science policy studies

United Nations
Educational, Scientific and
Cultural Organization

UNESCO Office in Beijing

Science & Technology Master Plan of Mongolia

2007-2020

MINISTRY OF EDUCATION CULTURE AND SCIENCE

SC/PSD/2007/RP

SCIENCE AND TECHNOLOGY MASTER PLAN OF MONGOLIA 2007-2020

Ulaanbaatar, Mongolia 2007

SC/PSD/2007/RP

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Foreword

In accordance with the Parliament Resolution number 24, Mongolian scholars from the Mongolian Academy of Sciences in collaboration with Ministries, have developed the Science and Technology Master Plan (2007–2020) of Mongolia. Accordingly, the Government of Mongolia has passed the decree to commence the implementation of this critical Plan.

This Master Plan is an essential and integral part of the broader National development strategies and policies; mission of the Master plan is to enhance the Science and technology capacity, increase the innovation system effectiveness, promote the Industry–Academia collaboration, contribute to the economic growth by establishing an enabling social, economic and legal environment, establish a basis for national technology development, promote the growth of high technology–based industries, and establish foundation for knowledge–based economy.

Continuous initiative and effective collaboration of our government, scholars, and business enterprises will ensure the achievement of the objectives proposed in this Plan. I am full of optimism that with the support and commitment of our stakeholders and partners, we will mobilize efforts towards the common goal.

PRIME MINISTER OF MONGOLIA

ENKHBOLD MIYEGOMBO

Foreword

Mr. Koichiro Matsuura
Director–General of UNESCO

Economic development is increasingly driven by the application of advanced scientific and technological knowledge. Consequently, nations, particularly "newly industrializing countries", strive to maximize global competitiveness through promoting national systems of innovation. However, advantages within a global innovation economy are often predicated upon explicit science, technology and innovation policies and the availability of sound institutions for their implementation.

In Mongolia, it is apparent that scientific and technological activities need to be integrated with other sectors in order to underpin development across the country's various regions. Although Mongolia is endowed with a comparatively strong science and technology base, including human resources and institutions, its scientific capacity is largely centralized in the capital. In addition, as the economic transition progresses to a more advanced stage, such resources are in danger of being underutilized, dissipated or even lost. As a result, the current stage of economic transition and development in Mongolia holds significant challenges for achieving equitable and sustainable socio–economic progress; there is hence an urgent need to build and maintain the country's innovation capacity.

The main role of UNESCO is to initiate and encourage new thinking on policy development. It is a major instigator of reforms and innovations through international co–operation at regional and international levels. As an international organization, UNESCO also supports regional science and technology policy networks, serving as a clearing–house and facilitating exchange of experiences. The action of UNESCO focuses on assisting Member States in the implementation of actions and recommendations contained in the Declaration and Framework for Action of the World Conference on Science. This worldwide reflection on the role of science in the twenty–first century, initiated and promoted by UNESCO and the International Council for Science, culminated in the conference "Science for the Twenty–First Century: a new commitment" (Budapest 26 June to 1 July 1999). The conference adopted the "Declaration on Science and the Use of Scientific Knowledge and the Science Agenda–Framework for Action", where the importance of science policy was reaffirmed. It also emphasized that "regional and international networking and co–operation can facilitate the exchange of national experiences and the design of more coherent scientific and technological policies".

Together with the Science and Technology Policy Asian Network (STEPAN), UNESCO's Beijing and Jakarta Offices assisted the Ministry of Education, Culture and Science of Mongolia to develop a master plan for science and technology for 2007–2020. The broad thrust of the master plan was endorsed at a national seminar in Ulaanbaatar on 11 May 2004. The Ministry drafted the Science and

Technology Master Plan for Mongolia, which was then approved by the Government in January 2007.

UNESCO was pleased to co–operate with the Ministry of Education, Culture and Science in developing this milestone in Mongolian science and technology. I congratulate the efforts of the Ministry of Education, Culture and Science, the Government of Mongolia, the Mongolian National Commission for UNESCO and other international and national consultants who took part in this important exercise.

It is my sincere hope that this Science and Technology Master Plan contributes in concrete ways to the overall development effort in Mongolia.

The Science and Technology Master plan was developed with an active participation

Acknowledgement

and inclusiveness of the science, industry, and private sector. The Master plan's purpose is to develop and implement an effective strategic policy, to set a favorable environment for S&T and innovation infrastructure by enhancing Mongolian S&T sector development, concentrating S&T capacity on social needs and demands, and adapting research institutes' management to market environment.

In the name of the Ministry of Education, Culture and Science of Mongolia, I would like to personally appreciate science, business representatives and scholars for their support in the development of this Plan.

Moreover, our Ministry is particularly grateful to National Commission, and UNESCO office in Beijing and its experts for their invaluable technical and methodological assistance in the development of the Master Plan.

Mongolian Academy of Sciences, National University of Mongolia, Mongolian University of Science and Technology, other research institutes, and university researchers and professors contributed greatly with their intellectual advice and expertise.

Several industry organizations were extremely collaborative during the survey on the industry research and development where they generously shared their data and provided other technical support: Erdenet Mining Corporation, Altan Taria Co. Ltd, APU Corporation, Darhan Steel Factory, Gobi Corporation, Golomt Bank, MCS Group.

We also appreciate all the organizations and individuals for their valuable opinion and participation during numerous meetings and interviews.

Last but not least, our Ministry is grateful to the Master Plan working team for their great deal of effort and daily coordination in the development of the Plan.

Minister of Education, Culture and Science

Enkhtuvshin Ulziisaikhan

Resolution of the Government of Mongolia

January 3, 2007 *Number 2* *Ulaanbaatar*

Science and Technology Master Plan for the period 2007–2020

The Government of Mongolia authorizes to:

Approve the Science and Technology Master Plan for the period 2007–2020.

Assign U.Enkhtuvshin, Minister of Education, Culture and Science, to organize and coordinate the implementation of the Master Plan at all stages, and to submit the consolidated reports of the implementation progress and evaluation/monitoring every two years.

Assign U.Enkhtuvshin, Minister of Education, Culture and Science, and N.Bayartsaikhan, Minister of Finance, to take necessary actions to reflect allocations to mobilize additional investments required to implement the Master plan into the social and economic guidelines and the annual budgets.

Assign relevant Ministers to implement the Science and Technology Plan in 2007–2020 according to the responsibilities stated in the targeted programs and activities of the Master plan, and take necessary measures to monitor the implementations.

Prime Minister of Mongolia M.Enkhbold

Minister of Education, Culture and Science U. Enkhtuvshin

Abbreviations

FTE	Full–Time Equivalent
GDP	Gross Domestic Expenditure
GERD	Gross Domestic Expenditure on Research and Development
ICT	Information and Communications Technology
ICT	Information and Communications Technology
IF	Impact Factor
ISI	Institute for Scientific Information
MAS	Mongolian Academy of Sciences
MECS	Ministry of Education, Culture and Science
MoCUD	Ministry of Construction and Urban Development
MoE	Ministry of Environment
MoF	Ministry of Finance
MoFA	Ministry of Food and Agriculture
MoFE	Ministry of Fuel and Energy
MoH	Ministry of Health
MoIC	Ministry of Industry and Commerce
MoRTT	Ministry of Roads, Transportation and Tourism
NIS	National Innovation System
PPP	Purchasing Power Parity
OECD	Organisation for Economic Co–operation and Development
R&D	Research and Development
S&T	Science and Technology
SILG	Strategic Industry Leaders Group
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UNESCO	United Nations Educational, Scientific and Cultural Organization

Glossary

Frascati Manual – is a document stipulating the methodology for collecting and using statistics about research and development. Over the past 40 years, the NESTI group has developed a series of documents, known as "Frascati Family", that includes manuals on R&D (Frascati Manual), innovation (Oslo Manual), innovation in developing countries (Bogota Manual), human resources (Canberra Manual), technological balance of payments and patents as science and technology indicators.

R&D[1] – Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

The term R&D covers three activities: basic research, applied research and experimental development

1. **Basic research** – is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.

Basic research analyses properties, structures and relationships with a view to formulating and testing hypotheses, theories or laws. The results of basic research are not generally sold but are usually published in scientific journals or circulated to interested colleagues. In basic research, scientists have some freedom to set their own goals.

Basic research can be oriented or directed towards some broad fields of general interest, with the explicit goal of a broad range of applications in the future. One example is the public research programmes on nanotechnology which several countries have decided on.

Firms in the private sector may also undertake basic research, with a view to preparing for the next generation of technology. Research on fuel cell technology is a case in point. It is defined in the Frascati Manual as "oriented basic research".

Oriented basic research may be distinguished from pure basic research as follows:

- Pure basic research is carried out for the advancement of knowledge, without seeking long–term economic or social benefits or making any effort to apply the results to practical problems or to transfer the results to sectors responsible for their application.
- Oriented basic research is carried out with the expectation that it will produce a broad base of knowledge likely to form the basis of the solution to recognized or expected, current or future problems or possibilities.

[1] OECD (2002), *Frascatti Manual*

2. **Applied research** – is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective. Applied research is undertaken either to determine possible uses for the findings of basic research or to determine new methods or ways of achieving specific and predetermined objectives. The results of applied research are intended primarily to be valid for a single or limited number of products, operations, methods or systems. Applied research gives operational form to ideas. The knowledge or information derived from it is often patented but may be kept secret.

3. **Experimental development –** is systematic work, drawing on knowledge gained from research and practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

   In the social sciences, experimental development may be defined as the process of translating knowledge gained through research into operational programmes, including demonstration projects undertaken for testing and evaluation purposes. The category has little or no meaning for the humanities.

All education and training of personnel in the natural sciences, engineering, medicine, agriculture, the social sciences and the humanities in universities and special institutions of higher and post–secondary education should be excluded. However, research by students at the PhD level carried out at universities should be counted, whenever possible, as a part of R&D.

The specialized activities of:

– Collecting
– Coding
– Recoding
– Classifying
– Disseminating
– Translating
– Analysing
– Evaluating

} by

– Scientific and technical personel
– Bibliograhic service
– Patent service
– Scientific and technical information, extension and advisory services
– Scientific conferences

are to be excluded, except when conducted solely or primarily for the purpose of R&D support.

Innovation – A technological product innovation is the implementation/commercialization of a product with improved performance characteristics such as to deliver objectively new or improved services to the consumer. A technological process innovation is the implementation/adoption of new or significantly improved production or delivery methods. It may involve changes in equipment, human resources, working methods or a combination of these.

Full–time equivalent (FTE) is a way to measure a worker's productivity and/or involvement in a project. An FTE of 1.0 means that the person is equivalent to a full–time worker. An FTE of 0.5 may signal that the worker is only half–time, or that his projected output (due to differences in qualification, for example) is only half of what one may expect.

Purchasing power parity (PPP) is the method of using the long–run equilibrium exchange rate of two currencies to equalize the currencies' purchasing power. It is

based on the law of one price, the idea that, in an efficient market, identical goods must have only one price. These special exchange rates are often used to compare the standards of living of two or more countries.

Patent is a document issued by the competent state authority which certifies the recognition of the given solution as an invention or industrial design, and grants the author an exclusive right to own the invention or industrial design for a certain period of time.

Industrial design refers to the creative activity of achieving a formal or ornamental appearance for mass–produced items that, within the available cost constraints, satisfies both the need for the item to appeal visually to potential consumers, and the need for the item to perform its intended function efficiently. In a legal sense, industrial design refers to the right granted in many countries, pursuant to a registration system, to protect the original ornamental and non–functional features of an industrial article or product that result from design activity.

Trademark is any sign that individualizes the goods of a given enterprise and distinguishes them from the goods of its competitors.

Utility models – In a number of countries protection may be obtained for "utility models." In essence "utility model" is merely a name given to certain inventions, namely—according to the laws of most countries which contain provisions on utility models—inventions in the mechanical field.

The Impact factor, very often abbreviated **IF**, is a measure of the citations to science and social science journals. It is frequently used as a proxy for the importance of a journal to its field. The impact factor for a journal is calculated based on a three–year period, and can be considered to be the average number of times published papers are cited up to two years after publication. For example, the 2003 impact factor for a journal would be calculated as follows:

IF calculation:

A = the number of times articles published in 2003–2004 were cited in indexed journals during 2005

B = the number of articles, reviews, proceedings or notes published in 2003–2004

2005 impact factor = A/B

(note that the 2005 impact factor was actually published in 2006, because it could not be calculated until all of the 2005 publications had been received.)

Scientific and technological activities (STA)[1]: systematic activities which are closely concerned with the generation, advancement, dissemination, and application of scientific and technical knowledge in all fields of science and technology. These include such activities as **R&D**, scientific and technological education and training (**STET**) and the scientific and technological services (**STS**)

STA = R&D+ STET+STS

"Zehets ajil" – The phrase "zehets ajil" means "available or completed work." In Mongolia this concept is used as completed results of applied research project that can be used for commercialization.

1 *OECD (2002), Frascatti Manual*

Chapter ONE.

BACKGROUND OF THE MASTER PLAN

1.1. The rationale of developing Science and Technology Master Plan

First documented government order to develop and implement Science and Technology (S&T) Master Plan was included in the "Government policy on science and technology" and "Approving the program of government activities" (1998). In 2004, the Parliament of Mongolia has passed a decree No. 24 to develop and implement the Master plan.

