983.8
	17,400.4	23,426.0	22,068.3	24,827.5	20,659.2	22,937.1
Lao PDR	66.6	65.2	59.1	35.8	52.9	31.3
	2.4	0.9	1.9	1.3	0.4	3.8
Malaysia	50,612.3	56,372.1	58,099.6	57,638.5	44,808.5	57,114.2
	45,526.6	49,480.8	51,808.8	53,814.4	41,336.3	49,489.6
Philippines	6,969.5	8,066.5	9,224.3	10,265.2	7,312.5	9,775.3
	7,741.6	8,966.6	8,755.9	6,928.5	7,475.0	12,522.8
Thailand	15,661.6	17,944.7	18,652.9	18,612.4	14,613.0	17,283.8
	12,515.6	13,856.3	12,797.1	15,922.7	11,906.9	14,000.5
Viet Nam	7,364.0	8,665.4	9,802.5	12,279.7	10,113.7	10,061.1
	3,025.5	2,621.7	3,224.0	3,359.7	3,299.3	2,193.0

Source: Year Book of Statistics Singapore, 2011.
International Enterprise Singapore

THAILAND

Thailand S&T Status Update

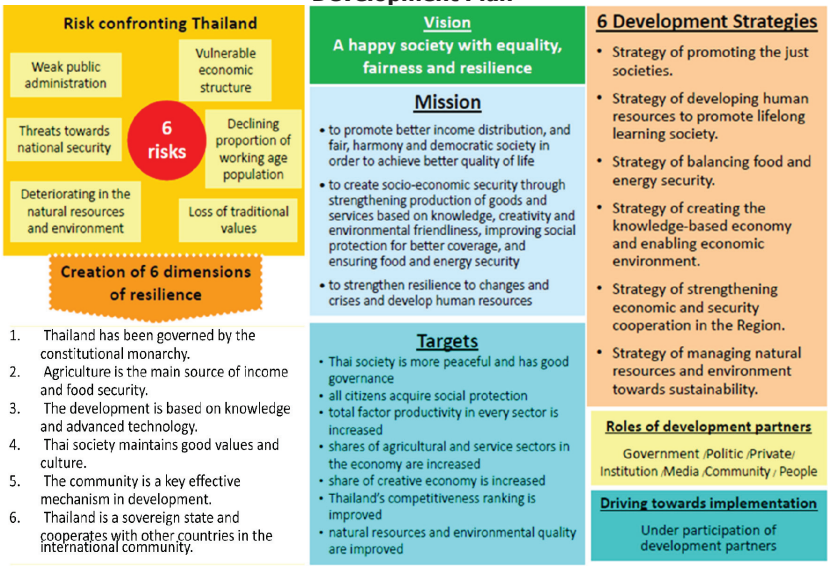
Input for the Study on the Status of S&T Development in ASEAN
(Country Visit Meeting – 5-6 September 2011)
Prepared by Kanchana Wanichkorn and Salinthip Thipayang
National Science Technology and Innovation Policy Office

1. S&T Policy and Development Strategy – this should include the latest national &T plans, laws, and innovation system framework.

1.1 Direction of the Eleventh National Economic and Social Development Plan

Always looking ahead, Thailand's National Economic and Social Development Plans have evolved continuously in accordance with the changing context of external environment and internal situations. Recognizing global challenges and risks confronting Thailand such as the ageing society, climate change, food and energy security, technological advancement, multi-polar economy and international terrorism, the framework of the Eleventh National Economic and Social Development Plan (2012-2016) is set to be driven under the people-centered development and broad-based participation approaches towards a balanced and holistic development. **It also sets a clear direction that science, technology and innovation (STI) are critical factors driving the country towards the inclusive and sustainable growth and moving the country out of the middle income trap.** The missions, objectives, targets, and strategies of the Eleventh National Economic and Social Development Plan are summarized in Figure 1.1.

Figure 1.1: Direction of the Eleventh National Economic and Social Development Plan

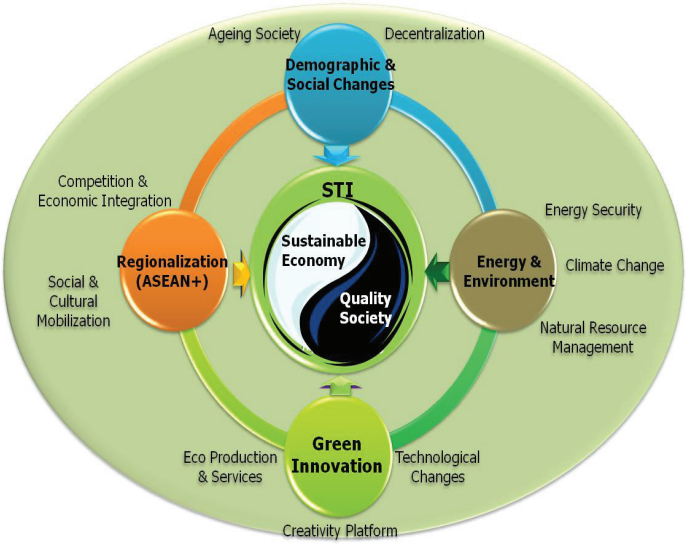


Source: The Office of National Economic and Social Development Board, 2011

1.2 Thailand's Science Technology and Innovation Master Plan 2012-2021

In line with the Eleventh National Economic and Social Development Plan, a new National Science Technology and Innovation Master Plan (National STI Master Plan) has been drafted for 2012-2021. As shown in Figure 1.2, the National STI Master Plan is designed to address four major driving forces shaping the balance of sustainable development and quality society, namely demographic and social changes, energy and environment, regionalization (ASEAN+) and green innovation. These driving forces entail many key challenging issues such as ageing society, decentralization, energy security, climate change, social and cultural mobilization.

Figure 1.2: Conceptual Framework of the National STI Master Plan - Key Issues and Driving Forces Shaping the Balance of Sustainable Economy and Quality Society



Source: National Science Technology and Innovation Policy Office, 2011

Based on the concept of "**Green Innovation** for Quality Society and Sustainable Economic Growth", the National STI Master Plan, soon to be submitted for endorsement by the cabinet, sets out five development strategies (Figure 3) consisting of three demand-led strategies of STI for development which are

Strategy 1: Empowering society and local communities;
Strategy 2: Enhancing economic competitiveness and flexibility; and
Strategy 3: Ensuring energy, resource and environmental security

and two foundation strategies for the development of STI which are

Strategy 4: Developing and enhancing STI human capital; and
Strategy 5: Promoting and supporting the development of STI infrastructure and enabling factors.

Table 1.1 summarizes the actions of each development strategy of National STI Master Plan 2012-2021.

Figure 3: Development Strategies of the National STI Master Plan

Source: National Science Technology and Innovation Policy Office, 2011

Table 1.1: Strategies and Actions of the National STI Master Plan

Strategies	Actions
1. Empowering society and local communities with STI	1. Promote STI development to empower local communities to be more eco-efficient and self-resilient 2. Support R&D in social/community enterprises and promote the use of local indigenous wisdom and clean technology to create value added to local products 3. Support R&D to improve the quality of health service and reduce dependency on imported medicine
2. Enhancing economic competitiveness and flexibility with STI	1. Promote STI development to increase productivity of agricultural, manufacturing and service sectors 2. Promote the development of green products and services for value creation

Strategies	Actions
	3. Support R&D and STI development to alleviate the impact of non-tariff barriers and increase opportunities for exports
3. Ensuring energy, resource and environmental security with STI	1. Promote the development of natural resources and environmental forecasting models 2. Promote the development and utilization of STI for adaptation and mitigation (GHG emission reduction) 3. Support R&D and utilization STI to increase the use of renewable and alternative energy 4. Promote the development of STI for natural resource and environmental management
4. Developing and enhancing STI human capital	1. Support HRD to increase the ratio of students graduated with bachelor degrees in science and technology to 60% 2. Support HRD and provide incentives to increase R&D personnel to 25 persons (FTE) per 10,000 of total population, of which 60% are in the private sector 3. Promote science awareness, STI capacity building programs and society of life-long learning
5. Promoting and supporting the development of STI infrastructure and enabling factors	1. Improve STI infrastructure and enabling factors to improve the country ranking in S&T infrastructure by IMD 2. Increase total R&D investment to 1% of GDP by 2016 and 2% by 2021 3. Develop STI infrastructure, policy incentives and legal measures such as regional science parks, national labs, tax incentives, matching grants, VC and IP management system. The goal is to stimulate R&D in the private sector to account for at least 70% of total national R&D investment by 2016.

The National STI Plan has also identified strategic economic sectors for which STI are keys to raise competitiveness. They include rice, processed food, renewable energy, rubbers, creative & digital contents, logistics, plastics & petrochemicals, electronics, fashion, automotive, tourism, and construction. The Plan also identifies strategic social issues such as STI awareness, science education, S&T for health and social/inclusive innovation.

2. **Infrastructure for S&T – the infrastructure should also include linkages (research consortia, industry-academe linkages) as well as bridging institutions such as S&T parks and technology financing companies.**

Thailand S&T Infrastructures include Science Parks, Centres of Excellence and government incentives for technical and financial supports.

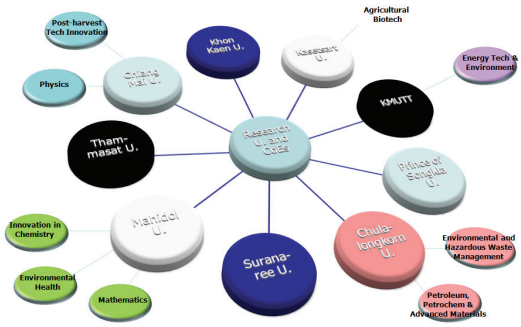
- Thailand Science Park was set up in 2002 and is managed by the Technology Management Centre (TMC) of the National Science and Technology Development Agency (NSTDA) under the Ministry of Science and Technology. There are 4 Science Parks in Thailand across all 4 regions of the country. The main Science Park is located at Khlong Luang district in Pathum Thani province and comprises of 4 main Research Centres namely:
    1. BIOTEC – National Centre for Genetic Engineering and Biotechnology
    2. MTEC – National Metal and Material Technology Centre
    3. NANOTEC – National Nanotechnology Centre
    4. NECTEC – National Electronics and Computer Technology Centre

  The first phase of the Thailand Science Park consists of over 140,000 sqm of built-up space, which has been completed and is fully occupied by the 4 national research centres and more than 60 corporate tenants. The second phase is now under construction and comprises of 4 inter-connected towers, which provides over 124,000 sqm of total floor area. Thailand Science Park is at an ideal location for companies to set up their science and technology based operations in Asia. The park provides services ranging from technology transfer from universities and technology centres, to financial assistance and business incubation. These services are readily accessible to the park's tenants as well as the private sector at large.
  Website:http://www.sciencepark.or.th/index.php?option=com_content&task=view&id=10&Itemid=377

  The other 3 regional Science Parks are namely:
    1. Northern Science Park in Chiangmai University in Chiangmai province
    2. North Eastern Science Park in Suranaree University of Technology in Nakornratchasima province
    3. Southern Science Park in Prince of Songkla University in Songkla Province

- Centres of Excellence in 9 research universities are as follows:

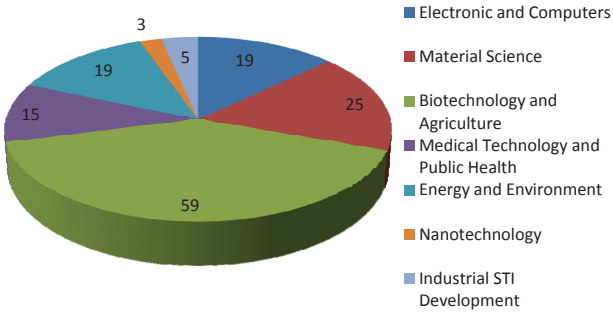
Figure 2.1: Thailand Centres of Excellence Clusters



- Chulalongkorn University
- Thammasat University
- Mahidol University
- Kasetsart University
- Chiang Mai University
- Khon Kaen University
- Prince of Songkla University
- King Mongkut's University of Technology Thonburi
- King Mongkut's Institute of Technology Ladkrabang

In addition, there are several other focused centers in universities and National Science and Technology Development Agency (NSTDA) across the country, which can be separated into 7 main sectors as shown in Figure 2.2 below. Most of these focused centres are in the Biotechnology and Agriculture sector.

Figure 2.2: Other Focused Centre in universities and NSTDA separated into 7 main sectors.



- Other technical assistance programs, financial supports and other government incentives include:

  - **Technical assistance programs**

    ITAP – Industrial Technology Assistance Programme at NSTDA is an industrial technology support program for SMEs to help them meet the challenges in introducing technology-based products and processes.

    iTAP services include:

    - Industrial Consultancy Services
    - Technical Training and Seminars
    - Techno-business Matching
    - Technology Acquisition
    - Provision of Industrial and Technology Information
    - Linkage to Other Industrial Service Organizations NSTDA

  - **Financial supports**

    Increasing private S&T investment by promoting PPP (Public Private Partnership) is the key government strategy in raising national R&D expenditure to GDP. Financial supports that Thai government gives to private companies include:

    - **CD (Company Directed Technology Development Programme) at NSTDA** – This is in the form of low interest loan to encourage the private sector to invest in R&D. The eligible

companies must have at least 51% Thai ownership, SME or large industries with considerable potential commercial impact and do not receive any grants in the same R&D project from other government's organizations. The maximum support is 30 million Baht per project and will not exceed 75% of the total project budget. Loan period should not exceed 7 years from first loan draw down. Grace period is not exceeding 2 years depending on the consideration of cooperating financial institutions. The interest rate is calculated as:

[(Bank's one year fixed deposit rate + 2.25)/2] % per annum

- **Good Innovation – Interest-free loan by NIA** (National Innovation Agency): The NIA in cooperation with 9 Thai commercial banks have provided about 8 billion baht to more than 500 companies over the past 6 years to assist their development of innovative products. The maximum loan per project is 5 million baht and the loan period is 3 years.

- **Innovation Coupon for SMEs by NIA and FTI:** NIA in cooperation with FTI (The Federation of Thai Industries) initiated this project called "Innovation Coupon" for SMEs with each supporting grant worth 800,000 baht and each project is to be completed within 1 year. The dateline to apply to this coupon is by February 2012. – **comment from the expert – Best incentive among ASEAN?**

- **Government Incentives**

  - **200% tax deduction:** In order to promote R&D investment in the private sector, the Ministry of Finance provides a 200%corporate income tax deduction for R&D spending by private enterprises.

  - **BOI - STI Programme:** This is the **BOI's Skills, Technology and Innovation Policy Programme**, which was launched in 2003 to act as a cross-sector mechanism driving the innovation. The incentives include exemptions on import tax as well as on income tax for up to 8 years. For companies located at the Thailand Science Park, BOI offers 50% income tax reduction for next profits for 5 years beyond the end of the standard 8-year corporate tax exemptions.

- **Foreign Researcher Expatriate work visa extension**: As of May 2010, work visas for foreign researchers have been extended to 4 years.

3. Human Resources involved in S&T R&D – for the purpose of uniformity, the Frascati definition will be used for the term "R&D personnel" and "researchers." If other definition is used, it should be indicated.

2-1 2546 2550

Table 2-1 R&D Personnel of Thailand for 2003 to 2007

(Item)	(R&D personnel)					
	( )			FTE(-)		
	(Headcount: persons)			(FTE: person-year)		
	2546 (2003)	2548 (2005)	2550 (2007)	2546 (2003)	2548 (2005)	2550 (2007)
[1] (R&D personnel)	76,184	67,876	73,498	42,379	36,967	42,624
- Private	12,099	11,751	12,902	7,010	7,750	8,645
- Public	64,085	56,125	60,596	35,369	29,217	33,979
(Researchers)	29,850	34,084	38,982	18,114	20,506	21,392
- Private	6,391	6,402	6,886	3,648	4,830	4,986
- Public	23,459	27,682	32,096	14,466	15,676	16,406
( )[2] (Population: million persons)	63,079,765	62,418,054	63,038,247	63,079,765	62,418,054	63,038,247
/ 10,000 (Total R&D personnel/10,000 population)	12.08	10.87	11.66	6.72	5.92	6.76
/ 10,000 (Total researchers/10,000 population)	4.73	5.46	6.18	2.87	3.29	3.39

: 1
2

Source: 1. National Research Council of Thailand and National Science and Technology Development Agency
2. Ministry of Interior

ตารางที่ 2-2 ค่าใช้จ่ายด้านการวิจัยและพัฒนาของประเทศไทยต่อนักวิจัยไทย ปี 2546 และ 2550

Table 2-2 R&D Expenditure of Thailand per Thai Researcher for 2003 and 2007

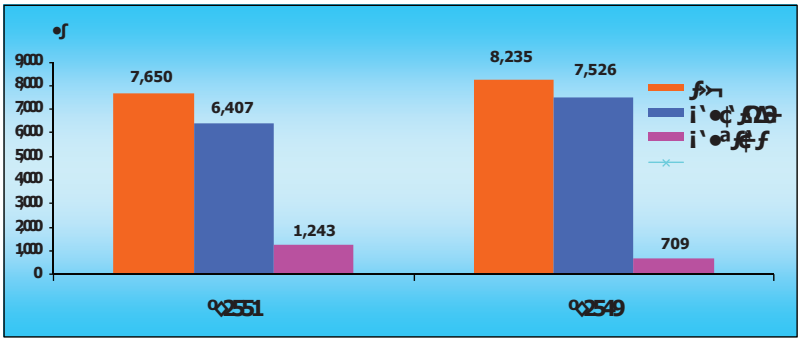
หน่วย/Unit: บาท/Baht

ค่าใช้จ่าย R&D ของประเทศต่อนักวิจัย (R&D Expenditure per Researcher)	2546 (2003)	2548 (2005)	2550 (2007)
-นักวิจัยแบบรายหัว (Researcher: headcount)	519,236	488,992	467,523
-นักวิจัยแบบทำงานเต็มเวลา (Researcher: full time equivalent)	855,648	812,776	851,954

ที่มา (Source): สำนักงานคณะกรรมการวิจัยแห่งชาติ และสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ
(National Research Council of Thailand and National Science and Technology Development Agency)

รูปที่ 2-9 บุคลากรด้านการวิจัยและพัฒนาแบบทำงานเต็มเวลาในภาคอุตสาหกรรมไทย ปี 2549 และ 2551

Figure 2-9 R&D Personnel (FTE) in Thai Industry for Year 2006 and 2008



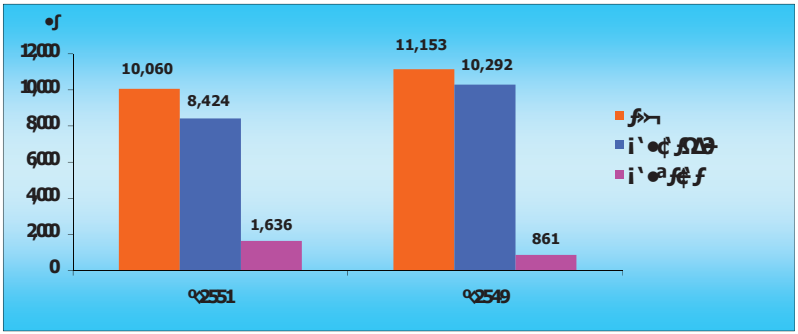
ที่มา (Source): สำนักงานคณะกรรมการนโยบายวิทยาศาสตร์ เทคโนโลยี และนวัตกรรมแห่งชาติ
(National Science Technology and Innovation Policy Office)

Table 3.1: R&D Personnel and Expenditure in Thai Industry by Industrial Sectors in 2008

Industrial Sectors	No. Of R&D Personnel in 2008	R&D Expenditure/ Million Baht
Food	1,213	667.0
Textile and Clothing	635	273.8
Wood, Paper and Printing	90	86.5
Petrochemicals	149	1,487.9
Chemicals	704	681.6
Rubber and Plastics	318	247.3
Metal and Mining	702	409.8
Machinery	634	990.5
Electronics	1,008	416.2
Medical Equipment	35	70.6
Automobiles	739	884.1
Household Furniture	180	75.0
Postal and Communication	197	130.2
Financial Intermediation	465	121.1
Computer	36	42.5
Other Research and Development	545	19.6
Total	**1,758**	**686.6**

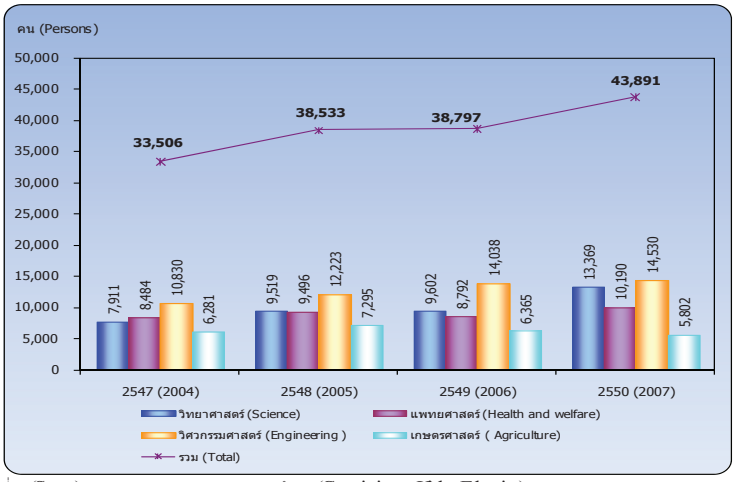
รูปที่ 2-12 บุคลากรด้านการวิจัยและพัฒนาแบบรายหัวในภาคอุตสาหกรรมไทยปี 2549 และ 2551

Figure 2-12 R&D Personnel (Headcount) in Thai Industry for Year 2006 and 2008



ที่มา (Source): สำนักงานคณะกรรมการนโยบายวิทยาศาสตร์ เทคโนโลยี และนวัตกรรมแห่งชาติ
(National Science Technology and Innovation Policy Office)

ผู้สำเร็จการศึกษาสายวิทยาศาสตร์ (Graduates in the Field of Science and Technology)



ที่มา (Source) สำนักงานคณะกรรมการการอุดมศึกษา (Commission on Higher Education)

หมายเหตุ : แพทยศาสตร์หมายรวมถึงสาขาที่เกี่ยวข้องกับสุขภาพด้วย (Include field of health and welfare)

ตารางที่ 3-4 กำลังแรงงานด้านวิทยาศาสตร์และเทคโนโลยี ปี 2550-2551 จำแนกตามระดับการศึกษา

Table 3-4 S&T Labor Force by Level of Education for 2007-2008

หน่วย/unit:

สถานภาพแรงงาน (Labor force status)	ปี (Year)							
	2550 (2007)				2551 (2008)			
	ต่ำกว่าปริญญาตรี (Lower than bachelor)	ปริญญาตรีขึ้นไป (Higher than bachelor)	อื่นๆ (Others)	รวม (Total)	ต่ำกว่าปริญญาตรี (Lower than bachelor)	ปริญญาตรีขึ้นไป (Higher than bachelor)	อื่นๆ (Others)	รวม (Total)
ผู้มีงานทำ (Total Employed)	1,527,279	1,117,028	-	2,644,307	1,661,094	1,210,895	-	2,871,989
- *ผู้ที่ทำงานด้านวิทยาศาสตร์และเทคโนโลยี (S&T employed)*	916,751	684,640	-	1,601,391	995,111	773,635	-	1,768,746
- *ตรงกับสาขาที่เรียน (S&T employed and graduated in S&T)*	713,848	473,664	-	1,187,512	762,661	498,712	-	1,261,373
- *ไม่ตรงกับสาขาที่เรียน (S&T employed and graduated in non-S&T)*	202,903	210,976	-	413,879	232,450	274,923	-	507,373
- *ผู้จบด้านวิทยาศาสตร์และเทคโนโลยีแต่ไม่ได้ทำงานด้านนี้ (Graduated in S&T but work in other fields)*	610,528	432,388	-	1,042,916	665,983	437,260	-	1,103,243
ผู้ว่างงานที่จบด้านวิทยาศาสตร์และเทคโนโลยี (Unemployed and graduated in S&T)	25,300	20,398	-	45,698	43,995	17,788	-	61,783
กำลังแรงงานด้านวิทยาศาสตร์และเทคโนโลยี (S&T labor force)	1,552,579	1,137,426	-	2,690,005	1,705,089	1,228,683	-	2,933,772

ที่มา: สำนักงานสถิติแห่งชาติ

Source: National Statistical Office

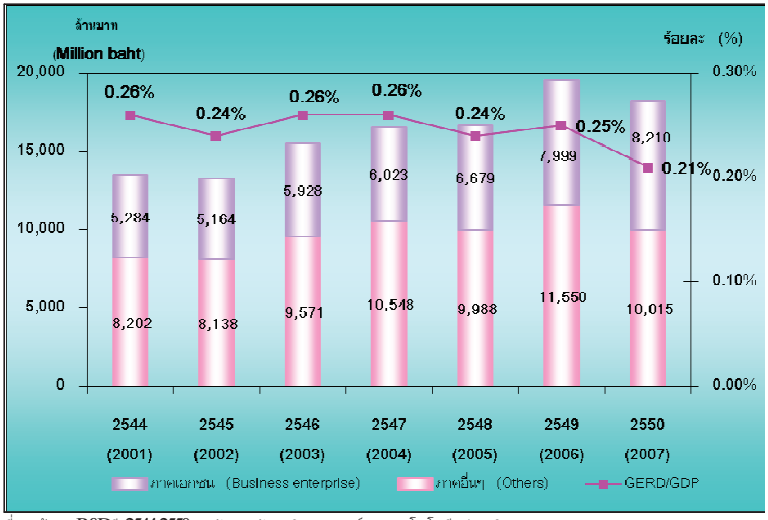
4. **Expenditures for R&D – should the amount indicated be in local currency, the Experts shall convert it to US dollar for purposes of uniformity.**

Table 4.1: R&D Expenditure Classified by Field of Research and Sector of Performance

Field of Research	R&D Expenditure (Million Baht)					
	Government	Higher Education	Public Enterprise	Business Enterprise	Private Non-Profit	Total
Natural Sciences	480.3 2.64%	1,183.4 6.49%	8.4 0.05%	2,185.7 11.99%	13.8 0.08%	3,871.5 21.2%
Engineering and Technology	741.3 4.07%	973.8 5.34%	363.0 1.99%	4,316.4 23.68%	0.0 0.00%	6,394.2 35.08%
Medical Sciences	819.4 4.50%	748.0 4.10%	25.8 0.14%	748.5 4.11%	8.8 0.05%	2,350.5 12.90%
Agricultural Sciences	893.3 4.90%	1,124.9 6.17%	22.5 0.12%	869.8 4.77%	7.9 0.04%	2,918.3 16.01%
Social Sciences	423.6 2.32%	1,752.5 9.62%	79.8 0.44%	65.5 0.36%	189.9 1.04%	2,511.3 13.78%
Humanity	11.6 0.06%	143.0 0.78%	0.0 0.00%	24.7 0.14%	0.2 0.00%	179.5 0.98%
Total	**3,369.4 18.49%**	**5,925.6 32.51%**	**499.4 2.74%**	**8,210.3 45.05%**	**220.5 1.21%**	**18,225.3 100.00%**

รูปที่ 2-3 ค่าใช้จ่ายด้านการวิจัยและพัฒนาของประเทศไทยปี 2544-2550

Figure 2-3 Thailand R&D Expenditure in 2001-2007



ที่มา: ข้อมูล R&D ปี 2544-2550: สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

ข้อมูล R&D ปี 2546-2550: สำนักงานคณะกรรมการวิจัยแห่งชาติและสำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

ข้อมูล GDP: สำนักงานคณะกรรมการพัฒนาการเศรษฐกิจและสังคมแห่งชาติ

Source: R&D data in 2001-2007: National Science and Technology Development Agency

R&D data in 2003-2007: National Research Council of Thailand and National Science and Technology Development Agency

GDP data: National Economic and Social Development Board

หมายเหตุ: ภาคอื่นๆ ประกอบด้วย ภาครัฐ รัฐวิสาหกิจ อุดมศึกษา เอกชนไม่ค้ากำไร ต่างประเทศ และไม่ระบุแหล่งที่มา

Remark: Others consist of government, state enterprise, higher education, private non-profit, aboard and not specified.