In addition, experts and scholars from Mongolia and other international organizations have constantly remarked, in their recommendations, about the importance of establishing an effective S&T system and structure, improving S&T financing mechanism, and developing and implementing economy growth targeted S&T strategies.

For instance, a policy recommendation by UNESCO composed in 2000 states: "a developing country's concern is to enhance the development of S&T, and to fully process national natural resources and raw materials for the production of internationally competitive products in order to enhance the growth of economy. A MASTER PLAN is necessary to match the S&T growth, new results, and commercialization system with the market and social needs. It is important to align R&D capacity with market demand, establish a system with improved S&T and research capacity and practical policy decision–making process by utilizing available opportunities and potentials in accordance with economic growth and social demands."

Multiple factors such as globalization, rapid growth of information technology, socio–economic system transformation of Mongolia, and recommendations of international experts have led to the development of the Master Plan.

This plan will be the key document to guide government, business, and public organizations' efforts toward intensive and comprehensive development of science and technology of Mongolia for 2020. The Master Plan implementation goal consists of developing advanced technology, using science capacity and resources as a source for economic growth, establishing effective innovation system, and promoting sustainable development of R&D sector.

1.2. Concepts followed during the Master Plan development, innovation trends

The development of the Master Plan was based on Network of Excellence, in other words, integrating and utilizing knowledge, experience, and ability of scientists from many sectors. Another essential ingredients of the S&T system are establishing performance–based R&D financing and the essence of having clear and measurable research evaluation.

During the development of National S&T Master Plan experiences and practices of other countries were applied by the following directions:

- Science and technology policy needs to be adaptable and flexible enough to respond to changes in the regional and global technology and business environment, therefore, comprehensive research is needed to initiate and adjust to an effective policy implementation mechanism;
- Increasing funding sources to support the collaboration and partnership between government – private – research organizations;
- Policy support for science and technology activity should be directed towards stimulating innovation activities that are essential in other sectors;
- Developing and implementing a policy that stimulates the commitment towards establishing a network with integrated and coordinated goals and directions; the efforts of such policy support should be aimed at enhancing technology development and its feasibility;
- Science and technology policy needs to aim at establishing a system with constant monitoring and evaluation to improve Government investment efficiency in S&T sector;
- Developing alternative implementation programs with valid and feasible science and technology policy priorities and objectives.
- To support interrelated science and technology activities
- To support the knowledge based innovation activities of the national development strategies
- To establish the science system as the basis of research and technology development and improve international S&T collaboration
- To improve the technology growth and innovation capacity of private enterprises. To focus on the improvement of technological capacity of priority industry sectors.
- Linking National S&T capacity with the regional and global network

The following principles were pursued in the development of the Master plan:

- Encouraging private sectors to participate in the development of S&T sector and utilizing S&T results
- Ensuring information transparency
- Developing a plan that reflects socio–economic interests and objectives
- Supporting the transfer and adoption of advanced foreign and domestic technologies
- Ensuring the transparency and acuracy of performance indicators of investments

1.3. The methodology and road map used in the development of the Master plan

The S&T Master plan was developed through the following sequence stages, using the strategic planning principle and approach.

1. Setting up a planning team, drawing a “road map”
2. Evaluating S&T sector to properly assess current situation
3. Setting S&T development goals up to 2020

4. Developing strategies to reach the goals
5. Setting indicators to measure and evaluate long–term, medium–term results; setting quantitative and qualitative indicators to measure goals and objectives
6. Integrating the documents and the results of analyses
7. Calculating the costs and possible risks that could arise during the implementation of the plan; verifying the implementation process results with a simulation software

With the use of participatory approach in the development of S&T Master plan, shown in the "road map," it is expected to be a result–based plan.

The context of the Master plan was developed after completing the following steps:

1. Sectoral analysis
2. Assessment
3. Policy development, goal setting
4. Activity implementation planning
5. Necessary funding estimation

Based on these analyses, Master plan implementation indicators were categorized into three groups – 1. Quality, 2. Innovation, 3. Management – which enables to reveal not only the end results but also the progress of the implementation process.

The overall S&T Master plan methodology consists of FIVE interrelated logical stages:

1. Reformulating the role and services of S&T sector to society; setting sector mission by using SWOT analysis, formulating vision, developing key strategies, setting values;
2. Identifying development goals and objectives;
3. Developing strategies to reach these goals and objectives;
4. Developing an action plan to implement the strategies;
5. Evaluating each stage of implementation; if necessary, making changes or modifications in the plan.

Using this methodology in the evaluation and monitoring process is useful not only to modify current programs/projects, but also to plan future policies and activities.

To summarize, the S&T Master plan was developed by using strategy planning, result–based management, cross–sectoral methodology.

1.4. Master plan framework and timeframe

Master plan's framework covers not only Ministry related S&T issues but also other essential socio–economic sectors in order to adopt an effective national innovation system.

As the sub–sector level, the following S&T sectors were selected:

- Medical sciences
- Natural sciences
- Agriculture
- Engineering
- Social sciences and humanities

1.5. Content structure of the Master plan

Each part of the Master plan content contains relevant evaluations and diagnoses:

1. Chapter one. Background of the Master plan
2. Chapter two. Current socio–economic and S&T situation of Mongolia
3. Chapter three. Policy objectives and strategies to develop science and technology for 2020
4. Chapter four. Financial framework Master plan implementation
5. Chapter five. The management framework of the Master plan implementation
6. Chapter six. Monitoring and Evaluation of the Master plan implementation
7. Chapter seven. Activity plan for 2010
8. ANNEXES

The following goals are to be implemented through 3 stages:

2007–2010 (1st stage)
2011–2015 (2nd stage)
2016–2020 (3rd stage).

The S&T Master plan contains 5 main goals:

1. Establish and develop a competitive R&D sector
2. Create an effective national innovation system
3. Create a legal and institutional system of protecting and utilizing the results of R&D
4. Reforming economy on the basis of technological innovation
5. Develop an effective international science and technology cooperation

The Master plan includes the models for 6 Targeted programs (Annex 2) which will serve as the main mechanism for the implementation of objectives and activities of the Master plan.

1. Identifying and implementing S&T priorities and key technologies of Mongolia
2. National innovation system (NIS) development
3. Enhancing S&T information, monitoring and evaluation system
4. Development of advanced technology in Mongolia
5. Training and supporting young researchers
6. Supporting university R&D

Chapter TWO.

CURRENT SOCIO–ECONOMIC AND S&T SITUATION OF MONGOLIA

2.1. Socio–economic development and S&T capacity

It is commonly agreed that the key to economic development lies in adopting knowledge–based economy. S&T and innovation development determines country's economic development and its competitiveness in the global market. In the initial stages of transition to market, the main concern was to sustain a macroeconomic stability, whereas today, the top priority is to develop a basis for long–term economic growth. In today's rapidly developing world, ability to swiftly process information, identifying critical mass, and investing in intellectual properties have become crucial factors of effective organization and economy development. Investing in intellectual properties has become one of the most efficient ways to utilize capital. Intangible property as a percentage of total assets of firms and corporations is rapidly increasing. As the commercialization of S&T results becomes more active, the process of innovation cycle becomes more recurrent leading to accelerated production of innovation products and technologies.

There is still a lack of contribution of S&T sector to the national economic growth, and our country's innovation activities are still obsolete in the global and regional level. Continuance of such trend further increases the risk of economy decline.

Based on comprehensive S&T analysis, the S&T Master plan's aim is to select an appropriate development module in order to develop an accurate policy.

Within the framework of the S&T Master plan development in 2007–2020, in 2006 the Ministry of Education, Culture and Science (MECS) has conducted an evaluation and assessment on S&T sector capacity, and consequently, has identified key issues of the sector.[1]

Compared to lower–middle–income economies, the imports as a percentage of GDP of Mongolia is 2–4 times lower[2]. This illustrates our economy's dependence on foreign countries with relatively low value added and trade ratio. Out of total export products of Mongolia, 45% is produced with non–technological content, 52% are low technology products, and 3% contain low–medium technology content. However, the percentage of imported products with medium–high, low–medium, and low technologies is very high.

Although, in the past, the Government has developed several policy documents and national programs on science and technology development, very few have come to realization. The socio–economic and industry development documents did not contain sufficient support on utilizing S&T resources, S&T – academia –

1 *"Science and technology sector assessment of Mongolia," MECS, 2006*
2 *"World development Indicators", 2005*

industry collaboration, or international cooperation on S&T. Without a system and infrastructure that supports these linkages, the public awareness on importance of S&T will remain low. Therefore, there is even a greater necessity for coordinating cross–sectoral activities, establishing accurate information and monitoring system, adopting effective innovation system, and setting accurate and feasible policy development strategies.

2.2. Current S&T situation

During the transition period, the Government of Mongolia has made numerous attempts to attain a policy on S&T development, utilizing R&D results, enhancing industry's role in S&T, and establishing a structure and legal environment that meets the global demands. Some of the major laws and regulations include: Constitution of Mongolia (1992), Law on National security (2001), National security policy (1994), Mongolian Foreign Affairs Policy (1994), Government policy on S&T (1998), Law on S&T (1998), Law on technology transfer (1998), Law on Legal Status of the Mongolian Academy of Sciences (1996), Law on higher education (2002), Patent law (1993, 2006), Copyright law (1993, 2006).

As of 2006, there are 2642 personnel working in 51 (47 government, 4 private) research organizations which include research institutes, R&D corporations, and universities.

S&T human resource quantity and structure has noticeably changed. The number of researchers has decreased from 3102 in 1995, to 2642 in 2004. The number of engineers and technical personnel, who play a direct role in the effectiveness and quality of R&D, has been reduced by 2.5 times. In 1996, researchers up to 40 years of age made up 52.2% of total researchers. The decrease of this figure to 44.3%, in 2004, is correlated to decrease in salary and popularity of S&T occupation.

90% of research institutes are located in the capital city, Ulaanbaatar. 75% of S&T personnel consist of researchers. In recent years there has been considerable progress regarding the training of young researchers. As of 2005, 171 young researchers and scientists from 32 research institutes and universities of Mongolia are studying abroad in 25 countries. As of 2006, the percentage of research personnel with education degrees (ScD, PhD, master) is at 48.9% which is not a low number, even compared to other countries. One–third of research personnel are in natural sciences sector, and each of social sciences and engineering sectors contain one–fifth of research personnel.

One of the widely used indicators to evaluate S&T capacity is the "number of researchers per 1 million population". This indicator tends to decrease in Mongolia in the past ten years. The decrease in numbers of college and university students enrolled in natural science, technology and engineering fields could lead to shortage of skilled specialists in this sector.

In the past 10 years, current S&T expenditures have increased by 5.6 times, and expenditures at 1995 prices have increased twice. As of 2005, S&T sector budget expenditure is 4,605.7 million tugrik (or 3.9 million US dollars) or 0.35% of GDP. According to statistics, 90% of funding for S&T sector is financed by government and 10% is generated from non–government sources.

When comparing S&T funding to other countries, it appears as if S&T sector activities of Mongolia are funded solely by the Government budget. This is due to a lack of research and/or detailed reports on source of funding, thus there are no available statistical data.

The S&T expenditure has been rapidly declining since 1990. In 1990, 1.0% of GDP was contributed to S&T activities which was comparable to developed countries. However since 1990, the number has been reduced to 0.35% in 2004 which is comparable among developing countries (Georgia – 0.3, Bolivia – 0.3, Kyrgyzstan – 0.2, Mauritania – 0.3).

As of 2004, R&D expenditure per researcher (including university professors and tutors) was US $1,300. This figure is almost 45 times lower compared to developing countries ($58,000).

Determining S&T activities and S&T expenditures of colleges and universities is not a simple task. In 2005, out of 2938 faculty staff in 11 public universities, 963 or 33% had education degrees. According to National Science Foundation data, colleges and universities consumed 20% of total R&D expenditures which suggests their researchers and scientists are not utilized to the fullest capacity.

In the past five years, increase of expenditures in basic research and decrease in applied research costs are not a favorable indication for a country with such limited S&T resources. It has passed five years since financing and initiating "Zehets ajil[1]" projects for the purpose of utilizing research results. Through 2000–2006, 52 "Zehets ajil" projects have been announced and implemented in the areas of new materials, adopting technologies, and exploiting natural resources.

Although funding among S&T sectors is relatively balanced, it is preferable to increase R&D funding for agriculture and engineering sectors. On the other hand, R&D funding for natural science sector is considerably higher than other sectors.

In 2004, out of 10.1 billion tugrik of total research institutes' capital 64.9% consisted of properties and 23.6% consisted of machinery and equipment. 45.5% of total machinery and equipment were obsolete. The indicators for facilities and equipment show downward numbers.

According to 2006 statistics, research institutes and universities require at least 405 different types (or 1198 pieces) of tools and equipment, which requires at least 4,449 million tugriks, in order to conduct advanced R&D.

One of the S&T performance indicators used in Mongolia is the number of publications in foreign countries. Like in most countries, natural science (44.2%) social science and humanities (23.3%) share most of the proportion of published books or articles.