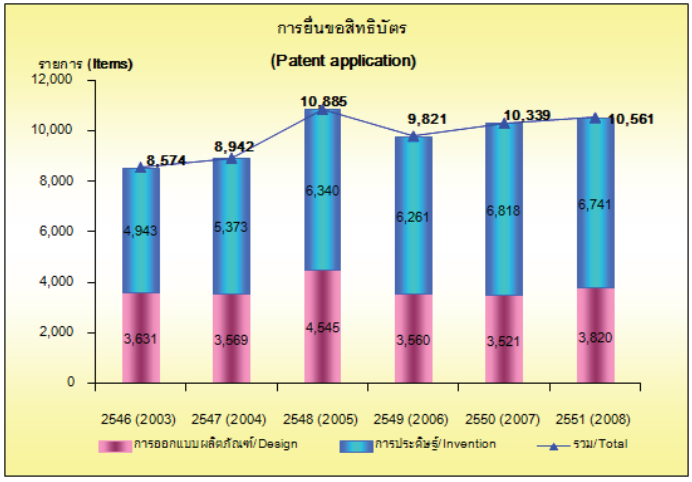
ตารางที่ 2-4 ค่าใช้จ่ายและจำนวนบริษัทที่ดำเนินกิจกรรมด้านการวิจัยและพัฒนาในภาคอุตสาหกรรมไทย ปี 2549-2551

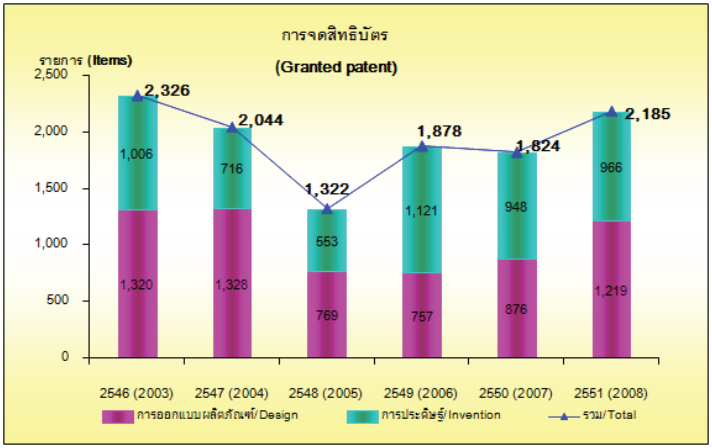
Table 2-4 R&D Expenditure and R&D Firms in Thai Industry for Year 2006-2008

ภาคอุตสาหกรรม (Industrial sector)	จำนวนบริษัททั้งหมด (แห่ง) (Total firms: firms)		จำนวนบริษัทที่ดำเนินกิจกรรมด้านการวิจัยและพัฒนา (แห่ง) (R&D firms: firms)		ค่าใช้จ่ายด้านการวิจัยและพัฒนา (ล้านบาท) (R&D expenditure: million baht)	
	2549 (2006)	2551 (2008)	2549 (2006)	2551 (2008)	2549 (2006)	2551 (2008)
การผลิต (Manufacturing)	19,800	20,868	1,008	603	6,620	6,293
บริการ (Service)	8,050	6,154	29	52	1,379	985
รวมทั้งหมด (Total)	**27,850**	**27,022**	**1,037**	**655**	**7,999**	**7,278**

ที่มา (Source): ปี 2549 : สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ (National Science and Technology Development Agency) ปี 2551 : สำนักงานคณะกรรมการนโยบายวิทยาศาสตร์ เทคโนโลยี และนวัตกรรมแห่งชาติ (National Science Technology and Innovation Policy Office)

5. S&T outputs – these include patents, publications and citations. The source of the figure should be identified e.g., Scopus, ISI, Science Engineering index (SEI), etc.





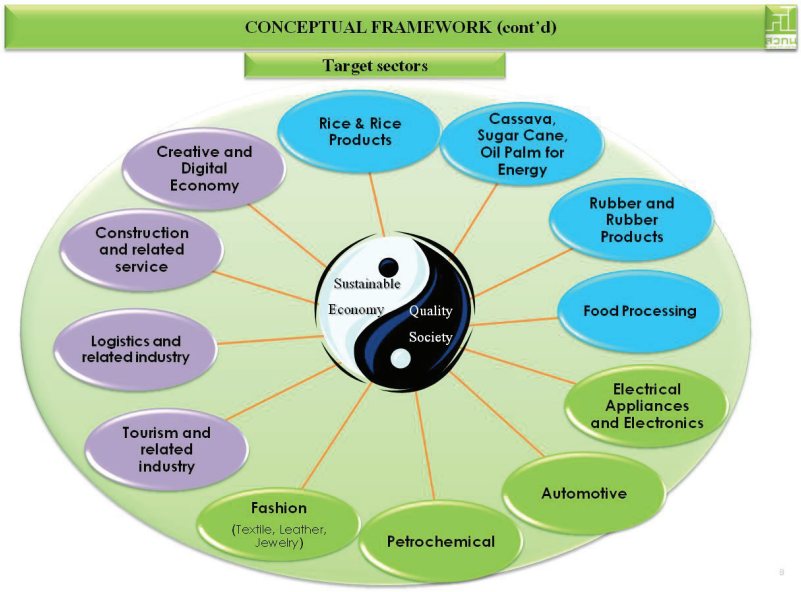
6. S&T Utilization Programs – this should include indicators of utilization in government, industry and social development.

Thailand has a clear STI policy to promote scientific research and focuses on creative and sustainable economic growth in sectors that will increase the global value chain. These sectors are highlighted in the National Science Technology and Innovation Policy (2012-2021) and can be summarised as follows;

6.1 Government utilisation programmes in the 12 economic sectors namely;

1. Rice and rice products
2. Cassava, sugarcane and oil palm for energy
3. Rubber and rubber products
4. Food processing
5. Electrical appliances and electronics
6. Automotive industry
7. Petrochemical industry
8. Fashion industry – textile, leather and jewellery
9. Tourism and related industry
10. Logistics and related industry
11. Construction and related industry
12. Creative and digital economy

Figure 6.1: Conceptual Framework – Thailand 12 target STI Sectors.



According to Thailand STI's Plan, Thailand is moving toward Sustainable Economy and Quality Society with the following 4 conceptual themes.

1. **Regionalisation with the ASEAN Economic Communities (AEC)** that will be fully integrated in 2015 and will impact all the ASEAN+ nations. Social and Cultural Mobility and Competition and Economic Integration will be the important issues that need to be considered if the 2020 vision will be realized.

2. **Green Innovation with the emphasis on Green Production and Services** (Eco Design), Creativity Platform and the Science and Technological Change. The Green Economy needs the knowledge of basic science, new emerging technology, Biotechnology, Material technology, ICT and Nanotechnology.

3. **Demographic and Social Change.** There certainly will be demographic and social changes in the next 10 years. As medical, pharmaceutical and health STI become more advances, Thai people live longer. As the results, there will be higher older citizen ratio in the country

(Aging Society). As the cities' populations increase, there is urgent need to decentralize power and create wealth in the rural areas and local communities.

4. **Energy, Food, Natural Resources and Environment.** The world natural resources especially fossil fuels and oil reserves are depleting. Thailand is the net importer of oil. Energy security, climate change and natural resource depletion are becoming more apparent. We need STI plan and policy that are well prepared to manage these issues.

Thailand's combined public and private R&D investment has not grown much over the past decade and fluctuated between 0.20% and 0.25% of GDP, which still falls short of the 1.0% average of 57 countries surveyed by IMD Business School. To avoid falling behind regional competitors and into the **"Middle Income Trap",** Thailand 11th National Economic and Social Development Plan has specified a high priority on raising total R&D investment to 1.0% of GDP, around 100 billion baht by 2016. This target is supported by the National Science Technology and Innovation Master Plan in promoting the key R&D clusters such as agro- and bio-based industries. Currently, the Public to Private R&D investment ratio is at 55%:45%. The target is to reverse this trend by increasing the Private R&D investment to 70% by 2016.

6.2 Thailand S&T Infrastructures

- **Mass Transits and Railway Development Projects**

Thailand national and local transport systems are set to be drastically transformed by new infrastructure projects. These projects include a more streamlined and highly connected mass transit system in Bangkok and other nearby provinces and major upgrades to the railway system, especially the installation of double tracks.

Table 6.1: Summary of Thailand Plans of Improving Railway System

Plan	Duration	Investment	Details
Master Plan for 12 Mass Transit Lines in Bangkok and Metropolitan Regions	2010 - 2029	830 Billion Baht	- Total length of 508 km - Cabinet Approval on 9 March 2010
5-Year Master Plan of Single Rail Track Project	2010 - 2014	176 Billion Baht	- Mostly on infrastructure upgrade - Cabinet Approval on 27 April 2010
Master Plan of	2014 – 2010		Phase 1: 767 km

Double Rail Track Project	2015 – 2019 2020 – 2024		Phase 2: 1,026km Phase 3: 1,247 km
High Speed Train Project (MOU with China)			- High speed rail connectivity emphasizing on China – Thailand railways cooperation routes - Currently in the stage of market sounding for PPP investment

Source: Ministry of Transportation, 2011

Table 6.2: Double Track Rail – Freight and Passenger Forecast

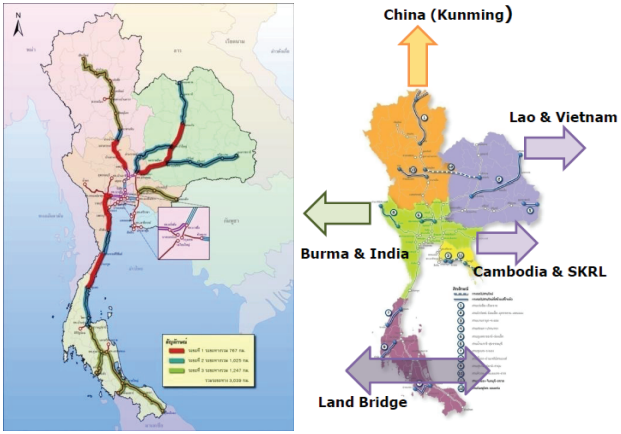
	2017	2022	2027	2032
Freight (m tones/year)				
Current	16.21	16.21	16.21	16.21
Urgent Phase	23.96	26.86	29.55	32.52
2nd Phase	-	27.91	30.71	33.79
3rd Phase	-	-	31.09	34.21
Passengers (trips/day)				
Current	138,300	156,500	161,300	161,300
Urgent Phase	175,300	198,500	220,400	245,900
2nd Phase	-	221,900	246,400	274,900
3rd Phase	-	-	277,900	310,200

Source: National Economic and Social Development Board (NESDB)

Figure : Master Plan for 12 Mass Transit Lines (2010-2029) in Bangkok and Metropolitan Regions

Source: Mass Rapid Transit Master Plan in Bangkok and Metropolitan Regions: M-MAP, http://www.otp.go.th/th/Bkk_mrt/

Figure : Double Tracks and New Railway Routes



Source: Office of Transport and Traffic Policy Planning, Ministry of Transportation

In parallel to the mass transits and railway development projects, THAIST (Thailand Advanced Institute of Science and Technology) in cooperation with BTS (Bangkok Mass Transit System), State Railway of Thailand and MRTA (Mass Rapid Transit Authority of Thailand) and have researched and studied the number of personnel required in these projects within the next 5 years to be around 3,679.

- **THEOS – Thailand Earth Observation Satellite**

The Thailand Earth Observation Satellite (THEOS) is the first operational earth observation satellite of Thailand. The THEOS program was developed by GISTDA, EADS Astrium, the prime contractor, initiated work on the satellite in 2004. On 1 October 2008, THEOS was successfully launched by Dnepr launcher from Yasny, Russian Federation. Today, GISTDA is developing a worldwide network of distributors to allow the users to use and access to all GISTDA products.

The roles of GISTDA are:

- To develop space technology and geo-informatics applications to be beneficial to the general public
- To develop the satellite data base and the derived natural resources information centre

- To provide data services relating to space technology and geo-informatics
- To provide technical services and develop human resources in satellite remote sensing and geo-informatics
- To conduct researches and development as well as to implement other activities related to space technology, including the development of small satellites for natural resources survey
- To be the core organization to establish common standards for remote sensing and geo-informatics systems

THEOS is used in the measurements of air temperature and pressure, wind direction and speed, sea surface temperature, location tracking, marine and meteorology and multi hazard monitoring.
Website: http://www.gistda.or.th/gistda_n/en/

- **Synchrotron Facility**

Synchrotron facility in Thailand is located at the Synchrotron Light Research institute (SLRI) at the Technopolis of Suranaree University of Technology in Nakhon-Ratchasima province in the north-eastern part of the country. SLRI was established as a public organization under the supervision of the Ministry of Science and Technology to operate and develop the Siam Photon Source and the Siam Photon Laboratory.

The components of a synchrotron involves different beamline structures such as slits, monochromators, focusing mirrors and other optical elements used for shaping and delivering the synchrotron light from the storage ring to the experimental stations. An experimental station, located at the end of a beamline, contains measurement systems for a specific measurement technique. SPL currently has 5 beamlines with 7 experimental stations in routine operation and 3 beamlines and 4 experimental stations under construction. The facility is used to study Small Angle X-ray Scattering (SAXS), Photoemission Spectroscopy (PES), Photoelectron Emission Microscopy (PEEM), Time-resolved X-ray Absorption Spectroscopy (Time-resolved XAS), Infra Red Spectroscopy and Imaging, X-ray Absorption Spectroscopy (XAS) and X-ray Fluorescence (XRF), micromachining beamline using Deep X-ray Lithography (DXL), X-ray Fluorescence (XRF) and Powder X-ray Diffraction (PXRD), Macromolecule Crystallography (MX) and X-ray Absorption Spectroscopy (XAS). Research institutes inside and outside Thailand can subscribe to use the facility with some fees.
Website: http://www.slri.or.th/en/

- **TISTR R&D Programmes**

TISTR (Thailand Institute of Scientific and Technological Research) is a non-

profit state enterprise under the Ministry of Science and Technology. The main R&D programmes in TISTR are in food, health, renewable energy and environment. The examples of the research topics include:

- Research and development of food products – collaboration with the German Government in promoting advisory services to enhance competitiveness of Thai SMEs in food industry. More services were offered focusing on convenience foods with the aim to provide one-stop advisory and information services through the project website: www.tistr-foodprocess.net.