2004 statistics on the number of publications per S&T personnel among S&T sectors show quite proportionate numbers. The number of patents per 100 S&T personnel reveals that engineering (3.6) and medical science (4.5) have the highest figures. The expenditure per personnel is highest in Agriculture sector (1.29 million tugriks), and lowest in engineering sector (0.69 million tugriks).

In 1990–2002, annual average number of registered patents was 130–140; nonetheless since 1994–2004, only 19 of total 67 license agreements were in effect. This shows a very ineffective utilization of intellectual properties.

In 2005, the Ministry of Education, Culture, and Science conducted a survey among 9 large industry enterprises: Erdenet Mining Corporation, APU Corporation, Buyan

1 *The phrase "zehets ajil" means "available or completed work." In Mongolia this concept is used as completed results of applied research project that can be used for commercialization.*

Co. Ltd, Newcom Co. Ltd, Gobi Corporation, 3rd Energy station of Ulaanbaatar, MCS Group, Darhan Steel Factory, Golomt Bank, and Altan Taria Co. Ltd. The results revealed that 8 of them performed R&D activities besides their main activity; 5 of these had a unit in charge of R&D activities. 7 of the participants responded they "cooperate with research institutes and universities." The forms of the cooperation are as follows:

Form of cooperation	Responses
Joint projects and researches	71.4%
Staff training and consulting	57.1%
Contract research work	42.9%
Donation	28.6%

The results of the survey also revealed that private enterprises spend considerable capital on R&D (in 2004 6,271.8 million tugrik). The fact that 2004 R&D expenditure of 5 respondents is 14.5% higher than 2003 state budget expenditure on R&D invalidates the early–mentioned perception that S&T sector activities of Mongolia are funded solely by government budget.

Current state of innovation: The global trends and experiences show that today economies are developed by utilizing intellectual capacity of society in dynamic socio–economic growth, by developing an effective education and innovation systems based on "knowledge–based" environment, and by establishing an infrastructure and legal environment through a government policy. Some of the prerequisites necessary for such development are available in Mongolia, for instance:

- The basic science sectors are developing
- The opportunities and conditions are becoming increasingly favorable for conducting applied research, technology development, and utilizing R&D results
- The basis of vocational education and training system is established
- Legal environment to create some of the elements of innovation structure, innovation–technology center, technology transfer center, industry park, is being established

However, the necessity to develop these through linkage with market demand is becoming increasingly complex.

For the purpose of developing and adapting to an effective innovation system, the following obstacles are encountered:

- The economic demand on commercializing research results is weak. This is caused by several things: limited capital of industry to expand innovation activities, high cost of developing a new technology, high economic risk, lengthy investment payback period.
- Financial and human resources are not structured in a way to support the implementation of science–industry projects; activities related to evaluating and utilizing government funded research results are not adequate.
- The interaction and collaboration among research institutes, colleges and universities, and industry is weakly linked which is an unfavorable factor for conducting joint innovation projects, exchanging and training researchers and engineers, and executing the stages of "applied research–experimental development–production.
- Market and innovation information on producing new products and technologies is not adequate.

- The significance of innovation process in the socio–economic development is not fully recognized by government and administrative agencies;

2.3. Current issues of the S&T sector

Based on the results of S&T sector assessment of Mongolia, the following issues were composed.

I. Innovation

1. Legal environment to enhance and coordinate innovation activities is not fully established; there is a lack of economic stimulus from the Government to support such environment.
2. Innovation infrastructure is not developed; knowledge and technology transfer mechanism is not well established.
3. Industry's participation in the innovation development is weak; the process of "maturing" of small enterprises is slow.
4. Activities to commercialize R&D results are inadequate; there is a weak collaboration among educational and research institutes, innovation organizations, and small, medium and big enterprises.
5. Industry technology is underdeveloped; science–industry link is weak; our economy is notably dependent on foreign technology.
6. Industry's response to adopt technology solution is weak; industry's overall demand and interest to implement R&D is low.

II. Quality

1. Research organizations lack laboratory facilities; lack of funding for equipment and tools; theoretical and practical expertise level of researchers is comparatively low; research organizations are not adapted to operate under competitive market conditions; the capability to conduct R&D is inadequate.
2. There is no advanced system to monitor and evaluate research expenditures, results, and productivity; the indicators to assess S&T level and capacity are too vague and irrelevant; detailed statistical data on S&T sector is lacking; there are no determined indicators to monitor and evaluate activities of researchers.
3. Due to high concentration on purchase of imported technologies and equipment, industry is ignoring the knowledge and technologies of domestic R&D sector, thus, causing waste of R&D expenditures and potentials.
4. The system of monitoring and assessment of S&T sector is merely at the early stages of development.
5. The Government has been funding applied researches with low domestic or international market demands. Lack of performance indicators to accurately evaluate S&T outputs and lack of precise priority directions has led to ineffective usage of already scarce resources in Mongolia.

III. Management

1. Although Mongolia is rich in natural and agricultural resources, S&T sector plays little role in utilizing them;
2. Subjects of research projects that are selected and implemented do not correspond to market demands; opportunities are limited for updating and exchanging information; management and control over government funded activities is not effective;
3. There is no policy on enhancing science–education collaboration;

4. Budget funding system for S&T sector is ineffective and inefficient; the amount of funding is insufficient, and the distribution and utilization of funds is not effective;
5. The policies of socio–economic and S&T development are not coordinated; there is no definite methodology of setting priority areas and key technologies; cross–sectoral coordination of S&T activities is weak; the role and activities of National Council of Science and Technology in S&T sector is limited; there is no integrated policy on technology development; the system of transferring, assessing, and adopting foreign technology is yet to be established; a policy on training S&T personnel is not refined; the S&T development policy is unclear and activity management is poorly organized;
6. Compared to other sectors, S&T sector of Mongolia receives very little financial support and loans; there are few joint projects and programs with foreign countries and organizations; most of the joint projects with foreign organizations are implemented according to the interest and benefit of the foreign side; inadequate actions are carried out to maximize the use of resources and to collaborate with Mongolian researchers who work abroad.
7. Results of R&D are not fully utilized, and their intellectual property rights are not properly enforced.
8. The salary of S&T personnel, which is significantly lower than the researchers in the domestic private sector or international academic peers, has a negative impact on young scholars to commit themselves to sustainable academic work.

2.4. The rationale for the system reforms

The slow transition progress of our economy into a knowledge–based economy, and slow development of innovation and technology are directly associated with slow adaptation to the new system and infrastructure following the disintegration of centralized economy. In addition, administrative authorities of every level neglect the importance of an issue, and they offer little incentives to promote selection and implementation of an appropriate innovation development approach. Consequently, without accurate priorities, opportunities are lost to exploit substantial amount of available resources.

In order to renew industrial technologies, increasing of investments has become one of the key priorities. This requires a great deal of commitment in order to increase the competitiveness and to promote technology development.

System reforms and promotion of an enhanced development of S&T and innovation are essential for a successful implementation of the Master plan. These include:

- Providing stimulus for investments in new knowledge and advanced technologies;
- Increasing the awareness of need for technology among stakeholders of economy;
- Enhancing innovation activities through constant upgrade of technologies;
- Increasing the Government support for establishing favorable custom duties and tariffs, enforcing intellectual property rights, improving the system of basic research and higher education.

Chapter THREE.

POLICY OBJECTIVES AND STRATEGIES TO DEVELOP SCIENCE AND TECHNOLOGY FOR 2020

3.1 Policy strategy options, implementation principles, and priorities

In order to address the systemic challenges, there is a need for a comprehensive state policy to optimize and develop the S&T and Innovation sectors meeting the market demands, to nurture knowledge, to rapidly commercialize and apply into the economy the findings and intellectual properties developed as a result of undertaken projects in the priority academic and research areas. In order to implement these actions, the strategy and key principles of the state policy are identified as follows.

1) Policy strategy

In addressing the sector challenges, the enhancement of competitiveness of R&D, the development of the effective infrastructure for innovation, undertaking of the technology renewal in selected economy sectors through combined efforts of the National academic institutions and adaptation of advanced international technologies will be undertaken through development of the enabling environment for "knowledge nurturing" and focus of resources in the few selected priority areas.

2) Key implementation principles

The public funds and resources allocated for R&D shall be primarily targeted at the following priority areas:

- Oriented basic research as a source for promotion of applied research and experimental development;
- Few selected S&T priority areas to lift the competitiveness of S&T internationally, to enhance the economic efficiency of R&D;
- Development of the National innovation infrastructure to develop and apply into the production of knowledge intensive products, services and technologies; to link the investments with the demand and interest of producers.

The public–private partnership, in the framework of R&D and technological renewal of economic sectors, shall be undertaken in line with the following principles:

- To jointly finance, from the state budget and private sector, the activities aimed to develop the applied research and innovation infrastructure;
- To enhance the competitiveness of key industry sectors through technology renewal and effective regulation of R&D activities;
- To promote from the state the private sector participation in enabling of

innovation market in the academic sector;
- To implement the S&T priority areas by means of targeted programs; to increase the non–government resources for the implementation.

3) Policy priorities of S&T

1. To reform the management, financial system, legal framework of S&T operations in line with the social, market demands, the National and regional development trends, effective use of the sector resources;
2. In promoting the "Academia–Science–Industry" integrated partnership to encourage the training of highly qualified engineers, analysts and professionals, and to undertake those academic and research works as the priority that are in line with the market development trends and demands;
3. To increase the role of S&T in the nation's development through directing the capacity and resources of the National S&T at addressing the social and economic challenges of priority industry sectors such as exploration of minerals, mining, agriculture, and energy;
4. To establish and develop national innovation infrastructure to train the professionals, and to ensure the legal framework that enables innovation activities in all sectors;
5. To develop strategic basic research that focuses on progressive ideas and initiatives for the technological innovation;
6. To fully introduce and apply the information and communication technology into education, health, civil service, business and commerce sectors.

3.2. Vision, Mission, and Values of the S&T sector

1) Vision

In the XXI century Mongolian S&T follows the primary principle to "be a nation developing the science based on new knowledge and advanced technology", *to practice the national innovation system as a driving force for social and economic development for 2020, and to ensure secure and quality living of the people by creating and producing advanced knowledge and by continuously supporting the science and technology progress and development,*

2) Mission

The mission of the science and technology of Mongolia is *to practice the effective management and finance systems based on the social and market demands, ensure ecological balance, by supporting effective utilization of sectoral resources, by facilitating effective education–science–industry collaboration, by gaining comparative advantage through enhanced competitiveness of small and medium enterprises, and by maintaining environmental and ecological balance.*

3) Values of the S&T

- Intellectual capital
- Integration of Research and Education
- Innovation Partnership

3.3. S&T development policy goals and strategies

Goal 1. Establish and develop a competitive R&D sector that meets market needs and demands

Strategy 1.1. To identify the S&T priorities and enable its implementation system in line with the structural changes of the economy and development trends

Strategy 1.2. To enhance the selection of R&D works to be financed from the public funds by optimizing the management, structure, and financing mechanisms of science and technology sector

Strategy 1.3. Restructuring the research organizations, enhance their capacity building, make structural changes in the Government R&D sector

Strategy 1.4. To intensify the collaboration among research institutes and universities

Strategy 1.5. To introduce significant reforms in the S&T human resource management

Goal 2. Create an effective national innovation system

Strategy 2.1. To create economic stimuli for the collaboration of science–industry activities and joint research work

Strategy 2.2. Implement a policy supporting all types innovation funding

Strategy 2.3. Create and develop the innovation infrastructure

Strategy 2.4. Establish a system that prepares specialists, and provides information and consulting service that are useful for participants in innovation activities

Goal 3. Improve the legal and institutional system of protecting and utilizing the results of R&D

Strategy 3.1. Improve the system of protecting and utilizing the intellectual property rights

Strategy 3.2. Establish an information database of government–financed R&D results; support and stimulate the activities related to commercialization and popularization of research results

Goal 4. Reforming economy on the basis of technological innovation

Strategy 4.1. Increase the demand on innovation in industrial sector, promote the technological renovation, support the efforts to intensify the technology development, create the conditions for formation of innovation clusters and network.Make a technological reform in the economy by developing advanced technologies and by actively participating in the international technological cooperation, and improve the technology competitiveness

Strategy 4.3. Create a sustainable legal and organizational environment supporting the S&T cooperation between public and private sectors

Strategy 4.4. Create a long–term technology forecast system of Mongolia

Strategy 4.5. Strengthening the role of R&D sector in the national economic system

Goal 5. Enhance the effectiveness of international science and technology cooperation

Strategy 5.1. Identify priority cooperation areas in the international and regional S&T, involve the Mongolian researchers studying and working abroad in the national research work, improve the capacity of laboratories, increase the funding from foreign sources for the preparation of young researchers.

Strategy 5.2. In order to develop the S&T priority areas, create a legal environment for the distribution of some part of the international aids and loans, provided to the Government, to the S&T sector.

3.4. Activities to implement the strategies, expected outcomes

Goal 1. Establish and develop a competitive R&D sector that meets market needs and demands

Strategy 1.1. To identify the S&T priorities and enable its implementation system in line with the structural changes of the economy and development trends

Implementation approaches

1) To define and develop the national priorities of S&T and key technologies.