- Integrated R&D on medical herb Phlai (*Zingiber cassumunar*) – The studies include utilisation of Phlai oil of different species at different production season, genetic diversity, resistance to rotten rhizome disease and R&D of patch-ointment for healing mouth ulcer.

- Development of scientific equipment for pharmaceutical and medical laboratories and cosmeceuticals from medical plants.

- Pollutant management and value added product from waste treatment plant in the community and the rural area.

6.3 Industry – Specialised estates and zones

Industrial clusters were set up at Map Ta Phut to enhance synergies and to become Thailand's new industrial heartland in the Eastern Seaboard region. The plan dated back in the early 1980s when the government attempted to draw industry away from the main Bangkok municipal area. The Ministry of Industry launched the Map Ta Phut Industrial Estate in 1989 in Rayong province and it is to be the production base for output of materials such as petrochemicals, refined oil products, natural gas products and refined metals. It is also established its own harbour, which has become the busiest industrial port in Thailand.

Industrial estates are important for the sustainable development because it is easier to control the pollution and environmental impacts when many factories concentrate within estates rather spread out in many areas. The outlook for new development is to transform ordinary industrial estates into eco-industrial towns with superb environmental protection and corporate social responsibility.

6.4 Social and Local Community Development

The Ministry of Science and Technology has initiated several projects to promote the use of science and technology for social and local community

development. For example,

1. "Science and Technology Villages", initiated in 1987 with nine pilot villages, the Ministry of Science and Technology has expanded the science and technology villages program to cover 160 villages around the country in 2010 (see Figure 6.1). Experts are provided to assist the villagers to integrate modern science and technology with their local know-how to enhance productivity and improve quality of life. The activities were quite varied depending on the local needs, which may include programs such as soil improvement, water management, food preservation, bio-energy production, environmentally-responsible farming system, and knowledge management of local wisdom and arts. (http://sciencevillage.most.go.th/)

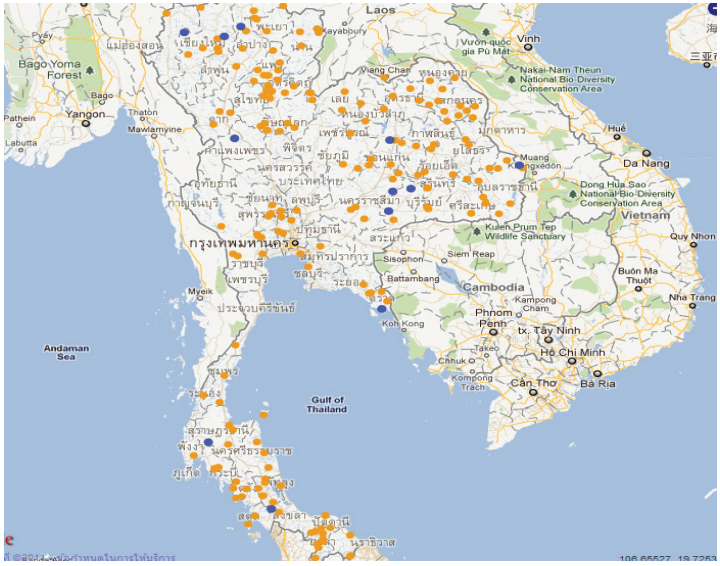


Figure 6.4: Locations of 160 Science and Technology Villages

2. "Technology Clinic" project which provides technology consulting and R&D services to business enterprises and individuals. Currently, there are more than 180 enterprises in 59 provinces around the country participating in this project. The Ministry of Science and Technology has also coordinated with community centers in rural areas to set up technology clinics for farmers. So far more than 6,300 farmers around the country have used the service. (http://www.clinictech.most.go.th/)

3. "Inclusive Innovation" Project. The National Science, Technology and Innovation Policy Office is currently working with the World Bank and a number of local partners such as the National Science and Technology Development Agency and King Mongkut's University of Technology Thonburi to develop policy recommendations on innovation systems to promote inclusive growth and diffuse innovations by grassroots entrepreneurs. With an aim to have each of the country's 7255 tambons (districts) benefit through the "One Tambon, One Product" policy, the National Science and Technology Development Agency hopes to develop at least 10 model science communities, 12 concepts from local wisdom and create at least 60 prototype technologies or services to assist elderly and disabled Thais through this scheme.

6.5 Other Key Activities to Foster Green Innovation

Embracing the concept of green innovation for sustainable development, a number of key activities have been ongoing in Thailand as outlined in this section.

6.5.1 Energy Policy and Development Agenda

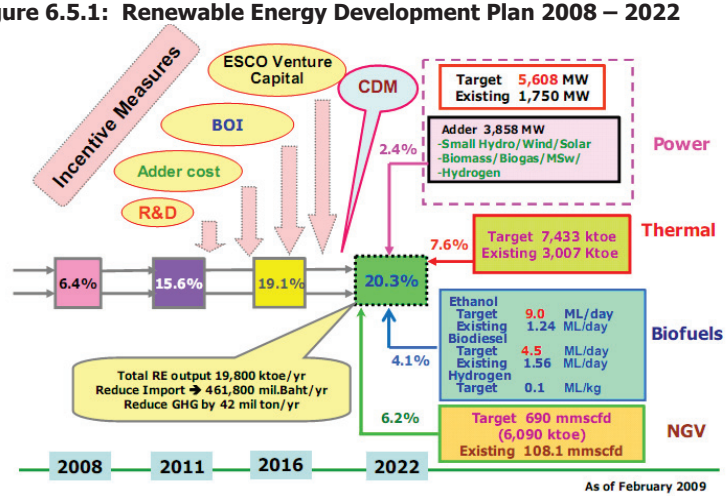
a) Renewable Energy Development Program

Given the impact of highly volatile oil prices on economic development in Thailand, a 15-year Renewable Energy Development Plan was developed by the Department of Alternative Energy Development and Efficiency (DEDE) to reduce dependency on imported oil. The objectives of this plan are

1) to utilize renewable energy as a major energy supply to replace oil imports;
2) to increase energy security;
3) to promote utilization of green energy in communities and enhance development of the renewable energy technology industry; and
4) to promote research and development of highly efficient renewable energy technologies.

The plan targets an increase in the share of renewable energy to 20% of the final energy mix by 2022. As shown in Figure 6.5.1, the renewable energy development plan (REDP) is divided into 3 phases. In the short-term (2008 – 2011), the focus is on promotion of commercial renewable energy technologies and potential energy sources such as biofuels, co-generation from biomass. For medium-term (2012 – 2016), the plan emphasizes on development of renewable energy technology industry and encourage new renewable energy R&D to achieve economic viability including new technologies for biofuels production. This includes the introduction of a model development for a Green City. In the long term (2017 – 2022), the plan aims to promote utilization of new renewable energy technologies, to extend green city modes throughout Thai communities.

Figure 6.5.1: Renewable Energy Development Plan 2008 – 2022



Source: Renewable Energy Development Plan 2008 – 2022, Department of Alternative Energy Development and Efficiency, Ministry of Energy

b) Energy Efficiency Improvement Program

Another key emphasis in Thailand's energy policy and development agenda is in energy efficiency improvement. National Energy Efficiency Plan has recently been developed to cover a period of 20 years from 2011 to 2030. The main highlights of the plan are as follows:

- Reduce the energy elasticity from 0.98, which is the average figure from the last 20 years, to 0.7 in the year 2030;
- Reduce the energy intensity by 25% in 2030;
- Apply five strategies to accelerate the plan;
  (1) Apply the compulsory program with strong regulation and standard, e.g., mandatory labeling or minimum energy performance standards (MEPS),
  (2) Apply complimentary program including voluntary agreement including demand side management and energy service company,
  (3) Encourage and realize the behavioral change in energy consumption in the widespread society, e.g., low carbon economy concept or eco-driving,
  (4) Support the technology development and innovation in efficient devices/appliances,
  (5) Capacity building and institutional arrangement from both public and private entities.

As summarized in Table 6.5.1, total cumulative energy savings from this plan is estimated for 290,000 ktoe and the avoided carbon dioxide from energy consumption is expected around 980 million tonnes from 2011 to 2030.

Table 6.5.1: Expected average energy saving and avoided CO_2 from Energy Efficiency Plan

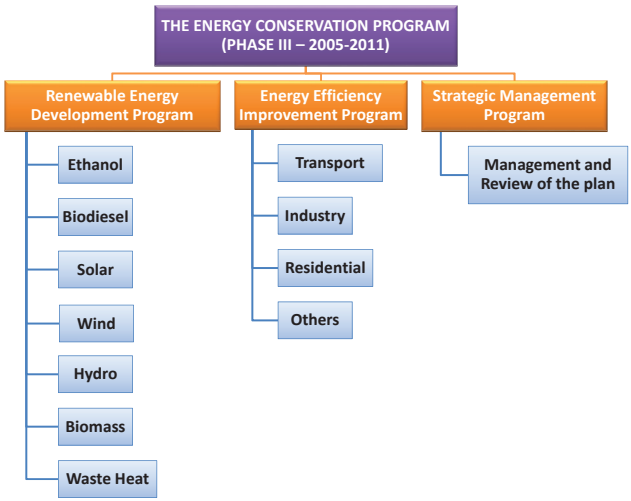
Economic sector	Average energy saving per year (ktoe)		Average avoided CO_2 per year (million tonnes)	
	2011-2015	**2011-2030**	**2011-2015**	**2011-2030**
Transport sector	1,300	6,400	4	20
Industry sector	1,120	5,500	4	17
Commercial and residential sector				
- Large scale commercial sector	220	1,100	1	6
- SME and residential sector	320	1,500	1	6
Total	**2,960**	**14,500**	**10**	**49**

Source: Energy Efficiency Plan 2011-2030, Energy Policy and Planning Office, Ministry of Energy

c) Energy Conservation Policy

Since 1995, with direct granted from Energy Conservation Promotion Fund (ENCON Fund) Thailand has launched three phases of energy conservation programs. As shown in Figure 6.5.2, the current third phase covers three different programs which are renewable energy development program, energy efficiency program, and strategic and administration program. In addition, a number of energy saving initiatives have also been launched to stimulate decision-making of entrepreneurs to implement energy efficiency improvement such as Revolving Fund for Energy Efficiency and Renewable Energy projects, Energy Service Company (ESCO) Venture Capital Fund, and Tax Incentives for Energy Savings.

Figure 6.5.2: Structure of the Energy Conservation Program on Phase III (2005-2011)



Source: Energy Conservation Program 2005-2011, Energy Policy and Planning Office, Ministry of Energy

6.5.2 Climate Change Technology Needs Assessments for Thailand

Thailand has been recently selected by the Global Environment Facility (GEF) as one of the 15 countries to receive GEF fund to conduct research to identify Climate Change Technology Needs Assessments (TNA) for the country. Results from this project will be submitted to the United Nations Framework Convention on Climate Change, Conferences of the Parties (UNFCCC COP) to improve Technology Needs Assessments within the framework of the UNFCCC. Experiences gained during the project implementation will also be shared amongst participating countries to enhance cross-country learning and used to develop guidelines for the second round countries to receive funds from GEF. The project involves three main activities which are

1. Prioritize Technologies for Mitigation and/or Adaptation. The process for prioritizing technologies for mitigation starts with identification of the country's development and sustainability priorities, with particular attention to Green House Gas (GHG) emission reduction potentials. This is followed by identification of priority sectors and the basis of the GHG emission reduction potential and contribution from low-carbon technology investments in these sectors to sustainable development. As in case of adaptation, the process involves prioritizing sectors and developing a portfolio of prioritized technologies for adaptation. Technologies could be

hard technologies involving equipment and infrastructure investment, or soft technologies, i.e. insurance schemes and crop rotation for adaptation.

2. Carry out market assessment and analyze barriers and develop an enabling framework for deployment and diffusion of prioritized technologies. This work includes policy analysis, financial analysis, legal and institutional analysis, market assessment and mapping to identify barriers hindering the acquisition, deployment, and diffusion of prioritized technologies. Recommendations will then be developed on enabling frameworks (both internal and external) for the adaptation of prioritized technologies.

3. Prepare a Technology Action Plan (TAP). This contains an action plan for deployment and diffusion of identified technologies in the country as well as enabling frameworks to overcome the barriers and facilitate the transfer, adoption, and diffusion of selected technologies.

The scope of project covers four areas which are 1) technology needs assessments in energy sector, 2) technology needs assessments for water resource management, 3) technology adaptation in agricultural sector, and 4) modelling of climate change. Sample preliminary results from the technology needs assessments for water resource management study are shown in Table 6.5.2.

Table 6.5.2: Prioritized Technologies for Water Resource Management in the Context of Thailand's National Policies and Strategies

National Policy	Strategies	Selected Technologies
1. National Strategy on Climate Change Management 2008-2012	Build capacity to adapt and reduce vulnerabilities to climate change impacts	- Weather & hydrological modeling: Long range forecasting - CWRM: Survey and mapping, including community stream water flow concept diagram -Flood and drought risk management: Nonstructural technologies/practices for risk reduction -Early Warning: Sensor web using observation and/or modeling data -Weather & hydrological modeling: Long range forecasting -Flood and drought risk management: Structural technologies/practices for risk reduction (irrigation structure/ rubber dam), Nonstructural technologies/ practices for risk reduction, Strategies for developing and managing secondary and emergency water resources (including conjunctive use)

National Policy	Strategies	Selected Technologies
		- CWRM: Survey and mapping, including community streamwater flow concept diagram, Engineering enhancement to increase efficiency in local water management (including rain harvest and wind break)
	Support R&D to better understand climate change, its impacts, and adaptation and mitigation options	Environmental observation: Automatic telemetry
2. National Water Policy Framework	Develop water network system connecting water resource-flood area-drought area and increase capital water supply and storage capacity	-Flood and drought risk management: Structural technologies/practices for risk reduction (irrigation structure/ rubber dam), Nonstructural technologies/ practices for risk reduction
	Build capacity for water resource management by supporting IT use and data collection and maintenance of infrastructures	- Environmental observation: Automatic telemetry - Operation of Water Infrastructures: Networking (via pipes or canals) and management of infrastructures (including zoning) -Flood and drought risk management: Nonstructural technologies/ practices for risk reduction - CWRM: Survey and mapping, including community streamwater flow concept diagram, Engineering enhancement to increase efficiency in local water management (including rain harvest and wind break)

Source: Draft Report of Technology Needs for Water Resource Management, Hydro and Agro Informatics Institute, July 2011

6.5.3 Promotion of Green Industry and Eco-Industrial Towns

Ministry of Industry has recently announced a Green Industry Project that will support small and medium sized enterprises (SMEs) to develop in sustainable manner by achieving 5 levels of Green Industry Development as shown in Figure 6.5.5. Companies who can achieve all five levels within the year 2014 will be awarded the Green Industry Mark (GI Mark), which makes them eligible for maximum benefits offered by Thailand Board of Investment (BOI). In the future, the project will be expanded to offer "Green Loans", issue a "Green Directory", and factor into government procurement processes.