- Elaborate the methods of identifying the S&T priorities and the list of key technologies, create legal and other environments, and provide information necessary for its implementation information. Largely use this method in the elaboration of the targeted economic technological program and projects of the concrete economic sector.
- Support and finance the research and experimental works conducted by universities, research institutes and business enterprises.
- The requirements when identifying the S&T priorities and key technologies are: 1) the priority should be able to solve simultaneously a number of important national problems or aimed to provide a solution to long term sustainable development of one of the sectors, 2) be able to play a predominant role in the solution of current and future challenges in the economy, society, science and technology, 3) be able to influence other fields and stream lines of the S&T, have a cross–sectoral character, 4) the priorities should have the level and outcome recognized at international level, be able to participate in the international scientific cooperation and attract foreign investments.
- The research priorities for 2010, within the framework of the subsectors of the S&T, responding to the above mentioned requirements are defined as below mentioned:

I. Research priorities of the Natural sciences

1. Develop geo–science basic research studies

2. Make a comprehensive assessment of ecological situation of Mongolia, create a technology and facilities reducing the environmental pollution of anthropogenic character
3. Conduct a comprehensive study of biological resources of Mongolia, and develop chemical and biological processing SMEs to produce specific and biologically active products.

II. Research priorities of Agricultural sciences

1. Protect and study the biological reserves of livestock, flora and fauna, utilize the biological, biotechnological and genetic methods in diagnosing and treatment
2. Cultivate new types of seeds acclimatized to the climate and environment changes of Mongolia, develop a technology of ecological complex of agriculture
3. Improve the monitoring methods of reserves and utilization of pastures, restore the pasture and land in degradation.

III. Research priorities of Technique and Technological sector

1. Create the technology of extraction of minerals and the technology to restore and process the final product;
2. Seek for energy efficient and renewable new technologies, seek for new minerals and construction raw materials, and develop new materials based on advanced technology.
3. Increase the competitiveness of woolen and cashmere products in the international market by improving traditional national technology and acclimatizing the advanced foreign technology.
4. Electronics production and information technology.

IV. Research priorities of Medical sciences

1. Improve the areas of: food security, food and nourishment, the spreading of infectious diseases, immunization, traditions and practices related to the healthy environment, the health of mother and child.
2. Improve the diseases related to: blood circulation, main diseases of children, youth and women, the diabetes, liver disorder. Develop the technology of transplantation and elaborate the bio–technological diagnostics.
3. Theoretical studies on technologies to develop and produce new medicines; conduct integrated studies of traditional and modern medicine.

V. Research priorities of Social sciences and Humanities

1. Conduct studies on the native language of the Mongols, its history, civilization, literature, art, philosophy, ethnical origins, traditions, customs, the mode of life.
2. The social and economic studies on futurology, study of science, politics and law.
3. Researches on the policy of neighboring countries, and of Western and Eastern developed countries concerning Mongolia, and study multilateral problems of relationships and cooperation with these countries.

2) Concentrate resources in priority areas of the S&T development

- The selection of research areas should take into account the following requirements:

1. the research field should have the priority place in the National economy or international scientific program,
2. have an important role in improving the quality of life,
3. to be aimed at strengthening the National security,
4. accelerate the industrial technological development, increase its competitiveness,
5. improve the development of agriculture, increase the amount and quality of food for population,
6. create a comprehensive cluster in the National economy based on S&T.

- Make systematic update on the S&T priorities and key technologies, coordinate it with the concrete stages of social and economic development, develop and perform optimal rapport of the basic and applied studies;
- Introduce the forms of science–industry cooperation in accordance with the market demand, create a favorable legal environment, assure the financial supply;
- Promote joint involvement of state and private sectors in setting S&T research priorities and key technologies;

Strategy 1.2. To enhance the selection of R&D works to be financed from the public funds by optimizing the management, structure, and financing mechanisms of science and technology sector

Implementation approaches

- Develop a flexible administrative and organizational system of the S&T that can facilitate the implementation of the priority tasks;
- Create few numbers of large National research centers to address the common goals and issues of Mongolia; consequently, increase research expenditure, concentrate the resources, and enhance the S&T and socio–economic impact of research work. The research centers to be created:
  - National research center of biology resources
  - National research center of agriculture
  - Medical research institute
  - National research center of mineral resources
  - Technology center of energy development
- Establish a unified system to monitor and evaluate the funding distribution, utilization, and performance of research work;
- Increase the financing resources of the S&T, improve the methods of calculation, planning and expenditures, and optimize the funding mechanism;
- Transfer from current system of financing the organization and staff to the system of financing research projects, in particular, few major targeted programs;
- Develop the quantity and quality indicators of assessing the development level of S&T and its statistics, create an information database.

Strategy 1.3. Restructuring the research organizations, enhance their capacity building, make structural changes in the Government R&D sector

Implementation approaches

- Improve the research organizations' capacity building by increasing the efficiency their activities, taking into account the distinctive characteristics

of the organizations when conducting basic and applied researches;
- Resolve the matters related to financial sources that is necessary for the renovation of equipments and laboratories of the research organizations;
- Restructuring S&T sector by creating a monitoring and assessment system of the activities and performances of research organizations;
- Establish a legal environment to estimate the value of intellectual properties and to include in the intangible assets of the research organization;
- Enforce the clauses of Law on calculating the value of and registering the intangible assets;
- Create a non–profit, NGO within the framework of the S&T priorities, support and expand their R&D activities, provide a favorable legal environment;

Strategy 1.4. To intensify the collaboration among research institutes and universities

Implementation approaches
- Implement a policy that ensures the coherence of research institutes and universities that conduct basic researches;
- Create joint research teams and groups of scientists and researchers of Universities and research institutes;
- Provide government support to create campuses at the Universities and specialized scientific villages;
- Increase the number and amount of research grants offered to young researchers and professors of the University;
- Support the initiative to create complexes and research–education–production centers to be shared by research and educational organizations;
- Transform and develop some Universities in the form of innovation and "research" University, obtain support of international organizations in the activities of research–education centers;

Strategy 1.5. To introduce significant reforms in the S&T human resource management

Implementation approaches
- Development and implement a program on "Training and supporting young researchers";
- Appreciate in adequate manner the achievement of the scientists and academic staff in research and experimental works, resolve the wage and other social issues of R&D personnel;
- Create favorable good living and working conditions for scientists specialized in priority areas of S&T, take measures creating legal environment and economic stimulation for supporting talented free–lance researchers;
- Develop and implement a document on ethics of scientists and researchers

Expected outcome:
- The S&T sector will develop in sustainable manner and rapidly, thanks to the creation of internationally competitive knowledge, creation of conditions

for its re–production, and development of competitive R&D sector in the country and abroad;
- Creation of a favorable good living and working conditions for S&T personnel;
- Improved utilization of human and financial resources;
- Enhanced resources to solve complex of some socio–economic issues due to creation of at least five National research centers;
- Improved effectiveness of sector activities as the result of elaboration of S&T administrative, organizational, and financial mechanisms;
- Improved research–education collaboration

Goal 2. Create an effective national innovation system

Strategy 2.1. To create economic stimuli for the collaboration of science–industry activities and joint research work

Implementation approaches

- Support and stimulate co–funding of R&D by public and private sectors, strengthen the cooperation between public and private sectors in the field of science and technology;
- State support in the implementation of joint R&D by firms and research institutions in the framework of S&T priorities;
- Coordinate closely the selection of government–funded R&D themes with innovation activities;
- Organize innovation activity as a principal form of activity of research institutes and universities;
- State support in creating, at research institutes and universities, the unit of technology transfer, incubator center, high–tech SME;
- Establish a council on technology policy at regional and national levels;

Strategy 2.2. Implement a policy supporting all types innovation funding

Implementation approaches

- Create a system of continuous funding for projects at all phases of innovation
- Create a venture fund in order to finance "Zehets ajil" and other activities such as developing and experimenting utility models, patenting, and marketing that is coordinated with the strategic and business plan;
- Establish legal environment for continuous support for all phases of innovation activities through financial policy;
- Expand state support on activities of startup innovation firms;
- Improve the legal environment on regulating the financial risks of innovation;
- Develop the cooperation of the parties involved in the innovation system;
- Create legal framework of owning, protecting, transferring and using the results of government–financed innovation projects;

Strategy 2.3. Create and develop the innovation infrastructure

Implementation approaches

- Develop the production–technological infrastructure (technology park, innovation and technology center, business incubator, technology transfer center);
- Develop the forms of cooperation of parties involved in the innovation system;
- Adopt the law on legal status of the elements of innovation infrastructure that was created with the participation of state property;
- Within the framework of economic priority areas, create and develop innovation infrastructure based on large regional industries;
- Provide state support aiming to create the centers responsible for: conducting the technological research, patenting, finding investors, protecting the legal rights of intellectual property;

Strategy 2.4. Establish a system that prepares specialists, and provides information and consulting service that are useful for participants in innovation activities

Implementation approaches

- Create a specialized National information database responsible for supporting innovation activities in order to protect, popularize and commercialize the results of government–financed innovation research;
- Create (independent, or under the research institute or university) centers of specialized education and consulting services on protection of intellectual property, standardization, delivering certificates, conducting technological evaluations;
- Establish, in the framework of innovation, a continued multi–level training system, introduce and diffuse the innovation culture in the science and production fields;
- Prepare specialized human resources in innovation activities; conduct a specialized training;
- Provide the colleges and universities – that have a license to conduct training on innovation policy and management – with skilled instructors and professors, enhance the learning environment;
- Advertise by mass media the results and achievements of successfully implemented innovation activities; regularly, organize the innovation exhibitions and trade fairs.

Expected outcome

- Establishment of an effective national infrastructure, legal environment, and management for innovation activities;
- Development of market relations (1) in use of intellectual resources, (2) innovation assets, (3) innovation products, (4) services supporting the innovation;
- Creation of multiple forms of funding and government supports for innovation activities;
- Creation of advanced technology based innovation clusters as the result of enhanced science – industry collaboration.

Goal 3. Improve the legal and institutional system of protecting and utilizing the results of R&D

Strategy 3.1. Improve the system of protecting and utilizing the intellectual property rights

Implementation approaches

- Develop quantity and quality indicators to assess R&D results; create an information database of these results, detailed S&T statistics and other S&T information, and diffuse them;
- Improve the mechanisms of protecting, introducing, utilizing, monitoring and assessing the Government–financed research results and findings;
- Set the intellectual productivity as main criteria and indicator to evaluate and assess the capacity of research institute and researchers;
- Intensify the cooperation among research, public and private sectors on commercializing and utilizing the results of research work.

Strategy 3.2. Establish an information database of government–financed R&D results; support and stimulate the activities related to commercialization and popularization of research results

Implementation approaches

- Create a unified information database of government–financed research and scientific work;
- Adopt and apply the rules and procedures regulating the use of research results financed by the state and joint financing. The interests of all involved parties (author, employer, contractor, executor, investor) will be protected in a balanced manner;
- Provide the opportunity for domestic firms to openly access information database on research results financed by the state budget;
- In special circumstances, take measures aiming to utilize the research results, financed by the state, through license agreement, free of charge; also in special cases, allow the sale of the research results through auction bids;
- Provide public awareness efforts on the protection of rights and use of the intellectual property.

Expected outcome

- Increased opportunity for research organizations and researchers to benefit from their academic work as the result of improved intellectual property utilization and protection;
- Establishment of information database on R&D results; consequently, increased opportunity to utilize and commercialize these results;
- Increase in the number of license agreements of R&D results.

Goal 4. Reforming economy on the basis of technological innovation

Strategy 4.1. Increase the demand on innovation in industrial sector, promote the technological renovation, support the efforts to intensify the technology development, create the conditions for formation of innovation clusters and network. Make a technological reform in the economy by developing advanced technologies and by actively participating in the international technological cooperation, and improve the technology competitiveness

Implementation approaches

- Create a stable integration of science and technology by stimulating the industrial sectors' demand on innovation and research results.
- Create favorable conditions for increasing foreign investment based on high technology;
- Introduce a system providing long–term discounted loans primarily for production of the high technology products.
- Provide tax discounts on domestic advanced technology products, for a specified period, in order to facilitate the exports of such products.
- Elaborate and execute the plan of implementing and using the advanced technology developed by domestic research organizations.
- Organize exhibitions and trade fairs of high technology goods and services.

Strategy 4.2. Create a sustainable legal and organizational environment supporting the S&T cooperation between public and private sectors

Implementation approaches

- Improve the participation of private sector in the innovation programs and projects.
- Enhance the interest and involvement of private sector in contracting and implementing innovation and S&T projects, and utilizing its results.
- Take necessary measure to promote the co–funding of major national innovation projects by Mongolian Development Fund, SME supporting fund, National S&T Foundation; simultaneously, increase the amount of Government funding for the projects.
- Establish and develop the innovation "active" zones, such as science villages, technology parks, free economic zones; enhance the involvement of private sectors in the activities of these zones.

Strategy 4.3. Create a long–term technology forecast system of Mongolia

Implementation approaches

- Build a sustainable system to forecast long–term technology development of Mongolia.
- Create a system to analyze and assess the S&T situation of Mongolia level.
- Conduct studies on trends of international S&T development.
- Define the indicators to measure the industry's innovation development level and their innovation activity performance; continuously update the indicators.

Strategy 4.4. Strengthening the role of R&D sector in the national economic system

Implementation approaches

- Develop and implement the priority areas of science–industry collaboration in conformity with the development trends of the priority socio–economic sectors;
- Substantially increase the contribution of research institutions in economic renovation by improving the outcome of their activities and their competitiveness at international level;
- Actively introduce and adopt foreign advanced technologies;

Expected outcome

- Improved capability of industrial sectors to absorb the technology; enhanced capacity to steadily develop this technology and conform it to the global economic technological needs.
- Developing advanced technologies will create favorable conditions to technologically restructure the economy.
- Establishment of favorable conditions to create a "technological network" based on advanced technology.
- Establishment of a favorable legal environment to introduce the technologies – developed by domestic research organization – in the industrial and service sectors;
- Expansion of science–industry collaboration due to increase in numbers of technology SMEs;
- Creation of a system to forecast demands on and development of technology;
- Expansion of a market for commercialization of intellectual capitals and knowledge.
- Establishment of a system to stimulate the development of advanced technologies and to increase the demand on innovation;
- Increase of interest and involvement of private sector in contracting, implementing, and funding the innovation and S&T programs and projects, and utilizing its results.

Goal 5. Enhance the effectiveness of international science and technology cooperation

Strategy 5.1. Identify priority cooperation areas in the international and regional S&T, involve the Mongolian researchers studying and working abroad in the national research work, improve the capacity of laboratories, increase the funding from foreign sources for the preparation of young researchers

Implementation approaches

- Expand the international S&T collaboration, increase its effectiveness; develop and implement a program to participate actively in the regional research cooperation;
- To identify the countries and organization to collaborate on international

S&T activities;

- Participate actively in the international and regional S&T cooperation, effectively utilize the resources of the Mongolian researchers studying and working abroad;
- Allocate some part of the foreign aid and loan to the Government for preparing young researchers in order to strengthen the equipment and laboratory supplies; enhance the specialization of young researchers on science priority areas;

Strategy 5.2. In order to develop the S&T priority areas, create a legal environment for the distribution of some part of the international aids and loans, provided to the Government, to the S&T sector

Implementation approaches

- Activate the participation of domestic and international donors and participants in the development and implementation of the S&T programs; create a tripartite cooperation of "International donors–MECS–participants in S&T activities";
- Concentrate domestic and international investments in the development of the S&T priorities;
- To implement the goals and activities of the Master plan through international cooperation and agreement.

Expected outcomes

- Increased involvement of Mongolian scientists and researchers in international research programs and projects.
- Creation of stimuli to attract Mongolian researchers – who study and work in developed countries – in the participation of domestic research work;
- Enhanced activities in the adoption of advanced foreign technologies
- Increased foreign aid and support (technology, funding, human resources) in the development of S&T priorities.

3.5. Favorable factors and potential risks

1) Favorable factors and opportunities

- Availability of intellectual and other resources and capacities in the education and science sector;
- Inherited traditions of collaboration between S&T and higher education;
- Increased budget revenues thanks to the stable prices of gold and copper in global markets, and hence, favorable opportunities for increased technology imports;
- Multinational corporations' trends to locate production and technology complexes in a distributed manner;
- Opportunities to improve the R&D base and to train R&D personnel, within the framework of collaboration with foreign countries and organizations;
- Increasing interest of producers to develop advanced technologies and innovation infrastructure, and to engage in innovation activities;
- Intellectual potentials of Mongolian scholars and researchers working

abroad.

2) Potential risks

- Decreased productivity, competitiveness, and efficiency of human resources and increased cheap workforce imports, due to growing number of firms that have little technology contents and limited value addition;
- Possibility of continued weak interest among producers to commit to a long–term business development;
- Uncertainty of the degree of commitment and preparedness of public agencies to re–allocate and concentrate budget resources on selected priority areas of S&T. The likelihood of this risk is high, and the consequences will be the undelivered targets, the delays in meeting deadlines, the increased transaction costs;
- Budget constraints due to worsened macroeconomic environment; possible economic risks due to increased prices of export raw materials at external markets. The risks of the possible delays and the undelivered targets can be addressed through adjustments in management system, re–allocation of resources in priority areas, additional mobilization of non–budgetary funds, and adjustments in the operational approaches;
- Errors in estimation of efficiency of R&D sector operations. Its effect, during the implementation of the Master plan and its programs, may lead to delays, increased costs and undelivered targets. These errors can be fixed at the operational level;
- Errors in estimation of efficiency of partnership and collaborative initiatives of science–industry. During the implementation of the Master plan and its programs, this could lead to delays, increased costs and undelivered targets. In this case these errors can be fixed at the operational level. It could also require amendments in some legislations;
- Unfavorable international political, economic, and technological factors (force majore risks).

Chapter FOUR.
FINANCIAL FRAMEWORK OF THE MASTER PLAN IMPLEMENTATION

According to projections, if science and technology activities continue to be financed based on current trends, by 2020 the expenditures will not exceed 0.37 percent of GDP. Under this alternative, the policy goals and activity plans of this Master plan are almost impossible to be realized. Therefore, this option is considered as the last resort which will be pursed under the most unfavorable economic conditions of the country. The financial projections of the S&T Master Plan were based on S&T sector assessment of Mongolia in conformity with two alternative options.

The projections were calculated based on the principles of developing S&T capacity in an "intelligent" manner, increasing its positive effect on the economic growth, and consequently establishing and developing the basis of the national innovation system.

The budget expenditures for S&T activities amount to 49.9 billion tugrik in the first phase, 215.2 billion tugrik in the second phase, and 630.2 billion tugrik in the third phase. The financing for science and technology activities was estimated at 1.52 percent of GDP by 2015 and 2.37 percent of GDP by 2020. The state expenditure on S&T is estimated at 0.92 percent of GDP by 2015 and 1.50 percent by 2020. These figures are the minimum estimate amounts for full implementation of the tasks and activities of the Master plan.

It is projected that the funding for the Master plan will derive from two sources. Firstly, the funding from government budget to implement the Master plan activities (developing the S&T and innovation priorities, creating the innovation infrastructure, establishing and supporting small innovation enterprises) were calculated. Secondly, it is projected to finance some activities – such as promoting science and innovation of science and public sectors, increase the demand on innovation in the business sector – from non–government sources.

The projected expenditures for the implementation of the Master Plan in 2007–2020 amount to 1,786.0 billion tugrik from which 920.8 billion will be financed from the Government budget and 865.2 billion tugrik to be financed from non–government sources. More detailed calculations and plans of expenditures are attached in Annex 1.

CHAPTER FIVE.

THE MANAGEMENT FRAMEWORK OF THE MASTER PLAN IMPLEMENTATION

5.1. The management in regulating the implementation of the Master Plan

The S&T Master Plan of Mongolia in 2007–2020 will be implemented through the action plan coordinated with the basic policies on social and economic development and mid–term objectives, and based on the structure and system of science, technology, innovation and industrial sectors.

The targeted programs will closely coordinate the national science, technology and innovation resources and capacities with the policy on developing the industrial sector, and with the objectives and activities of the technological programs of economic sectors. Also the capacities of the National R&D and innovation infrastructure will be used effectively to the maximum extend.

On the other hand, the strategy and programs of economic sectors should respond to the needs of activating the innovation, ensuring the competitiveness of national industries in the international technology market, fully exploiting and developing R&D capacities and resources of the country.

5.2. Distribution of duties and responsibilities

1) The role, responsibility, and leadership of the Government will be crucial administrative and organizational factors for the implementation of the Master Plan. The Government of Mongolia will assume the below–mentioned duties in undertaking the Master Plan:

- To be consistent in implementing the objectives and tasks, defined by the plan; to create a favorable policy and legal environment needed for its performance; to provide funding support;
- The funding gaps of resources for the implementation of the Master Plan will be financed from international resources in the framework of the National policy coordinating the foreign aid to Mongolia.
- To ensure the coordination of the activities of Ministries in order to implement the plan and to create a unified management and organization arrangements at national and local levels;
- To ensure the participation of domestic and international actors in the execution of the plan, providing leadership and coordination;
- To develop and implement the medium, short term and annual plans at a national level. The implementation of the plan will be assessed at each stage in collaboration with concerned parties, and reported to the Government and all other concerned parties;

- To strengthen, in national and local level, the capacities of the S&T administration and planning, its monitoring and assessment;

2) National Council of Science and Technology will coordinate the cross–sectoral research and experimental works of Ministries will assume the following duties:

- To discuss a progress reports on the implementation of the Master Plan and develop a recommendation;
- To develop a recommendation aiming to define the ways of increasing the efficiency of the Plan taking into account the results of its performance and the tendencies of foreign and domestic innovation development;
- To develop a recommendation on the types of procurement in the context of Master Plan implementation and on the necessary amount of financing;
- To discuss scientific, technological and organizational challenges in the course of implementation of the Master Plan and to develop a recommendation on solving those challenges;
- To develop a recommendation on determining the activities, programs, projects, and their necessary funding which will be undertaken in the year;
- To review and assess the S&T activity reports of Science and Technology Councils of the Ministries. The final conclusions of this report will be used by sectoral Ministries, research institutes and the MECS to develop the plan and to project the annual budget for the following year;

3) The Ministry of Education, Culture and Science is a coordinating body in implementing the targeted programs. In the framework of implementing the program, MECS will develop a system for knowledge creation, establish the innovation infrastructure, create a legal environment for utilizing innovation and applied researches in economic sectors. In the strategic framework of implementing the Master Plan, MECS will assume the below mentioned duties:

- To provide standardized methodological administration of the Master Plan implementation, to coordinate and analyze the implementation, and submit to the Government consolidated reports of the implementation progress and evaluation/monitoring every two years;
- To monitor the activities of the organizations implementing the tasks and actions, reflected in the Master Plan;
- To develop draft laws needed for the implementation of the Master Plan and submit it to the Government;
- To elaborate, approve and enforce the legal norms needed for the implementation of this plan;
- To inform the public, through media, about the Master Plan's implementation progress, spending, results, and achievements.
- Assess the implementation progress of concrete activities/actions, reflected in the Master Plan and undertake necessary actions.
- By the end implementation stage period of the Master Plan, to prepare a detailed report on the progress, setbacks, and achievements of the planned tasks; develop an action plan for the further stages and submit it to the government;
- With participation of with other Ministries, the Mongolian Academy of Sciences and business sector to identify the S&T priorities, update the list

of core technologies, and organize and implement concrete activities;

- To create a unified information data base of government–funded science and research works, make it publicly available;
- To evaluate the technological levels of economic sectors, to analyze the perspectives of research and technology development with participation of the sectoral Ministries, the Mongolian Academy of Sciences, and professional organizations;
- To develop a proposal on the establishment of cross–sectoral working group on the coordination of research works and technology programs of the concerned sectors;
- To organize the establishment of innovation infrastructure through close cooperation between the Ministries of the concerned sectors;

4) The sectoral Ministries (MoF, MoIC, MoFE, MoFA, MoE, MoH, MoCUD, MoRTT) will organize activities related to development, implementation of policies on the technological reformation of the sector.

The following S&T related tasks and activities will be implemented:

- Develop and implement a unified policy on S&T
- Enhance the S&T and innovation capacity of the relevant sector
- Incorporate the issues of the relevant sector in the ""Identifying and implementing S&T priorities and key technologies of Mongolia" program
- Develop, contract, and implement S&T programs and projects within the sector
- Evaluate and assess the performance of R&D results; support the commercialization of R&D results
- Take necessary measures to enhance science–industry collaboration within the sector
- Cooperate closely with research institutes, colleges and universities

5) Mongolian Academy of Sciences, Ministries, agencies and state Funds (National S&T Foundation and other national funds) **supporting the science and technological activities** will participate in identifying and implementing the research priorities and in developing the national innovation system. Also, the Mongolian Academy of Sciences will assume the duty to coordinate the government–financed basic researches.

5.3. Stages and terms of implementation

The objectives of the program will be implemented through three stages:

First stage	2007–2010
Second stage	2011–2015
Third stage	2016–2020

The activities and their funding are projected in conformity with the main goals.