Figure 6.5.5: Five Levels of Green Industry defined by Ministry of Industry

Source: Thailand Board of Investment, http://www.boi.go.th:8080/issue/201105_21_5/162.htm

Moreover, the Ministry of Industry is also preparing the second phase of the green industry development project. It targets 700 products to be certified with a carbon footprint label. The project will focus on 30 industries to undertake green production. The aim is to ensure the acceptance of Thai products in international markets.

Along the same principle, the Industrial Estate Authority of Thailand (IEAT) plans to turn its 42 industrial estates into eco-industrial towns within the next decade. Eco-industrial towns will allow every sector to participate in drawing up a development plan that incorporates environmental and health concerns with labour and community issues. An eco-industrial town differs from a traditional industrial estate as it allows all stakeholders, especially communities, to play a role in its development. The plan, which represents co-operation between the IEAT and the Federation of Thai Industries (FTI), is currently in the process of being drafted. Some projects have already begun including the Green Star project, where villagers are participating in assessing the environment in the industrial estates. While eco-industrial estates should use resources efficiently and recycle waste as a matter of policy, eco-industrial towns go a

step further by building networks with the local communities and people living and working on the estates. The first phase will focus on developing 15 pilot eco-industrial towns by 2014. Phase two will expand the areas to be developed between 2015 and 2019. The IEAT has already approved a budget of 478 million Baht to improve security measures at the Map Ta Phut Industrial Estate.

7. Areas of Strength in S&T – includes all areas related to S&T such as medicine and health. All Member States are welcome to suggest to the Experts available materials that may be useful such as Peter Haddaway's study on ASEAN and the OECD Review of Innovations in Southeast Asia.

***** **See also Attachment 1: "Benchmarking Thailand's Research Peformance " by Dr. Peter Haddawy******

Eight major science and technology indicators of Thailand are analyzed and compared with those of other countries. The main purpose in doing so is to present the status of science and technology (S&T) in Thailand, to point out the strengths and weakness, and to facilitate S&T policy formulation. Summary of each indicator is as follows:

1. Competitiveness Ranking

The 2008 World Competitiveness Yearbook of the International Institute for Management Development (IMD) ranks Thailand's scientific infrastructure as the 37th of total 55 countries, which sharply increased from the 49th in 2007 and technological infrastructure as the 43rd, which slightly increased from the 48th in 2007. Also, in the same year the World Economic Forum (WEF)' s Global Competitiveness Report ranks Thailand's innovation and sophistication as the 34th of total 134 countries.

2. Research and Development

Thailand's gross expenditure on research and development (GERD) in 2006 was about 19,548 million baht, while its percentage of the gross domestic product (GDP) is 0.25, slightly increased from 0.24% of the previous year.

With regard to R&D personnel (calculated as full-time equivalent: FTE) in 2005, there were 36,967 person-years, or 5.92 person-years per 10,000 population. The number dropped by 12% from 6.72 of the year 2003.

3. Science and Technology Personnel

The number of new graduates in the field of science and technology at all degree levels in 2006 was 184,497 persons. Of which, those with qualification lower than bachelor degree level accounted for about 53.6%; with bachelor degree level,

41.5%; with master degree level, 4.3%; and with doctorate level, 0.6%.

In terms of S&T labor force in 2007 there were about 2.7 million people with qualified education in S&T. Of which 98% had employment. However, it was found that considerate proportion of S&T graduates did not work in S&T field. About 1.04 million S&T graduates (or 38% of totalS&T labor force) worked in non-S&T fields. The top three popular non-S&T occupation were salespersons and demonstrators, fashion models (21%), general managers (17%) and office clerks (14%).

4. International Flow of Technology

From 1995 to 2004 Thailand continuously experienced deficit balance of payment regarding high-technology trade. The value of imports was on average US $2,500 million (at constant price year 2000) per year which was higher than that of exports in the same period. In 2005, Thailand's high-technology imports and exports were about US $37,000 million and US $34,000 million (at constant price year 2000). Radio, television and communications equipment had the highest value of import (US $ 18,952 million at constant price year 2000) and export (US $19,037 million at constant price year 2000).

In terms of technology balance of payment, Thailand's deficit has continuously increased since 2004. Although the earning from technology in 2007 took up to 45,815 million baht, the foreign technology fee was 178,504 million baht.

5. Patents and Petty Patents

In 2007, there were 10,339 patent applications in Thailand (5% increased from 2006) and 1,824 granted patents (3% decreased from 2006). Out of the granted patents, 876 patents were for product design and 948 patents were for invention. A majority (62%) of patents for product design were granted to Thais, whereas a majority (88%) of patents for invention was granted to foreigners.

In 2007, the number of petty patent applications in Thailand was 1,435 (44% decreased from the previous year). The number of petty patents granted was 902 (an increased of 14% from 2006). Most of the petty patents (94%) were granted to Thais.

6. Scientific and Technological Publication

In 2007, there were 3,796 S&T papers published in Thai journals (2.9% increased from 2006). The total number of citations was 2,057 (9.8% increased from 2006). Mahidol University had the highest share of 602 papers.

The number of papers published in the Science Citation Index (SCI) by Thais was 4,215 in 2007 (37% increase from 2006of 3,075 papers). Mahidol University researchers had the highest share of 1,002 papers. The majority of papers (1,439

papers) were in Medical Sciences. Papers from Mahidol University appeared to have the highest ratio of citations per publication (0.84 times per paper).

7. Information and Communication Technology

In 2007, the number of available fixed line telephones in Thailand was 9.3 million (14.7 lines per 100 people). However, only 7.0 million lines were in operation. In terms of mobile phones, there were 44.6 million subscribers in 2007 (70.7 subscribers per 100 people). Regarding computers and internet users, in 2007 there were 3.7 million computers (3.7 computers per 100 people) and 9.3 million internet users (15.5 internet users per 100 people).

8. Literacy and Attitudes toward Science and Technology

The result on science literacy survey showed that Thais correctly answered 69% of the basic S&T factual questions (13 out of 20 questions). Levels of factual knowledge of science in Thailand are comparable with those of Japan, China, Malaysia and United States on almost the same level. It was found that most Thais could give correct answers to the following questions.

1) It is the father's gene that determines baby's gender (74%).
2) Electrons are smaller than atoms (64%).
3) Lasers work by focusing sound waves (62%).

Although most Thais have good knowledge on science and technology and have positive attitudes toward S&T, "scientist" is not a desirable career for Thais, either for themselves or for their children. The desirable careers for Thais are businessman, doctor, soldier/police and teacher/professor.

Source: National Science Technology and Innovation Policy Office (2008)

8. Capability for S&T Human Resource Development in Higher Education

Universities with comprehensive S&T programs
The nine designated national research universities:

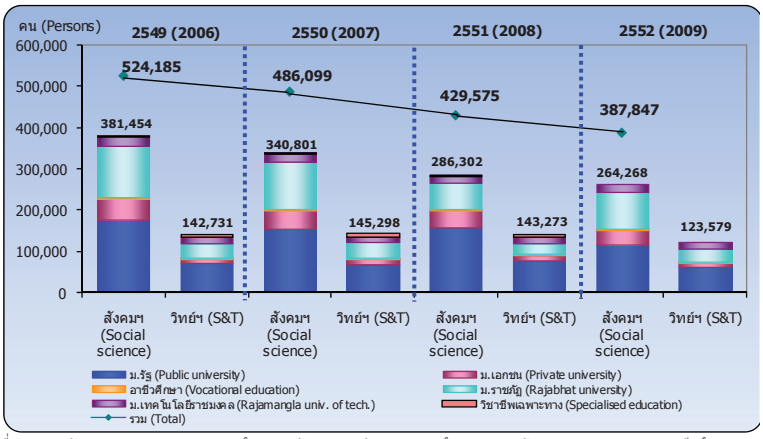
- Chulalongkorn University
- Thammasat University
- Mahidol University
- Kasetsart University
- Chiang Mai University
- Khon Kaen University
- Prince of Songkla University
- King Mongkut's University of Technology Thonburi
- King Mongkut's Institute of Technology Ladkrabang

Plus other two leading S&T-intensive universities:

- King Mongkut's University of Technology North Bangkok
- Suranaree University of Technology

รูปที่ 3-5 จำนวนนักศึกษาใหม่ระดับปริญญาตรีของประเทศไทย: ปีการศึกษา 2549-2552

Figure 3-5 Number of New Enrollments of Thailand in Bachelor Degree Level: Academic Year 2006-2009



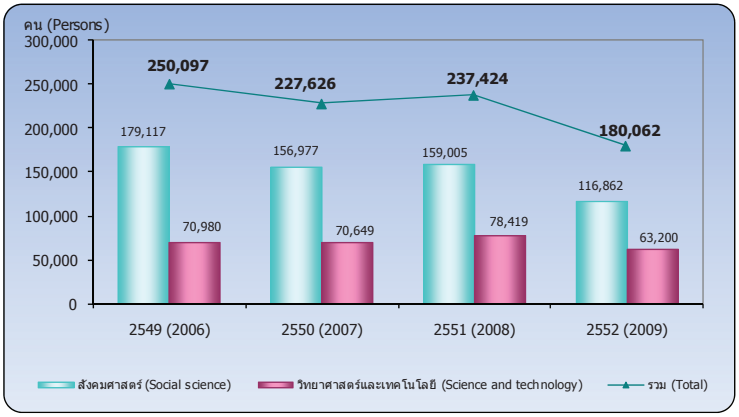
ที่มา: สำนักงานคณะกรรมการการอุดมศึกษา สำนักงานเลขาธิการสภาการศึกษา และสำนักงานคณะกรรมการการอาชีวศึกษา

Source: Commission on Higher Education, Office of The Education Council and Vocational Education Commission

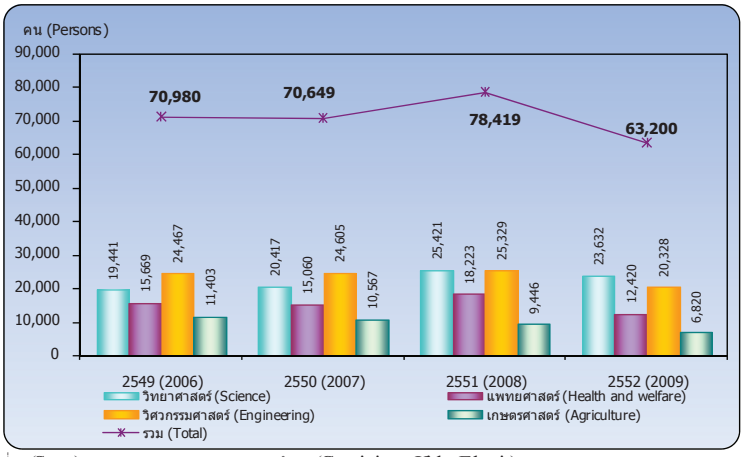
รูปที่ 3-6 จำนวนนักศึกษาใหม่ระดับปริญญาตรีของสถาบันอุดมศึกษาของรัฐ ปีการศึกษา 2549-2552

Figure 3-6 Number of New Enrollments in Bachelor Degree Level (Public Educational Institute Only): Academic Year 2006-2009

นักศึกษาใหม่ทั้งหมด **(Total New Enrollments)**



นักศึกษาใหม่สายวิทยาศาสตร์ **(New Enrollments in the Field of Science and Technology)**

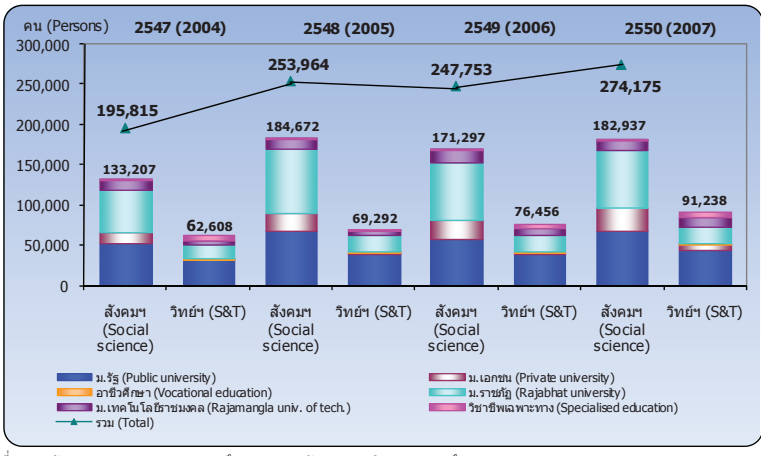


ที่มา **(Source)** สำนักงานคณะกรรมการการอุดมศึกษา **(Commission on Higher Education)**

หมายเหตุ : แพทยศาสตร์หมายรวมถึงสาขาที่เกี่ยวข้องกับสุขภาพด้วย **(Include field of health and welfare)**

รูปที่ 3-7 จำนวนผู้สำเร็จการศึกษาระดับปริญญาตรีของประเทศไทย ปีการศึกษา 2547-2550

Figure 3-7 Number of Graduates of Thailand with Bachelor Degree: Academic Year 2004-2007