Table 5.1. Activity areas

First stage 2007–2010	**Second stage 2011–2015**	**Third stage 2016–2020**
Main goal		
• Develop R&D sector relying on oriented basic research • Increase industrial sector's demand on technological innovation • Establish innovation infrastructure, coordinate their activities	• Strengthen the role of R&D sector in the economy • Develop and implement the targeted programs in conformity with S&T priorities and core technologies • Create an effective and comprehensive innovation system	• Provide a sustainable development of a knowledge creating R&D sector • Expand the framework of targeted programs in conformity with S&T priorities and core technologies • Enhance the technological capacity of industrial organizations and strengthen the international competitiveness of domestic high technology firms • Ensure the sustainable development of an effective innovation system
Approaches to guide and manage the resources		
• Decrease the amount of funding for non–priority S&T and increase the amount of funding for strategic basic researches • Increase the wage of scientists and researchers • Improve the allocation and efficiency of government budget funding • Concentrate the government budget support on commercialization of innovation project results	• Renew the base of scientific equipment and facilities and increase the amount of investment • Increase the government budget funding for major research programs • Funding research projects, implemented in collaboration with foreign organizations in the context of priority areas • Increase the participation of business sector in the co–funding the research projects of priority areas • Increase the required budget financing for establishing innovation production technology infrastructure	• Increase the necessary amount of funding for the implementation of large–scale technology programs. Decrease the amount of government funding and increase the funding amount of non–government sources • Increase the amount of budget expenditure in creating major elements of S&T infrastructure • Enhance the role and participation of S&T specialized funds in the financing of R&D sector; Increase the research funding for joint international research programs with the assistance of foreign S&T foundations • Increase the investment private enterprises in the science and innovation sector • Increase the role of private enterprises in the development of innovation infrastructure

Measures to be undertaken

Increase the efficiency of R&D activities

- Establish a system of identifying and implementing the R&D priorities. Ensure the participation of science, industry, and government sectors in identifying the priorities
- Conduct the reevaluation of properties of the research institutes
- Provide legal framework for ensuring the continuity of the functions of research institutes, following the privatization
- Establish a system of National research center and laboratory; create the conditions for organizing its activities
- Assess the competitive level and development trends of S&T
- Create a monitoring and evaluation system of the activities of research institutions

Increase the volume of capacity building of research institutions and commercialize the results of intellectual activities

- Improve the system of legal protection of S&T results
- Create favorable environment to transfer the intellectual property ownership rights, created by government funding, to the research institutes and innovation firms
- Support the research institutes and universities in patenting the research results
- Provide financial support from the government in commercializing research results

Create favorable conditions for government and business sector cooperation in the field of innovation

- Provide government support for creating a long–term demand on innovation in the production sector
- Develop and implement 3–4 large–scale targeted programs in the field of technology

Support and stimulate the funding from business enterprises in R&D activities, and support the outsourcing of R&D and technologies within a firm

- Provide financial support from the Government in conducting joint research by research institutes, universities and business sector
- Concretize the conditions and requirements of government–financed R&D performed by private firms

Create favorable environment and interests for the investment in R&D

- Ensure a constant increase in the government budget for the program of the Master Plan
- Constantly increase the expenditures needed for renewal of equipments for research works
- Create a training–research centers and "Research University" by intensifying the science–education collaboration

Improve the cooperation between government and business sectors in the field of science and innovation

- Create a system, where the business sector is funding strategic researches of significant social impact
- Enhance the involvement of private sector in the activities of S&T funds
- Expand the participation of private sector in the development of innovation infrastructure

Commercialization of advanced technologies

- Create new conditions for making R&D an integral part of the economy
- Implement major cross–sectoral economic and scientific projects, commercialize their results in order to reach a new technological level
- Implement major S&T action projects at the national research centers

Increase the amount of foreign and domestic investments in the R&D

- Restructure some research institutes, without changing the profile of the research, in order to attract foreign investment
- Provide support in establishment of science–production complexes

Measures to be undertaken

Develop the cooperation between scientific and education institutions, support and train young researchers

- Develop a program to support and train young researchers
- Provide research grants for young researchers
- Support the practice of students at the research institutes and their participation in research projects
- Create and develop research and training centers at universities

Support technological renovation in industrial sectors

- Support the dissemination and propagation of progressive experiences of the organizations with active innovation activities
- Actively support the participation and involvement in the international technological activities

Participate in the regional and international R&D

- Intensify the science and technological cooperation with the countries of the region; create joint research centers
- Interrelate the R&D activities with the international programs and projects, implemented at regional level
- Provide Government funding for the priority research project implemented jointly with foreign countries

Support the creation of Center of Excellence in the field of science and technology

- Create National research centers and network of laboratories in the priority sectors and fields
- Create advanced industrial technologies in the National research center, laboratories, and "Research Universities"; create Center of Excellence the main goal of which is to disseminate these technologies in economic sectors

Develop financial and production–technology infrastructure of innovation

- Create a venture fund in order to support the innovation activities
- Support the major research institutes and universities in the creation of the business incubator and technological parks
- State assistance in the creation of technology diffusion zones
- Support the creation innovation clusters in the regional level

Increase the amount of foreign and domestic investments in the R&D

- Restructure some research institutes, without changing the profile of the research, in order to attract foreign investment
- Provide support in establishment of science–production complexes

Develop the science infrastructure

- Establish the major elements of science infrastructure, support the creation on this basis scientific and innovation clusters
- Create specialized funds supporting the scientific and technological activities

Develop a market of intellectual production and high technology

- In order to increase the commercialization of government–financed research results, support the transfer of rights and utilization of intellectual properties
- Stimulate the capacity building of the intellectual properties of research institutes
- Develop the system of "High technology market"

The targeted programs will be developed based on the following factors and conditions:

1) The preconditions of developing and implementing new technological targeted programs are as follows:

1. Be able to compete at international market
2. Have the capacity to develop the necessary technological and workforce resources
3. Have a widespread framework and amplitude of the cooperation between state and business institutions; assured commitment of private sector to participate in the implementation of the programs.

2) The following five principles are required in the development of the cross–sectoral targeted programs:

1. The themes of the Program will aim at implementing the technological solutions, developed in the country.
2. The program will aim at using R&D results to produce advanced technologies, commercialize and penetrate them in economic sectors; at the same time, the opportunities to use foreign technologies shall be limitless.
3. The program will be implemented by cooperation between state and business sectors; most of the funding in high technology production and services will be invested by business sector.
4. The management of the program should be flexible in promptly using new science findings and technological solutions.
5. The outcome of the program should manifest by its sustainability and capacity for further development; in other words, the positive outcome and effects in the course of the implementation of the program should continue even after its completion.

The tasks, identified in the Master Plan, will be implemented within the framework of the National and sector targeted programs.

Table 5.2. Targeted programs to be implemented in the first stage of the Master plan

Targeted programs	Content	Framework	Launch
1. "Identifying and implementing S&T priorities and key technologies of Mongolia" program	Create a system of identifying and implementing the priorities and key technologies through discussion and participation of specialists, researchers and businessmen and decision–makers	National	2007
2. "National innovation system development" program	Establishing the basis of effective national innovation system that responds to distinctive characteristics of Mongolia	National	2007

3. "Enhancing S&T information, monitoring, and evaluation system" program	Creating an information system that can provide the necessary information in the of policy development and decision–making process in the field of science and technology	Cross–sectoral	2008
4."Development of advanced technology in Mongolia" program	Developing advanced technologies targeted at: improving the research capacity; responding to the multifaceted needs of the industry, population; facilitating the sustainable development of the country; creating favorable conditions of good living, increasing the export	National	2007
5. "Training and supporting young researchers" program	Within the framework of priority directions prepare young generation of the science; improve the conditions and environment of their work and life	National	2007
6. "Supporting university R&D" program	Develop the University centered science, enhance the contribution of students, scientists and professors of the University in the social development by strengthening the alliance of training–science–production	Sectoral	2007

Chapter SIX.

MONITORING AND EVALUATION

6.1. General guiding concepts in monitoring and evaluating the Master plan

There are following guiding concepts in monitoring and evaluating the implementation process of the Master plan:

- Providing integrated information database during the implementation of activities to accomplish the objectives of the Master plan
- Outlining the responsibilities of participants (Ministries, research institutes, universities, private enterprises, and other agencies and unions) in the implementation of National and sectoral targeted programs
- Making decisions based on evaluations of independent experts.

6.2. Stages of monitoring and evaluation, and the responsible organizations

During the monitoring and evaluation stages, Ministry of Education, Culture and Science – with the participation of sectoral stakeholders – will assume the following responsibilities:

- Setting appropriate indicators to monitor, evaluate, and assess the implementation of the Master plan
- Establishing an information database, and gathering and inputting new information data according to the S&T statistical system
- Making policy evaluations and assessments
- Developing a progress report on the Master plan implementation, submitting it to the Government, and ensuring its accessibility to the public

The implementation progress of targeted programs of the Master plan will be monitored and evaluated in accordance with the predetermined evaluation indicators, each of which varies in goals, objectives, activities, and timeframes.

In the last year of each implementation stage, overall evaluation and assessment will be conducted on the achievement of objectives and activities.

In May of each year, the Ministry of Education, Culture, and Science will submit to the Government the results of the evaluation and assessment, together with the proposal for further actions. The report should emphasize the achievement of Master plan's goals, objectives, final output within the intended timeframe and funds, and the efficiency of used funds.

Output indicators

The following are the main indicators to evaluate the implementation of the Master plan. During the monitoring and evaluation stage, the Ministry of Education, Culture, and Science – in collaboration with other relevant organizations and stakeholders – can select from the list of indicators listed in the Annex 3.

Table 6.1. Output indicators

	Indicators	2007	2010	2015	2020
I. R&D funding and expenditure: (%, 2006 prices)					
1.	GERD as a percentage of GDP	0.539	0.854	1.523	2.374
2.	Government expenditure on R&D as a percentage of GDP	0.502	0.690	0.920	0.949
3.	Non–government expenditure on R&D as a percentage of GDP	0.038	0.164	0.603	1.424
4.	Higher education expenditure on R&D as a percentage of GDP	0.108	0.190	0.398	0.712
5.	Percentage of GERD financed by government	93.00	80.77	60.39	40.00
6.	Percentage of GERD financed by non–government sources	7.00	19.23	39.61	60.00
7.	Expenditure on basic and applied researches as a percentage of GERD	89.00	81.17	68.09	55.00
8.	Expenditure on experimental development as a percentage of GERD	11.00	18.83	31.91	45.00
9.	Gross domestic expenditure on technology and engineering researches, billion ¥	0.000	0.236	4.771	37.092
10.	Gross domestic expenditure on high technology R&D, billion ¥	0.0	0.575	7.225	32.264
11.	Gross domestic expenditure on high technology R&D financed by government, billion ¥	0.0	0.053	1.5	9.677
12.	Total researchers per thousand total employment	2.68	2.92	3.44	4.0
13.	Total private sector researchers per thoussand employment	0.134	0.244	0.383	0.6
14.	Total industry researchers per thousand total employment	4.67	5.06	5.87	6.72
15.	Total researchers with PhDs as a percentage of total researchers	20	25.8	35.4	45
16.	Total researchers under the age of 40 as a percentage of total researchers	24	26.5	30.8	35
17.	Total research institutes with internet connections as a percentage of total research institutes	80	90	100	100
18.	Percentage of research equipment renovation (compared to 2006)	1.2	1.8	3.1	10.5

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ANNEX 1. Funding requirements and projections for Master plan

Mongolian economy indicator projections until 2020 (medium scenario)

	2006*	2007*	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GDP (billion current tugrik)	1930.0	2268.5	2755.9	3179.6	3751.4	4409.6	6253.9	7092.3	7977.3	9497.1	11043.6	13185.9	15527.2	17369.2	20222.1
GDP, 1995 prices (billion tugrik)	856.8	957.1	1107.3	1217.0	1367.9	1532.0	2069.8	2235.3	2394.1	2714.9	3035.2	3484.4	3944.4	4244.1	4749.2
Resident population (thousand)	2609.0	2645.5	2679.9	2714.7	2750.0	2785.8	2822.0	2855.8	2890.1	2924.8	2959.9	2995.4	3031.4	3067.7	3104.5
Population growth (%)	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Exchange currency (year average)	1263.4	1295.5	1327.9	1361.1	1395.1	1423.0	1451.4	1480.5	1510.1	1540.3	1571.1	1602.5	1634.6	1667.3	1700.6
GPD per capita (current U$)	585.5	661.9	774.4	860.5	977.8	1112.4	1526.9	1677.5	1827.8	2108.1	2374.8	2747.0	3133.6	3395.9	3830.3
Growth percentage	8.0	13.0	17.0	11.1	13.6	13.8	37.3	9.9	9.0	15.3	12.7	15.7	14.1	8.4	12.8
GDP per capita (thousand tugrik)	739.8	857.5	1028.3	1171.2	1364.1	1582.9	2216.1	2483.5	2760.2	3247.1	3731.1	4402.0	5122.1	5662.0	6513.8
Growth percentage	11.1	15.9	19.9	13.9	16.5	16.0	40.0	12.1	11.1	17.6	14.9	18.0	16.4	10.5	15.0
Real economic growth	7.2	11.7	15.7	9.9	12.4	12.0	35.1	8.0	7.1	13.4	11.8	14.8	13.2	7.6	11.9

S&T sector funding and expenditure projections

№	Indicators	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1	GERD, 2000 prices (million tugrik)	6997.3	11036.1	17029.4	23736.0	33094.4	45082.3	73734.8	94083.4	118082.5	156005.9	199950.1	261827.7	336462.4	408846.0
2	GERD as a percentage of GDP	0.539	0.637	0.742	0.854	0.973	1.1	1.234	1.375	1.523	1.679	1.841	2.012	2.189	2.374
3	Government expenditure on R&D as a percentage of GDP	0.502	0.566	0.629	0.69	0.746	0.799	0.846	0.886	0.92	0.945	0.962	0.969	0.965	0.949
4	Non–government expenditure on R&D as a percentage of GDP	0.038	0.071	0.112	0.164	0.227	0.301	0.388	0.489	0.603	0.733	0.88	1.043	1.224	1.424
5	GERD per capita (million tugrik)	3935.6	5392.1	7530.8	9872.9	13105.3	17185.2	27014.9	33735.1	41540.2	53860.0	67892.3	87498.2	110792.0	132794.4
6	Expenditure on basic research as a percentage of GERD	37.993	36.839	35.685	34.532	33.378	32.224	31.07	29.916	28.762	27.609	26.455	25.301	24.147	22.993
7	Expenditure on applied research as a percentage of GERD	51.019	49.558	48.096	46.635	45.173	43.712	42.25	40.788	39.327	37.865	36.404	34.942	33.481	32.019
8	Expenditure on experimental development as a percentage of GERD	10.988	13.603	16.218	18.834	21.449	24.065	26.68	29.295	31.911	34.526	37.141	39.757	42.372	44.988

ANNEX 2. Targeted programs of the Master plan

1. "Identifying and implementing S&T priorities and key technologies of Mongolia" program

Rationale

Identification of &T priorities and key technologies is one of the main factors for Mongolian economic growth, research development of high–technology sectors, and efficiency of government expenditure on R&D.