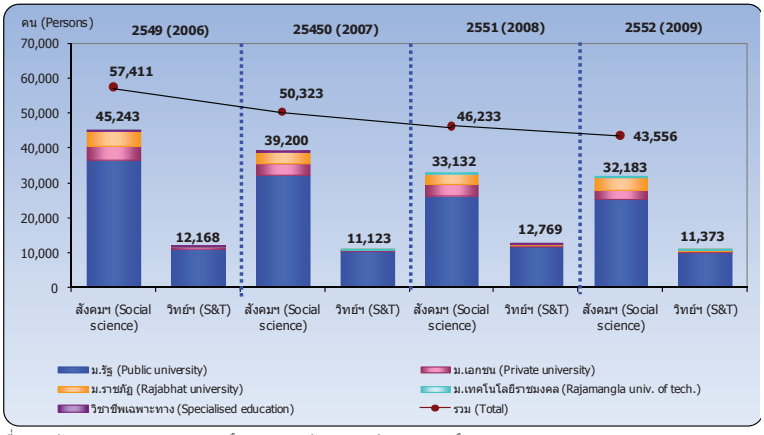


ที่มา: สำนักงานคณะกรรมการการอุดมศึกษา และสำนักงานเลขาธิการสภาการศึกษา

Source: Commission on Higher Education and Office of The Education Council

รูปที่ 3-9 จำนวนนักศึกษาใหม่ระดับปริญญาโทของประเทศไทย ปีการศึกษา 2549-2552

Figure 3-9 Number of New Enrollments of Thailand in Master Degree Level: Academic Year 2006-2009

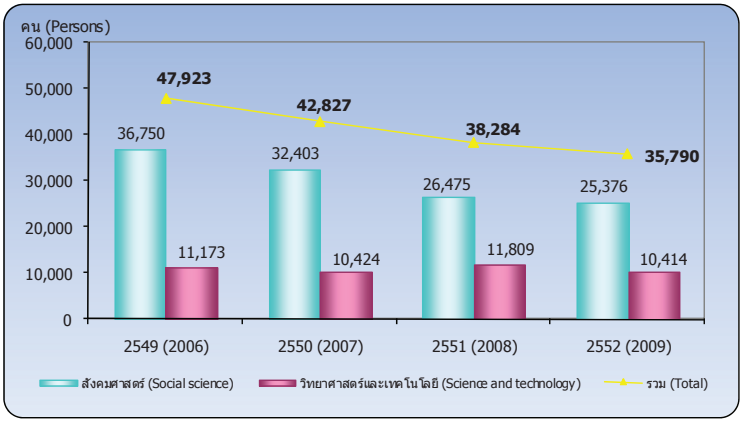


ที่มา: สำนักงานคณะกรรมการการอุดมศึกษา และสำนักงานเลขาธิการสภาการศึกษา

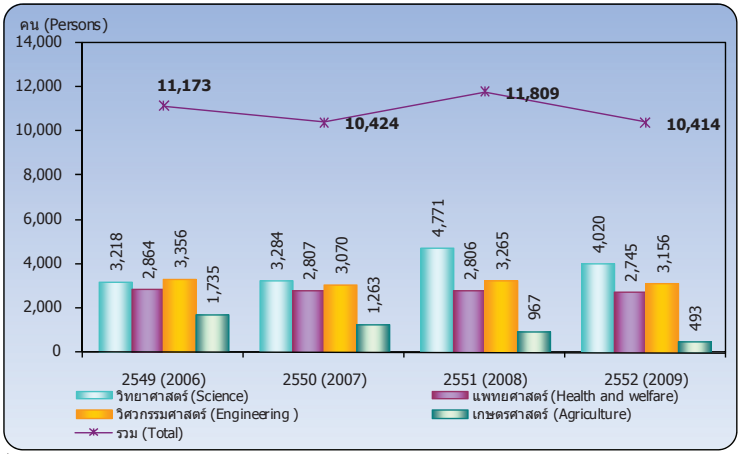
รูปที่ 3-10 จำนวนนักศึกษาใหม่ระดับปริญญาโทของสถาบันอุดมศึกษาของรัฐ ปีการศึกษา 2549-2552

Figure 3-10 Number of New Enrollments in Master Degree Level (Public Educational Institute Only): Academic Year 2006-2009

นักศึกษาใหม่ทั้งหมด **(Total New Enrollments)**



นักศึกษาใหม่สายวิทยาศาสตร์ **(New Enrollments in the Field of Science and Technology)**

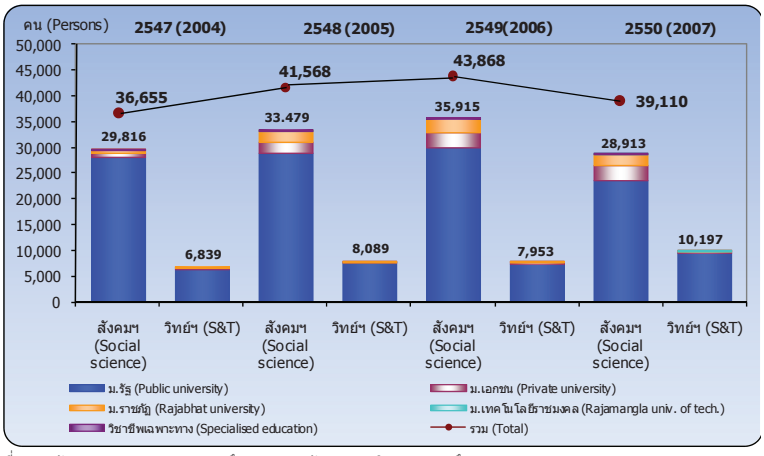


ที่มา **(Source)** สำนักงานคณะกรรมการการอุดมศึกษา **(Commission on Higher Education)**

หมายเหตุ : แพทยศาสตร์หมายรวมถึงสาขาที่เกี่ยวข้องกับสุขภาพด้วย **(Include field of health and welfare)**

รูปที่ 3-11 จำนวนผู้สำเร็จการศึกษาระดับปริญญาโทของประเทศไทย ปีการศึกษา 2547-2550

Figure 3-11 Number of Graduates of Thailand with Master Degree: Academic Year 2004-2007



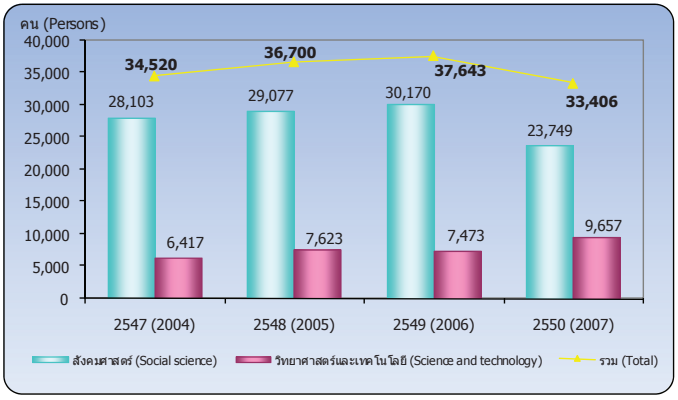
ที่มา: สำนักงานคณะกรรมการการอุดมศึกษา และสำนักงานเลขาธิการสภาการศึกษา

Source: Commission on Higher Education and Office of The Education Council

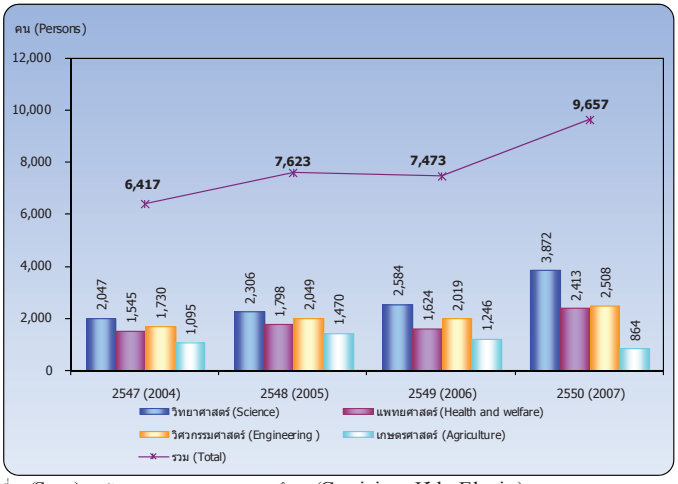
รูปที่ 3-12 จำนวนผู้สำเร็จการศึกษาระดับปริญญาโทของสถาบันอุดมศึกษาของรัฐ ปีการศึกษา 2547-2550

Figure 3-12 Number of Graduates with Master Degree (Public Educational Institute Only): Academic Year 2004-2007

ผู้สำเร็จการศึกษาทั้งหมด **(Total Graduates)**



ผู้สำเร็จการศึกษาสายวิทยาศาสตร์ **(Graduates in the Field of Science and Technology)**

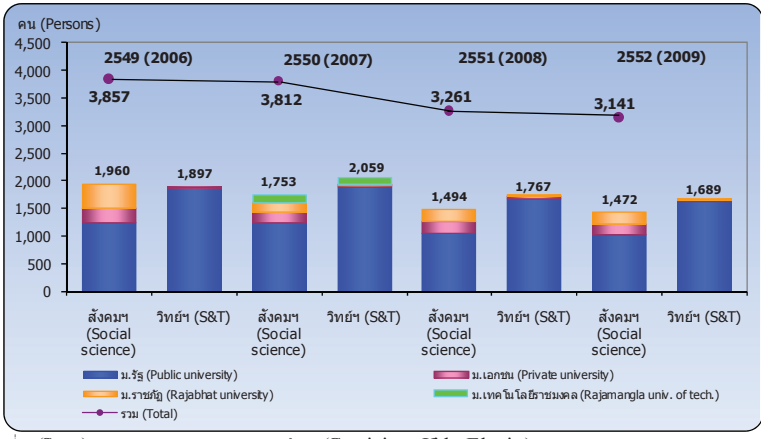


ที่มา **(Source)** สำนักงานคณะกรรมการการอุดมศึกษา **(Commission on Higher Education)**

หมายเหตุ : แพทยศาสตร์หมายรวมถึงสาขาที่เกี่ยวข้องกับสุขภาพด้วย **(Include field of health and welfare)**

รูปที่ 3-13 จำนวนนักศึกษาใหม่ระดับปริญญาเอกของประเทศไทย ปีการศึกษา 2549-2552

Figure 3-13 Number of New Enrollments of Thailand in Doctoral Degree Level: Academic Year 2006-2009



ที่มา (Source) สำนักงานคณะกรรมการการอุดมศึกษา (Commission on Higher Education)

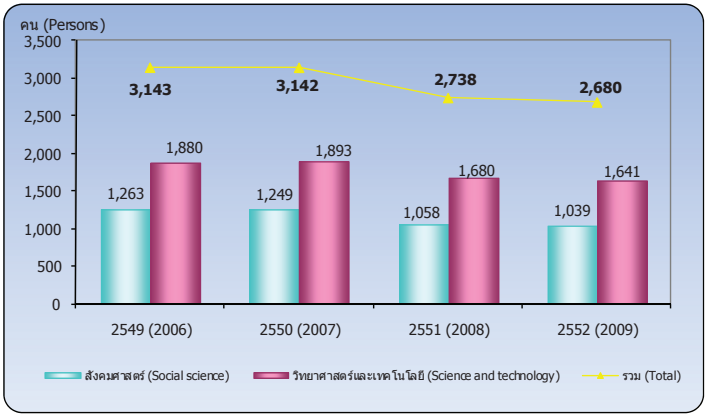
หมายเหตุ: ข้อมูลนักศึกษาในสายวิทยาศาสตร์ฯ ระดับปริญญาเอก รวมนักศึกษาในระดับประกาศนียบัตรแพทย์เฉพาะทางด้วย

Remark: Data on S&T students in doctoral degree include students in higher graduate diploma of clinical sciences.

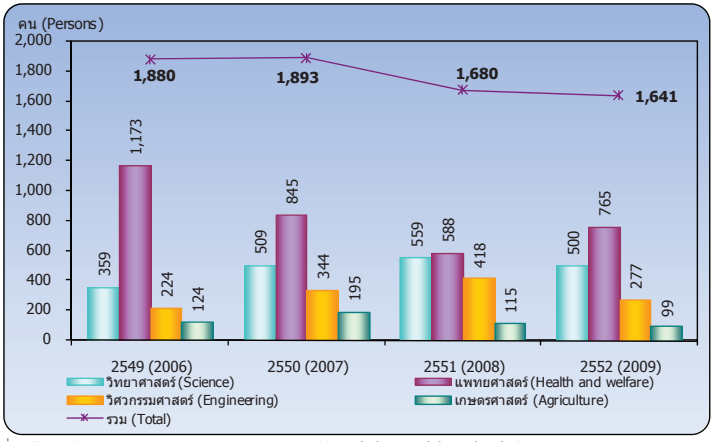
รูปที่ 3-14 จำนวนนักศึกษาใหม่ระดับปริญญาเอกของสถาบันอุดมศึกษาของรัฐ ปีการศึกษา 2549-2552

Figure 3-14 Number of New Enrollments in Doctoral Degree Level (Public Educational Institute Only): Academic Year 2006-2009

นักศึกษาใหม่ทั้งหมด **(Total New Enrollments)**



นักศึกษาใหม่สายวิทยาศาสตร์ **(New Enrollments in the Field of Science and Technology)**



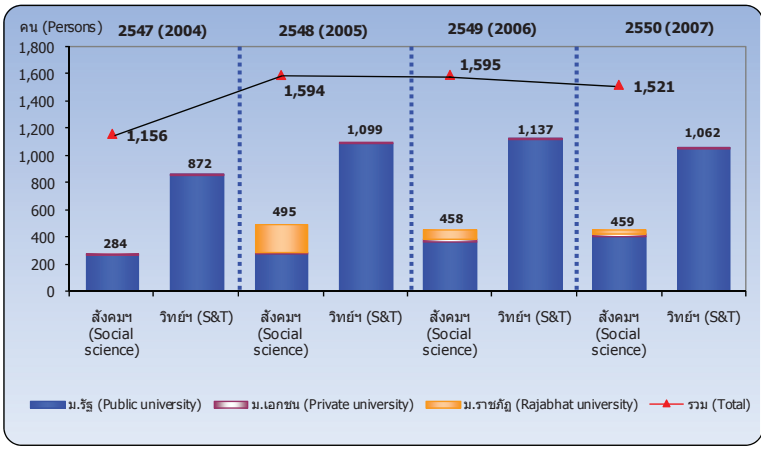
ที่มา **(Source)** สำนักงานคณะกรรมการการอุดมศึกษา **(Commission on Higher Education)**

หมายเหตุ: ข้อมูลนักศึกษาในสายวิทยาศาสตร์ฯ ระดับปริญญาเอก รวมนักศึกษาในระดับประกาศนียบัตรแพทย์เฉพาะทางด้วย

Remark: Data on S&T students in doctoral degree include students in higher graduate diploma of clinical sciences.

รูปที่ 3-15 จำนวนผู้สำเร็จการศึกษาระดับปริญญาเอกของประเทศไทย ปีการศึกษา 2547-2550

Figure 3-15 Number of Graduates of Thailand with Doctoral Degree: Academic Year 2004-2007



ที่มา (Source): สำนักงานคณะกรรมการการอุดมศึกษา (Commission on Higher Education)

หมายเหตุ: ข้อมูลนักศึกษาในสายวิทยาศาสตร์ฯ ระดับปริญญาเอก รวมนักศึกษาในระดับประกาศนียบัตรแพทย์เฉพาะทางด้วย

Remark: Data on S&T students in doctoral degree include students in higher graduate diploma of clinical sciences.

ตารางที่ 3-1 ผู้สำเร็จการศึกษาสาขาแพทยศาสตร์ในระดับปริญญาเอกและประกาศนียบัตรบัณฑิตชั้นสูงด้านการแพทย์และวิชาที่เกี่ยวข้องปีการศึกษา 2550

Table 3-1 Clinical Sciences Graduates with Doctoral Degree and Higher Graduate Diploma: Academic Year 2007

สถาบันการศึกษา (Organization)	ปริญญาเอก (Doctoral degree)	ประกาศนียบัตรบัณฑิตชั้นสูง (Higher graduate diploma)	รวมทั้งหมด (Total)
จุฬาลงกรณ์มหาวิทยาลัย (Chulalongkorn University)	17	165	**182**
ขอนแก่น (khonkaen University)	41	-	**41**
นเรศวร (Naresuan University)	6	-	**6**
มหาวิทยาลัยมหิดล (Mahidol University)	67	38	**105**
มหาวิทยาลัยสงขลานครินทร์ (Prince of Songkla University)	21	70	**91**
มหาวิทยาลัยเชียงใหม่ (Chiangmai University)	12	59	**71**
รวมทั้งหมด (Total)	**164**	**332**	**496**

ที่มา (Source) สำนักงานคณะกรรมการการอุดมศึกษา (Commission on Higher Education)

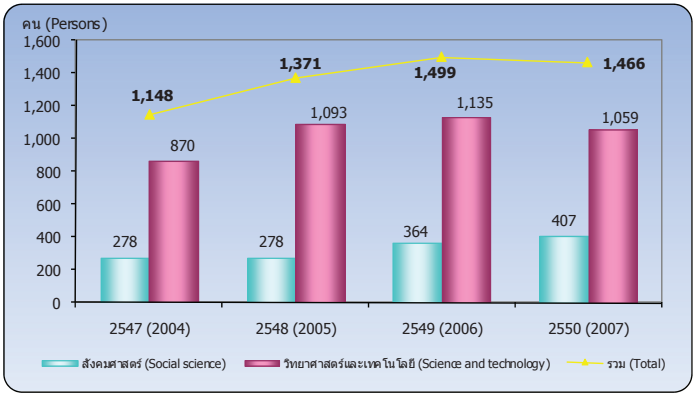
หมายเหตุ: มหาวิทยาลัยมหิดล รวมศิริราชพยาบาล และโรงพยาบาลรามาธิบดี

Remark: Mahidol university includes Siriraj hospital and Ramathibodi hospital

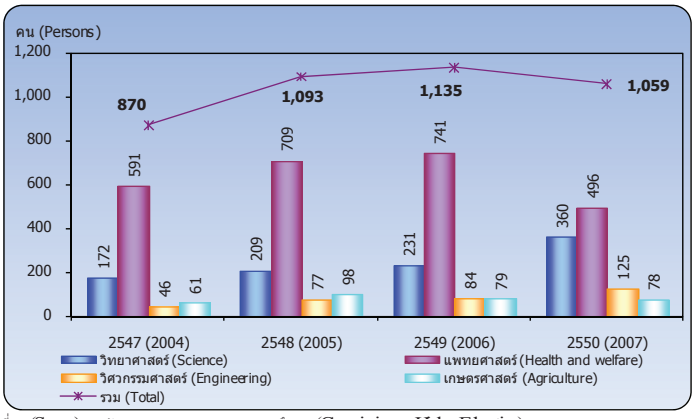
รูปที่ 3-16 จำนวนผู้สำเร็จการศึกษาระดับปริญญาเอกของสถาบันอุดมศึกษาของรัฐ ปีการศึกษา 2547-2550

Figure 3-16 Number of Graduates with Doctoral Degree (Public Educational Institute Only): Academic Year 2004-2007

ผู้สำเร็จการศึกษาทั้งหมด **(Total Graduates)**



ผู้สำเร็จการศึกษาสายวิทยาศาสตร์ **(Graduates in the Field of Science and Technology)**



ที่มา **(Source)** สำนักงานคณะกรรมการการอุดมศึกษา **(Commission on Higher Education)**

หมายเหตุ : แพทยศาสตร์หมายรวมถึงสาขาที่เกี่ยวข้องกับสุขภาพด้วย **(Include field of health and welfare)**

ตารางที่ 3-3 ผู้มีงานทำและสำเร็จการศึกษาด้านวิทยาศาสตร์และเทคโนโลยี ปี 2547-2551 จำแนกตามสาขาวิชา

Table 3-3 S&T Labor Force and Graduates by Fields for 2004-2008

หน่วย/unit: คน/Persons

สาขาวิชาวิทยาศาสตร์และเทคโนโลยี (Science and technology field)	ปี (Year)				
	2547 (2004)	2548 (2005)	2549 (2006)	2550 (2007)	2551 (2008)
วิศวกรรมศาสตร์ (Engineering)	592,997	567,759	596,389	644,503	688,761
สุขภาพ (Health)	230,568	208,854	187,678	203,423	218,714
สถาปัตยกรรมและการสร้างอาคาร (Architecture and construction)	106,494	111,158	99,603	99,772	102,363
คอมพิวเตอร์ (Computer)	72,600	79,934	95,264	92,758	99,788
การเกษตร การป่าไม้ และการประมง (Agriculture, forest and fishery)	62,453	74,098	69,974	84,673	86,410
วิทยาศาสตร์ชีวภาพ (Biological science)	18,670	13,130	22,785	22,353	18,787
การผลิตและกระบวนการผลิต (Production and processing)	14,287	22,386	16,852	18,199	20,100
วิทยาศาสตร์กายภาพ (Physical science)	8,665	11,380	12,047	12,495	16,710
สัตวแพทย์ (Veterinary medicine)	5,469	4,786	10,320	6,587	8,257
คณิตศาสตร์และสถิติ (Mathematics & statistics)	1,942	1,187	93	2,748	1,483
รวม (Total)	**1,114,145**	**1,094,671**	**1,111,001**	**1,187,512**	**1,261,373**

ที่มา: สำนักงานสถิติแห่งชาติ

Source: National Statistical Office

หมายเหตุ: ข้อมูลปี 2547-2548 ได้ปรับปรุงใหม่ให้สอดคล้องกับความหมายของคู่มือแคนเบอร่า

Remark: Data for 2004-2005 were adjusted according to Canberra Manual.

9. Major Contributors to GDP

Thailand Country Report: GDP data and GDP forecasts; economic, financial and trade information; the best banks in Thailand; country and population overview

DATA ON GDP AND ECONOMIC INFORMATION

Central bank	Source	Bank of Thailand
International Reserves	Source	US$ 163.286 billion (Source: IMF; Data updated: November 2010)
Gross Domestic Product - GDP	Source	US$ 332.47 billion (2009 estimate)
GDP (Purchasing Power Parity)	Source	616.783 billion of International dollars (2009 estimate)
Real GDP growth	Source	
GDP per capita - current prices	Source	US$ 5,174 (2009 estimate)
GDP per capita - PPP	Source	$9,598 International Dollars (2009 estimate)
GDP (PPP) - share of world total	Source	1980 1990 2000 2010 2015**

2000	2001	2002	2003	2004	2005	2006	2007
4.8%	2.2%	5.3%	7.1%	6.3%	4.6%	5.1%	4.9%
2008	**2009**	**2010**	**2011***				
2.5%	**-2.3%**	**7.8%**	**4%**				

**Estimate*

		0.45% 0.7% 0.74% 0.79% 0.79% ***Forecast*
GDP - composition by sector	Source	• agriculture: 11.6% • industry: 43.3% • services: 45.1% (2009 estimate) *(Data released on November 2010)*
Gross domestic expenditure on R&D (*% of GDP*)	Source	N/A *(Data released on November 2010)*
Inflation	Source	2008 2009 2010 2011* 5.5% -0.8% 3.3% 4% **Estimate*
Unemployment rate	Source	2008 2009 2010 2011* 1.4% 1.5% 1% 1.2% **Estimate*
Household saving rates	Source	N/A *(Data released on November 2010)*
Public debt (General government gross debt as a % of GDP)	Source	2007 2008 2009 2010 2011* 38.3% 37.3% 45.2% 44.1% 43.7% **Estimate*

Public deficit (General government net lending/borrowing as a % of GDP)	Source	2007: 0.2% · 2008: 0.1% · 2009: -3.2% · 2010*: -2.7% · 2011**: -2.3% **Estimate **Forecast*
Government bond ratings	Source	Standard & Poor's: BBB+/Negative/A-2 Moody's rating: Baa1 Moody's outlook: NEG *(Foreign Currency Government Bond Ratings; Data last updated Nov 2010)*
Market value of publicly traded shares	Source	2007: US$196.046 billion · 2008: US$102.594 billion · 2009: US$138.189 billion
Largest companies in Thailand	Source	PTT Public Company (Oil & Gas Operations), Siam Cement (Construction), Siam Commercial Bank (Banking), Kasikornbank (Banking), Bangkok Bank (Banking) (2010)

Sources: http://www.gfmag.com/gdp-data-country-reports/163-thailand-gdp-country-report.html#ixzz1WwR5WAz8
http://www.gfmag.com/gdp-data-country-reports/163-thailand-gdp-country-report.html#axzz1WwPPj4TI

http://en.wikipedia.org/wiki/Economy_of_Thailand

The **economy** **of** **Thailand** is a newly industrialized economy. It is a heavily export-dependent economy, with exports accounting for more than two thirds of gross domestic product (GDP).

Recently, Thailand experienced GDP growth by 8.0% in 2010 making it one of the fastest growing economies in Asia and the fastest growing economy in South East Asia. The country has a GDP net worth of 9.5 trillion Baht (on a purchasing power parity (PPP) basis), or US$584 billion (PPP) making it the 24th largest economy in the world. This classifies Thailand as the **2nd largest economy** in Southeast Asia after Indonesia. Despite this, Thailand ranks midway in the wealth spread in Southeast Asia as it is the 4th richest nation according to GDP per capita, after Singapore, Brunei and Malaysia. Thailand's nominal economic output as of June 2010 is $313.8 billion USD,[5] while holding some $172 billion in foreign exchange assets which ranks 11th in world. Thailand has strong automobile industry which grew by 63% in 2010 with 1.6 million cars produced ranking it as 13th in the motor vehicle producing countries in the world. Experts predict that by the year 2015 Thailand will be one of the top 10 motor vehicle producing countries in the world.[6]

Thailand's economy functions as an anchor economy for the neighboring developing economies of Laos, Burma, and Cambodia. Thailand's recovery from the 1997–1998 Asian financial crisis depended mainly on exports, among various other factors. Thailand ranks high among the world's automotive export industries along with manufacturing of electronic goods.

Tourism revenues are on the rise and contributing to about 6% of GDP. The GDP growth of Thailand was 8.0% in 2010, higher than previous highs of 5-7% under the previous civilian administration. Thailand enjoys high foreign investment and consumer confidence. Unemployment is at 1.2% as year 2010, with estimations of falling to 1% by the year 2012 therefore Thailand has one of the lowest unemployment rates in the world. Decades of economic growth reduced poverty in Thailand. Thailand enjoys one of the lowest poverty rates in Asia. In 2010, Thailand, along with Japan, South Korea, Taiwan, Brunei and Malaysia were the only countries in Asia with less than 2% of the country's total population living under $1.25 per day.

Due to rising oil and food prices, the annual inflation rate for 2010 shot up to 3.5% in July, but it will unlikely reach higher rates as oil and food prices are stabilizing and Thailand is receiving high foreign reserves and capital investment.

10. Major Exports – this should be ranked in order of importance or share. Only a maximum of ten exports should be indicated.

Top 10 Thai Exports 2011 Unit : MILLION BAHT

	รายการ	2554/2011
1	Computers and Parts	322,765.6
2	Automobiles and Parts	312,633.1
3	Jewelry	243,305.5
4	Rubber	226,640.2
5	Plastic	157,450.5
6	Electrical Circuits	148,529.4
7	Chemicals	144,514.7
8	Rubber Products	142,259.7
9	Cooking Oil	142,243.0
10	Rice	124,652.4

Top 5 Thai Imports 2011 Unit: MILLION BAHT

	รายการ	2554/2011
1	Crude Oil	576,540.3
2	Machinery	323,298.1
3	Chemicals	270,618.0
4	Minerals	250,987.5
5	Electronics and Parts	237,411.1

Source: http://www.ops3.moc.go.th/infor/db_sql/gp_main_trade.asp

Source: http://www.economywatch.com/world_economy/thailand/export-import.html

The main destinations for Thailand's exports are the rest of Asia and the US. The country also ranks high among the world's automotive export industries and electronic goods manufacturers. Thailand is also among the world's largest exporter of several agricultural products, such as rice, shrimps, tapioca, rubber and sugar.