Setting a list of S&T priorities and key technologies – and periodically review and update that list – based on mid–term objectives of socio–economic development of Mongolia is an imperative aspect of S&T policy. The purpose of this program is to regularly implement this activity on the scientific basis.

In order to facilitate an industry – and consequently the economy – growth, Australia has been using an approach called Action Agenda with a great success. The concept of this approach is a Strategic Industry Leaders Group (SILG) comprised of the industry stakeholders (businessmen, policy–makers, and scientists) identifies the priority actions that the industry itself will take to realize its full potential.

Goal

Identification and implementation of S&T priorities and key technologies with the participation of scientists, businessmen and policy–makers

Program activities

- Establish a mechanism to set priorities and identify key technologies, and implement them
- Develop the guidelines of actions of a SILG
- Select priority two or three industries with highest growth potentials for which an Action Agenda is proposed, and select the SILG for each industry
- Initiate the SILG activities; there will be following requirements in setting priorities and key technologies:
    1) The priorities and key technologies will be able to achieve several national development goals, and/or will be aimed at sustainable growth of a particular industry
    2) Be able to play a main role in reaching socio–economic and S&T objectives
    3) The priorities and key technologies will be feasible to implement and to positively impact on the development of S&T and other sectors, and to improve cross–sectoral communications
    4) Set priorities that can propel international cooperation and attract foreign investments
- Implementing the Action Agendas

Impact

- Comprehensive and feasible plan of S&T priorities and key technologies implementation

- Improved science–industry–government collaboration
- Growth in industry production and productivity
- Increase of funding sources for R&D
- Establishment of a mechanism of effective and efficient use of resources
- Increase in commercialization of R&D results

Program profile

1. Program title	Identifying S&T priorities and key technologies of Mongolia
2. Legal rationale	Government policy on S&T, articles 2.1.5 and 3.6 (1998) S&T law, articles 8.3.2 and 8.3.3 (1998)
3. Contractor	Ministry of Education, Culture and Science
4. Challenges to address	• Unclear priorities and methods to set and implement priorities and key technologies • Unclear purpose of technologies • Inefficient use of scarce resources • Lack of common goals among industry stakeholders
5. Program goal	Identification and implementation of S&T priorities and key technologies with the participation of scientists, businessmen and policy–makers.
6. Timeframe and stages of implementation	Stage I: 2007–2008 Stage II: 2009–2011 Stage III: 2012–2014
7. Program activities	• Establish a mechanism to set priorities and identify key technologies, and implement them • Develop the guidelines of actions of a SILG • Select priority two or three industries with highest growth potentials for which an Action Agenda is proposed, and select the SILG for each industry • Initiate the SILG activities • Implementing the Action Agendas
8. Impact	• Comprehensive and feasible plan of S&T priorities and key technologies implementation • Improved science–industry–government collaboration • Growth in industry production and productivity • Increase of funding sources for R&D • Establishment of a mechanism of effective and efficient use of resources • Increase in commercialization of R&D results
9. The entity responsible for implementation	Ministry of Education, Culture and Science, and other ministries Mongolian Academy of Sciences Research institutes and universities Business enterprises

2. National innovation system (NIS) development program

Rationale

In modern world, it is evident that the key to successful development of an economy is to develop an innovation policy that meets the economy's needs and unique characteristics.

Currently, Mongolian government has no regulation on innovation policy, therefore, national innovation system of our country has not been established to the full extent. Therefore, immediate initiation of innovation system development is crucial for our economy and other social sectors.

Goal

To establish the basis of national innovation system development

Activity directions

- Review and evaluate current innovation system of Mongolia
- Link the policy goals, strategies, and actions of the innovation system with the National Development Goals
- Develop an implementation and management plan and funding projections of the program
- Develop and implement the legal documents necessary for innovation system development

The purpose of these documents is to coordinate innovation activities, identify the role and responsibilities of stakeholders in innovation activities, administer the activities and funds, and enhance the Government's role in innovation activities, which will address the following directions:

- The goals and objectives of government policy on innovation
- Guiding principles of government policy innovation
- Means of government support on innovation
- Types of innovation activities
- Government contract to establish innovation
- Innovation activity funding source
- Innovation programs
- The role of government organizations and agencies in the implementation of government policy on innovation
- Participants of innovation activity
- International cooperation on innovation activity

Impact

- Establishment of favorable legal environment and organized infrastructure of innovation system
- Development of market relations (1) in use of intellectual resources, (2) innovation assets, (3) innovation products, (4) services supporting the innovation;
- Establishment of multiple forms and mechanisms of government funding for innovation activities
- Creation of advanced–technology–based clusters as the result of

enhanced research institute–industry collaboration

Program profile

1. Program title	National innovation system (NIS) development program
2. Legal rationale	• S&T development national program – 2010 (2000) • Assessment on S&T sector of Mongolia (2006)
3. Contractor	Ministry of Education, Culture and Science
4. Challenges to be addressed	• Establish legal environment of innovation system, national innovation law • Setting NIS indicators • Setting innovation priorities
5. Program goal	To establish the basis of national innovation system development
6. Timeframe and stages of implementation	Stage I: 2007–2010 Stage II: 2011–2015 Stage III: 2016–2020
7. Activity directions	• Evaluate and measure current innovation system of Mongolia • Linking the policy goals, strategies, and actions of the innovation system with the National Development Goals • Developing an implementation and management plan and funding projections of the program • Developing and implementing the legal documents necessary for innovation system development
8. Impact	• Establishment of favorable legal environment and organized infrastructure of innovation system • Development of market relations (1) in use of intellectual resources, (2) innovation assets, (3) innovation products, (4) services supporting the innovation; • Establishment of multiple forms and mechanisms of government funding for innovation activities • Creation of advanced–technology–based clusters as the result of enhanced research institute–industry collaboration
9. The entity responsible for implementation	

3. "Enhancing S&T information, monitoring and evaluation system" program

Rationale

Continuous evaluation of S&T capacity plays a significant role in accurately identifying S&T policy and strategies, developing those strategies by interrelating them with socio–economic objectives.

To evaluate sector activities and its socio–economic impact, and to disseminate information on R&D results, it is essential to adopt a S&T information, monitoring and evaluation system that meets criteria for international classifications and standards.

During the assessment of the S&T sector, following issues emerged regarding the statistics, indicators, and monitoring the policy implementation:

- Lack of S&T statistics and indicators
- Absence of integrated information network of government financed research projects
- Lack of accurate and essential information on S&T sector
- Insufficient accessibility of information on research results to industry and other users
- Lack of surveys on public awareness on S&T role and purpose

Goal

Establishing an integrated system of S&T and innovation information, statistics, monitoring and evaluation that can be useful for decision–makers, researchers, and public, according to international classifications and standards

Activity directions

Collecting and integrating S&T information and statistics according to international classifications and standards: Current S&T information and statistics, and indicators to make prognosis of future trends will be collected and stored at the S&T Information network according to OECD standards. This integrated information network will be part of the National S&T statistics.

Online S&T information service will contain the information on S&T human resource, projects and programs and facilities. These searchable databases will be accessible to government agencies, research institutes and centers, universities, industry and public institutions. This online service includes, but not limited to: Human resources; Directory of S&T organizations; S&T facilities and equipment; S&T projects and programs, and their results; Information on technology transfer and commercialization; Database of Mongolian researchers' publications, articles and citations.

Collecting and integrating innovation statistics and data, and setting appropriate indicators according to international standards: Developing indicators related to industry innovation level, innovation product export, and innovation technology transfer is necessary. The information system of these statistics requires continuous update and modification.

Impact

- Become the main source of information and statistics to support public S&T policy development and prioritization of S&T activities
- Provide effective information service based on customers requirement; link information sources with users; popularization of S&T activities
- Operate as a link between stakeholders in S&T sector; consequently enhancing the quality and efficiency of S&T activities
- Establishment of effective monitoring and evaluation system
- Ability to monitor and evaluate policy, projects and programs, R&D, research organization
- Ability to project the efficient use of funds. Projecting the funds needed for development of venture fund
- Gathering information and statistics during the development of key technologies

Program profile

1. Program title	Enhancing S&T information, monitoring and evaluation
2. Legal rationale	• Government policy on S&T, article 3.8 and 7.5, 1998 • S&T law, article 7.1.4, 1998 • Assessment of the S&T sector of Mongolia, 2006
3. Contractor	Ministry of Education, Culture and Science
4. Critical issues	• Lack of S&T statistics and indicators • Absence of integrated information network of government financed research projects • Lack of accurate and essential information on S&T sector • Insufficient accessibility of information on research results to industry and other users • Lack of surveys on public awareness on S&T role and purpose
5. Program goal	Establishing an integrated system of S&T and innovation information, statistics, monitoring and evaluation that can useful for decision–makers, researchers, and public, according to international classifications and standards.
6. Timeframe and stages of implementation	Stage I: 2008–2010 Stage II: 2011–2015 Stage III: 2016–2020
7. Activity directions	• Gathering and integrating S&T information and statistics according to international classifications and standards • Online S&T information service • Improving innovation statistics
8. Impact	• Become the main source of information and statistics to support public S&T policy development and prioritization of S&T activities • Provide effective information service based on customers requirement; link information sources with users; popularization of S&T activities • Operate as a link between stakeholders in S&T sector; consequently enhancing the quality and efficiency of S&T activities
	• Establishment of effective monitoring and evaluation system • Ability to monitor and evaluate policy, projects and programs, R&D, research organization • Ability to project the efficient use of funds. Projecting the funds needed for development of venture fund • Gathering information and statistics during the development of key technologies
9. The entity responsible for implementation	Ministry of Education, Culture and Science Mongolian Academy of Sciences National S&T Foundation

4. "Development of advanced technology in Mongolia" program

Rationale

Advanced technology is a modern technology (nanotechnology, biotechnology, ICT, airspace technology, automated robotic technology, etc.) that is at the juncture of various science fields such as physics, chemistry, molecular biology, electronics, and others.

Advanced technology requires a large amount of initial investment. Experiences of other countries reveal that successful development of advanced technologies requires many factors such as cross–sectoral coordination, length of R&D process, and sustainable commitment from government.

One of the ways to address the issue of obsolete technologies is through support to the development of advanced technologies.

Goal

To improve the level of production and service technologies by introducing and utilizing foreign technologies, and by adopting international technology inventions

Program activities

- Establish a favorable policy and legal environment for developing advanced technologies
- Improve the R&D equipment and laboratory level of research organizations. Consequently, integrating top research centers and institutes into Center of Excellence, in the areas of biotechnology, nanotechnology, and ICT.
- Create new national laboratories with advanced technologies
- Train S&T personnel to operate in advanced technologies
- Conduct research projects in the areas of nanotechnology, biotechnology, telecommunication, and electronics
- Supporting the production of advanced technologies

Impact

- Establishment of National capacity to develop advanced technologies
- Development of advanced production technologies in medical, agriculture, industry sectors

Program profile

1. Program title	Development of advanced technology in Mongolia
2. Legal rationale	Government policy on S&T (1998) Order No. 248, 2005 of the Minister of Education, Culture and Science
3. Contractor	Minister of Education, Culture and Science
4. Challenges to be addressed	• Obsoleteness technologies • National capacity to develop advanced technologies • Low numbers of produced technologies by industry
5. Program goals and objectives	Improving the level of production and service technologies by introducing and utilizing foreign technologies, and by adopting technology inventions from abroad. • Providing laboratories and equipment necessary for conducting research on advanced technologies • Creating a capacity of research on advanced technologies • Creation of advanced technology production
6. Timeframe and stages of implementation	• 2007–2010 • 2011–2015 • 2016–2020
7. Program activities	• Establishing a favorable policy and legal environment for developing advanced technologies • Improving the R&D equipment and laboratory level of research organizations. Consequently, integrating top research centers and institutes into Center of Excellence, in the areas of biotechnology, nanotechnology, and ICT. • Creation of new national laboratories with advanced technologies • Training S&T personnel to operate in advanced technologies • Conducting research projects in the areas of nanotechnology, biotechnology, telecommunication, and electronics • Supporting the production of advanced technologies
8. Impact and output indicators	• Establishment of National capacity to develop advanced technologies • Formation of advanced production technologies in medical, agriculture, industry sectors Indicators: • 20% of education program in higher education to consist of advanced technology subjects (by 2011) • 30% of government scholarships to foreign universities to be granted on subjects related to key technologies of Mongolia (by 2011) • 10% of researchers working on advanced technologies to consist of researcher under the age of 40 (2007–2009) • 30% of researchers working on advanced technologies to consist of researcher under the age of 40 (2007–2009) • 50% of researchers working on advanced technologies to consist of researcher under the age of 40 (2007–2009)

9. The program implementing institutions	Ministry of Education, Culture and Science Ministry of Industry and Commerce ICT Agency Mongolian Academy of Sciences Research institutes and universities

5. "Training and supporting young researchers" program

Rationale

The proportion of young researchers in the sector has been declining each year, whereas, the proportion of elder scientists has been increasing. One of the major factors to improve the quality, competitive level, and efficiency of R&D is the strengthening S&T sector by young skilled researchers.