The US is Thailand's largest export partner and the third-largest supplier after Japan and China. Although traditionally Thailand's major markets have been North America, Japan and Europe, economic recovery witnessed by Thailand's regional trading partners also helped boost growth in Thai export. The country has also increased its exports in some of its non-traditional export markets, including India, China and the Middle East.

As the Thai economy recovered from the 2008 global financial crisis, demand for its goods increased and Thai exports in 2010 surged by 25.1% from 2009. Thailand is a member of the World Trade Organization (WTO) and the Cairns Group of agricultural exporters.

Thailand's Import and Export Indications at a Glance (2010)

Total value of exports: US$191.3 billion

Primary exports - commodities: textiles and footwear, fishery products, rice, rubber, jewelry, automobiles, computers and electrical appliances

Primary exports partners: US (10.9 percent of total exports), China (10.6 percent), Japan (10.3 percent)

Total value of imports: US$156.9 billion

Primary imports - commodities: capital goods, intermediate goods and raw materials, consumer goods, fuels

Primary imports partners: Japan (18.7 percent of total imports), China (12.7 percent), Malaysia (6.4 percent)

11. Major Trading/Economic Partners in ASEAN – should indicate major partner for export and import.

Trade summary between Thailand and ASEAN(9)

Source: http://www.ops3.moc.go.th/menucomen/trade_sum/report.asp

description	value : million us$					growth rate (%)					share (%)				
	2008	2009	2010	2010(Jan.-Jul.)	2011(Jan.-Jul.)	2008	2009	2010	2010(Jan.-Jul.)	2011(Jan.-Jul.)	2008	2009	2010	2010(Jan.-Jul.)	2011(Jan.-Jul.)
Thailand - WORLD															
Total Trade	356,998.46	286,089.66	377,730.36	211,866.61	266,752.86	21.50	-19.86	32.03	40.95	25.91	100.00	100.00	100.00	100.00	100.00
Export	177,775.20	152,426.29	195,306.69	108,591.48	136,498.54	15.54	-14.26	28.13	34.02	25.70	100.00	100.00	100.00	100.00	100.00
Import	179,223.26	133,663.37	182,423.68	103,275.13	130,254.32	28.05	-25.42	36.48	49.06	26.12	100.00	100.00	100.00	100.00	100.00
Trade Balance	-1,448.06	18,762.91	12,883.01	5,316.36	6,244.22										
Thailand - ASEAN(9)															
Total Trade	70,291.20	57,188.63	74,661.89	42,678.68	53,705.27	21.49	-18.64	30.55	41.70	25.84	19.69	19.99	19.77	20.14	20.13
Export	40,151.28	32,489.67	44,333.56	25,315.72	31,381.45	22.45	-19.08	36.45	49.22	23.96	22.59	21.32	22.70	23.31	22.99
Import	30,139.92	24,698.97	30,328.33	17,362.96	22,323.82	20.24	-18.05	22.79	32.01	28.57	16.82	18.48	16.63	16.81	17.14
Trade Balance	10,011.36	7,790.70	14,005.23	7,952.76	9,057.62										
Thailand - BRUNEI															
Total Trade	211.14	226.57	227.15	129.85	194.33	3.28	7.31	0.25	2.79	49.66	0.06	0.08	0.06	0.06	0.07
Export	123.72	117.39	128.65	76.96	78.16	32.52	-5.12	9.60	23.06	1.57	0.07	0.08	0.07	0.07	0.06
Import	87.42	109.19	98.50	52.89	116.16	-21.29	24.90	-9.79	-17.09	119.63	0.05	0.08	0.05	0.05	0.09
Trade Balance	36.30	8.20	30.15	24.07	-38.00										
Thailand - INDONESIA															
Total Trade	11,734.04	8,467.79	13,024.37	7,548.86	10,813.75	33.27	-27.84	53.81	73.78	43.25	3.29	2.96	3.45	3.56	4.05
Export	6,324.54	4,667.33	7,346.43	4,367.86	6,042.85	31.25	-26.20	57.40	81.40	38.35	3.56	3.06	3.76	4.02	4.43
Import	5,409.50	3,800.47	5,677.93	3,181.00	4,770.89	35.71	-29.74	49.40	64.30	49.98	3.02	2.84	3.11	3.08	3.66
Trade Balance	915.04	866.86	1,668.50	1,186.86	1,271.96										
Thailand - CAMBODIA															
Total Trade	2,130.30	1,658.30	2,556.98	1,608.64	1,674.97	51.72	-22.16	54.19	76.09	4.12	0.60	0.58	0.68	0.76	0.63
Export	2,040.08	1,580.59	2,342.09	1,474.85	1,563.20	50.52	-22.52	48.18	67.38	5.99	1.15	1.04	1.20	1.36	1.15
Import	90.22	77.72	214.90	133.80	111.77	85.04	-13.86	176.51	312.84	-16.46	0.05	0.06	0.12	0.13	0.09
Trade Balance	1,949.86	1,502.87	2,127.19	1,341.05	1,451.42										

Thailand - LAOS

Total Trade	2,393.03	2,105.34	2,885.34	1,651.43	2,170.07	34.35	-12.02	37.05	42.47	31.41	0.67	0.74	0.76	0.78	0.81
Export	1,776.18	1,642.63	2,135.93	1,249.13	1,551.02	35.47	-7.52	30.03	36.87	24.17	1.00	1.08	1.09	1.15	1.14
Import	616.84	462.71	749.41	402.30	619.05	31.23	-24.99	61.96	63.19	53.88	0.34	0.35	0.41	0.39	0.48
Trade Balance	1,159.34	1,179.92	1,386.52	846.83	931.96										

Thailand - MYANMAR

Total Trade	4,707.54	4,326.28	4,886.82	2,728.46	3,329.82	44.44	-8.10	12.96	12.10	22.04	1.32	1.51	1.29	1.29	1.25
Export	1,331.32	1,544.70	2,072.96	1,200.20	1,566.26	38.99	16.03	34.20	42.20	30.50	0.75	1.01	1.06	1.11	1.15
Import	3,376.22	2,781.58	2,813.87	1,528.26	1,763.57	46.70	-17.61	1.16	-3.88	15.40	1.88	2.08	1.54	1.48	1.35
Trade Balance	-2,044.90	-1,236.88	-740.91	-328.06	-197.31										

Thailand - MALAYSIA

Total Trade	19,636.49	16,237.63	21,275.34	12,305.47	14,531.86	19.47	-17.31	31.02	47.08	18.09	5.50	5.68	5.63	5.81	5.45
Export	9,910.47	7,662.90	10,566.59	6,040.85	7,305.03	26.75	-22.68	37.89	55.13	20.93	5.57	5.03	5.41	5.56	5.35
Import	9,726.02	8,574.73	10,708.76	6,264.62	7,226.83	12.87	-11.84	24.89	40.06	15.36	5.43	6.42	5.87	6.07	5.55
Trade Balance	184.46	-911.82	-142.17	-223.77	78.20										

Thailand - PHILIPPINES

Total Trade	5,789.54	4,805.08	7,261.25	4,171.71	4,213.39	12.38	-17.00	51.12	76.45	1.00	1.62	1.68	1.92	1.97	1.58
Export	3,512.51	3,021.91	4,885.98	2,854.54	2,616.47	16.62	-13.97	61.69	85.33	-8.34	1.98	1.98	2.50	2.63	1.92
Import	2,277.03	1,783.17	2,375.27	1,317.17	1,596.91	6.40	-21.69	33.20	59.85	21.24	1.27	1.33	1.30	1.28	1.23
Trade Balance	1,235.48	1,238.74	2,510.72	1,537.38	1,019.56										

Thailand - SINGAPORE

Total Trade	17,220.87	13,297.79	15,302.58	8,614.57	11,536.67	8.30	-22.78	15.08	17.64	33.92	4.82	4.65	4.05	4.07	4.32
Export	10,114.65	7,573.80	9,009.49	4,903.94	6,536.47	5.15	-25.12	18.96	20.08	33.29	5.69	4.97	4.61	4.52	4.79
Import	7,106.21	5,723.98	6,293.09	3,710.63	5,000.20	13.14	-19.45	9.94	14.56	34.75	3.97	4.28	3.45	3.59	3.84
Trade Balance	3,008.44	1,849.82	2,716.40	1,193.31	1,536.26										

Thailand - VIETNAM

Total Trade	6,468.25	6,063.84	7,242.06	3,919.69	5,240.42	31.58	-6.25	19.43	26.95	33.69	1.81	2.12	1.92	1.85	1.96
Export	5,017.80	4,678.42	5,845.45	3,147.39	4,121.99	31.90	-6.76	24.95	34.54	30.97	2.82	3.07	2.99	2.90	3.02
Import	1,450.45	1,385.42	1,396.61	772.30	1,118.43	30.45	-4.48	0.81	3.23	44.82	0.81	1.04	0.77	0.75	0.86
Trade Balance	3,567.36	3,293.00	4,448.84	2,375.09	3,003.56										

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VIETNAM

1. S&T Policy and Development Strategy

Vietnam's strategies for Science and Technology are the following:

- To ensure a scientific base for Vietnam's socioeconomic development with the orientation of sustainability and international integration.
- To contribute to the raising of quality of economic growth and the competitiveness of the national economy.
- To build and develop S&T capacity.

Key development tasks have been identified until 2020 in support of these strategies.

A set of R&D priorities has also been identified and these are in the following areas:

- ICT
- Biotech on Community Health Care
- Nano and New Materials
- Automation
- Environmental Protection and Natural Disaster Prevention
- Space Technology

Each of these priorities are handled/managed by a Directorate of National Target Program. In addition, there is now a National Target Program on Climate Change chaired by the Prime Minister. All Target Programs are cross-sectoral. They are separate from the sectoral ministries and separate also from the Ministry of Science and Technology (MOST). Each directorate has to deal with the Ministry of Finance.

2. S&T Infrastructure

The National System of S&T or the national infrastructure for S&T in Vietnam is composed of the following:

- The Ministry of Science and Technology (MOST)
- R&D institutions in ministries
- Higher Educational Institutions (HEI's)/universities
- R&D institutions affiliated to localities, associations and business entities
- Science and Technology departments in ministries and provinces

In the process of formulating S&T strategies the following are involved:

- National Council for S&T Policy
- Vietnam Academy of S&T (VAST)

- National Assembly
- Vietnam Communist Party

There are 3 groups of research institutions in Vietnam: the Vietnam Academy of Science and Technology (VAST) based in Hanoi; the sectoral public R&D institutes found in line ministries and MOST; and the university based research institutes.

VAST has 32 research institutes employing a total of nearly 4,000 researchers. The largest institute in VAST is the Institute of Materials Science (IMS). Starting 2009 VAST has also started awarding MS and PhD degrees.

The sectoral public R&D institutes, on the other hand, are found in the ministries of:

- Industries and Trade
- Transportation
- Agriculture and Rural Development
- Construction
- Health
- Natural Resources & Environment
- Science and Technology

The Ministry of Trade and Industry has the biggest number of R&D institutes. These are on Petroleum, Oil & Gas; Electronic, Automobile, Chemicals, Energy, Textile, Manufacturing and Shipping. The Ministry of Agriculture and Rural Development (MARD), on the other hand, has R&D institutes for Water, Forestry, Agriculture and Fisheries. MOST has an Applied Technology Institute and a Nuclear Research Institute. There are other research institutions which are mostly for social science research.

3. Human Resources in S&T

The only figure available is the nearly 4,000 researchers working in the 32 research institutes of VAST.

4. Expenditures for S&T/R&D

Vietnam's investment in R and D grew from US$ 60 Million in 1997 to US$ 270 Million in 2005. 2% of Government Budget is earmarked for R and D. 85% of the investments in R and D come from the State Budget.

5. S&T Outputs

- Patents
- S&T Publications

} To be submitted

6. Utilization of S&T Outputs

The best example of technology utilization from R&D outputs is in the case of vaccines. Vietnam has invested much for several decades in human resource development and in R&D for vaccines. The results have been commercialized through a government spin off enterprise. Today, Vietnam is 100% self sufficient in basic vaccines for immunization.

The Government has embarked on a support program for technology spin off companies. This is called the Incentive for Spin off Project. The incentive translates to US$ 35,000/Project. During the first year that it was implemented in 2005-2006 a total of 16 spin off companies benefited from the program. In the second year of the program there were only 2 beneficiaries of the program.

There are also national programs to utilize technologies or technological know how for the benefit of the people. These examples can be cited: the Vietnam National Energy Efficiency Program, the Vietnam Food Processing Program for Communities and the Vietnam National Program in Response to Climate Change.

In addition incubation centers are operated within universities to assist spin offs from generated technologies.

7. Areas of Strength in S&T/R&D

The areas of strength in S&T/R&D in Vietnam can be based on what are considered to be the best institutes in the VAST. These are the institutes of Material Science, Biotechnology, Information Technology, Mathematics and Chemistry. International publications is the key indicator for this.

In terms of technologies which created self sufficiency, vaccines and rice technology can be cited.

8. Capability to Develop Advanced Human Resources for S&T

There are 380 universities in Vietnam, 276 are public while 104 are private. They can be categorized into national, regional and specialized universities. The national universities are the Vietnam National University (VNU) Hanoi and the Vietnam National University (VNU) Ho Chi Minh. The specialized universities are the Hanoi University of Science and Technology and the Hanoi Civil Engineering University.

The national universities, the specialized universities and some regional universities offer MS and PhD degrees in the various fields of science, technology and engineering. It is note worthy to mention that the research institutes in VAST take in graduate students coming from different universities in the different regions for their dissertation work. The Institute of Material Science (IMS), for example, is currently hosting the dissertation research of 75 PhD students coming from different regions of Vietnam.

Information has been given that Vietnam will open a new university for Science and Technology. This is in a new campus 30 kilometers from Hanoi. It already opened but it limited its students to MS and PhD students only. In the future it will have B.S. programs. This is a collaboration between the Vietnam Government and the French Government. Initial investment was Eur 200 Million.

9. Major Contributors to GDP

The major contributors to Vietnam's GDP are agriculture, garments, tourism and construction.

10. Major Exports

Vietnam's major exports are: crude oil, marine products, rice, coffee, rubber, tea, garments and shoes.