Goal

Increasing the supply of S&T workforce by intensifying the training of 500 young skilled researchers in the near future

Main activities

- Grant the necessary funding for doctorate research work to top young scientists
- Grant the necessary funding for post–doctorate research work to top young scientists
- Award grants and scholarships to support master's and doctorate's research work (domestic, abroad)
- Rank and assess the skill level of young and middle aged researchers
- Establish a flexible and effective management in the "Supporting the training of young researchers" program
- Adopt a productive R&D system
- Increase opportunities for young scientists to improve qualifications and encourage the building of a social image
- Address pay and social welfare issues of young scientists.

Expected outputs

- Improved level of skills of young researchers
- Increased role of young researchers in R&D sector and its priority areas
- Creation of a mechanism to address the pay and related social welfare issues of young researchers

Program profile

1. Program title	Training and supporting young researchers
2. Legal rationale	Government policy on S&T (1998) S&T law (2006)
3. Contractor	Ministry of Education, Culture and Science
4. Critical issues to be addressed	S&T human resources supply Quality level of R&D Stimulating the interest young generations in the field of science
5. Program goal	Increasing the supply of S&T workforce by intensifying the training of 500 young skilled researchers in the near future
6. Timeframe and stages of implementation	Stage I: 2007–2010 Stage II: 2011–2015 Stage III: 2016–2020
7. Main activities	• Granting the necessary funding for doctorate research work to top young scientists • Granting the necessary funding for post–doctorate research work to top young scientists • Awarding grants to support master's and doctorate's research work (domestic, abroad) • Ranking the skill level of young and middle aged researchers • Establish a flexible and effective management in the "Supporting the training of young researchers" program • Adopting a productive R&D system • Providing opportunities for young scientists to improve their levels of skills and occupation • Dealing with incomes, benefits, and other social issues of young researchers
8. Expected outputs and indicators	• Improved level of skills of young researchers • Increased role of young researchers in R&D sector and its priority areas • Creation of a mechanism to address the pay and related social welfare issues of young researchers Indicators: Increase in proportion of researchers of ages 35–40 Increase in salary of young researchers Increased number of R&D projects Increased number of young researchers trained abroad
9. The entity responsible for implementation	Ministry of Education, Culture and Science Mongolian Academy of Sciences Universities and other research organizations

6. "Supporting university R&D" program

Rationale

As the science and technological advancements approaches its peak in XXI century, the role of higher education in society has been becoming increasingly important. This trend which emerged independent from government policy regulations or support has now become the role model of global development evolution.

This program focuses on enhancing the role higher education sector in R&D sector development based on analyzes of developed countries' actions with respect to facilitating universities toward S&T and education sector development.

Using global trends as a model, enhancing the role of universities in the National S&T policy in the areas of education, knowledge creation and production is essential for social welfare.

Goal

The goals of this program are: enhancing the R&D development of higher education sector and strengthening academia–science–industry collaboration.

Program activities

A) "Ensuring higher education legal environment" subprogram development and implementation (2007–2008)
- Developing the guiding principles of higher education legal environment
- Developing and implementing legal documents of higher education sector

B) "Strengthening laboratories and facilities supply" program (2007–2012)
- Setting R&D priorities of each universities and identifying the necessary technology or equipment to facilitate the implementation of these priorities
- Establishing a large–scale shared laboratory with necessary equipment
- Providing top researchers or research teams who are conducting advanced R&D's with necessary equipments
- Developing a long–term plan toward a sustainable supply of laboratories and facilities, ensuring its funding from annual government budget necessary for its implementation

C) Improving the quality of education of master's and doctorate's programs (2007–2015)
- Establishing a mechanism to coordinate graduate programs with basic and applied researches (program to provide graduate scholarship)
- Providing stimuli to support continuous heritage of scholar school (program to fund post–doctoral R&D and provide top young scientists with advanced equipments).

D) Initiating innovation activities in higher education sector (2007–2015)
- Encouraging active participation of researchers and university professors in the establishment of the industry park and the growth of gross domestic production
- Attracting non–government sources of funding the higher education sector R&D

- Identify and utilize a mechanism to support S&T and innovation activities in higher education system
- Assessing S&T and innovation output in the higher education sector

Outputs

Major outputs by successfully implementing this program include: Improved supply of laboratories and facilities, increased competitive level of national researchers, and improved quality of products and services.

Program profile

1. Program title	"Supporting university R&D" program (2007–2015)
2. Legal rationale	– Government policy on S&T (1998) – Education law (2002)
3. Contractor	Ministry of Education, Culture and Science
4. Challenges to be addressed	– Establishing a favorable legal environment for freedom of scholarship – Enhancing the role of universities in the S&T and higher education sector – Ensuring scholars' institutional memory and heritage by strengthening university–research institute collaboration and coordination – Strengthening science–industry collaboration
5. Program goals and objectives	Enhancing the R&D development of higher education sector and strengthening academia–science–industry collaboration
6. Timeframe and stages of implementation	– Strengthening laboratories and facilities supply, 2007–2012 – Improving the competitive level of University R&D, integration of education and research, 2010–2015
7. Program activities	– Ensuring higher education legal environment subprogram development and implementation – Strengthening laboratories and facilities supply program – Improving the quality of education of master's and doctorate's programs – Initiating innovation activities in higher education sector
8. Outputs	– Improved supply of laboratories and facilities – Increased competitive level of national researchers – Improved quality of products and services.
9. The entity responsible for implementation	– Ministry of Education, Culture and Science; Ministry of Finance – National S&T Foundation – National University of Mongolia, Mongolian University of S&T, University of Agriculture, University of Medical Science

ANNEX 3. S&T and innovation indicators

№	Indicators
	I. R&D funding and expenditure
1.	Government expenditure on R&D (GERD)
2.	Non–government expenditure on R&D
3.	Higher education expenditure on R&D
4.	Business enterprise expenditure on R&D
5.	GERD, 2000 prices
6.	GERD as a percentage of GDP
7.	Government expenditure on R&D as a percentage of GDP
8.	Non–government expenditure on R&D as a percentage of GDP
9.	Higher education expenditure on R&D as a percentage of GDP
10.	Business enterprise expenditure on R&D as a percentage of GDP
11.	Percentage of GERD financed by government
12.	Percentage of GERD financed by non–government sources
13.	Percentage of GERD financed by industry
14.	GERD per capita
15.	Expenditure on basic research as a percentage of GERD
16.	Expenditure on applied research as a percentage of GERD
17.	Expenditure on experimental development as a percentage of GERD
18.	Expenditure on basic research as percentage of Government expenditure on R&D
19.	Expenditure on applied research as percentage of Government expenditure on R&D
20.	Expenditure on experimental development as percentage of Government expenditure on R&D
21.	Expenditure on basic research as a percentage of non–government expenditure on R&D
22.	Expenditure on applied research as a percentage of non–government expenditure on R&D
23.	Expenditure on experimental development as percentage of non–government expenditure on R&D

24.	Expenditure on basic research as a percentage of higher education expenditure on R&D
25.	Expenditure on applied research as a percentage of higher education expenditure on R&D
26.	Expenditure on experimental development as percentage of higher education expenditure on R&D
27.	Expenditure on basic research as a percentage of business enterprise expenditure on R&D
28.	Expenditure on applied research as a percentage of business enterprise expenditure on R&D
29.	Expenditure on experimental development as percentage of business enterprise expenditure on R&D
30.	Gross domestic expenditure on high–technology R&D (GEHTRD)
31.	GEHTRD as a percentage of GERD
32.	Percentage of GEHTRD finance by government
33.	Percentage of GEHTRD finance by non–government sources
34.	Percentage of GEHTRD finance by industry
II. Human resources	
35.	Total S&T personnel
36.	Total researchers
37.	Total researchers in public research institutes
38.	Total researchers in higher education organizations
39.	Total R&D personnel in business enterprises
40.	Total researchers in public research institutes as percentage of total researchers
41.	Total researchers in higher education organizations as a percentage of total researchers
42.	Total R&D personnel in business enterprises as a percentage of total researchers
43.	Total researchers in public research institutes per thousand total employment
44.	Total researchers in higher education organizations per thousand total employment
45.	Total R&D personnel in business enterprises per thousand total employment
46.	Total researchers with PhD's
47.	Total researchers with PhD's as a percentage of total researchers

48.	Total researchers with PhD's as a percentage of total PhD's
49.	Total researchers with high–technology training and education
50.	Total researchers who underwent through additional training as a percentage of total researchers
51.	Total researchers under the age of 40
52.	Total researchers under the age of 40 as a percentage of total researchers
III. International collaboration	
53.	Number of collaboration contracts and agreements in S&T sector with foreign and international countries and organizations
54.	GERD financed by abroad (thousand U$)
55.	GERD financed by abroad as a percentage of total GERD
56.	Total research projects implemented through foreign collaboration
57.	Total foreign joint projects as a percentage of total domestic projects
58.	Total S&T joint seminars and workshops conducted
59.	Total presentations at international S&T seminars
60.	Total research and experimental laboratories established through international collaboration
61.	Total Mongolian researchers trained in foreign countries
62.	Total researchers who received education degrees through international collaboration
63.	Total international joint exhibitions
64.	Total outputs through joint research projects
65.	Total patents registered through joint research project results
66.	Total patents as a percentage of total joint research project results
IV. Research laboratories and equipment supply	
67.	Total research laboratories
68.	Total laboratories with accreditation
69.	Total experimental laboratories and centers
70.	Total research institutes with internet connections as a percentage of total research institutes
71.	Percentage of research equipment renovation (compared to 2006)

V. S&T activity output	
72.	Total publications
73.	Total publications abroad
74.	Total publications abroad as a percentage of total publications
75.	Total subjects published
76.	Total subjects published as a percentage of total publications
77.	Total subjects published abroad
78.	Total subjects published abroad as a percentage of total subjects published
79.	Total research articles
80.	Total articles published in journals with high impact factor
81.	Total articles as a percentage of total publications
82.	Total articles published abroad as a percentage of total articles
83.	Total S&T presentations in domestic and international seminars
84.	Total S&T presentations as a percentage of total publications
85.	Total S&T presentations at international seminars and meetings
86.	Total S&T presentations at international seminars and meetings as a percentage of total S&T presentations
87.	Number of total applications for patents (per 10,000 population)
88.	Number of total patents
89.	Number of patents in the ICT sector as a percentage of total patents
90.	Number of patents in the biotechnology sector as a percentage of total patents
91.	Number of patents in the nano–technology sector as a percentage of total patents
92.	Number of triadic patents
93.	Number of high technologies developed
94.	Developed high technologies as a percentage of total developed technologies
95.	Number of license agreements
96.	Intellectual property utilization index

ADDITIONAL ANNEXES. Other findings and documents used for the development of S&T Master Plan in 2007–2020

ANNEX A. ACTIVITY PLAN IN 2007–2010.

This section includes activities for the I stage (2007–2010) of the Master plan.

Projected activities (Table 7.1.) include activities to achieve the goals and objectives, legal documents and its objectives, and the organizations to responsible for implementations. This chapter also contains the targeted programs (Table 7.2.) which consist of program components and outputs.

Table 7.1. Projected activities of the Master plan in stage I (2007–2010)

№	Activities	Type of document	Document development time-frame	Implementation period	Responsible parties
I. Creating a competitive R&D sector, establish an environment for further development.					
1.	Establish a monitoring system, that is independent from a Ministry mandate, for public research institutes' activities Review and assess organizational structure Submit to the Government an action plan to reform and modify the structure	Government decree	2008	2008–2010	MECS, other ministries, MAS, public research organizations
2.	Coordinate and manage government-financed basic researches, develop a monitoring mechanism	Government decree	2008	2008–2009	MECS, MAS, public research organizations
3.	• Develop rules and regulations on legal environment of National research centers and laboratories • Develop and implement a policy document to establish a structure with S&T, innovation, human resource capacities	Government decree	2009	2009–2010	MECS, MAS
4.	Develop a program on strengthening research laboratories	Government decree	2008	2008–2011	MECS, MAS, public research organizations

5.	Develop a policy document on linking and coordinating "S&T–academia"	Order by the Minister of Education, Culture and Science	2007	2008–2010	MECS
6.	Renew the list of research organizations, undertake the asset inventory	Updated list of research organizations	2007	from 2008	MECS, State Property Committee
7.	Update the R&D priorities	Government decree	Every two years	2007–2010	MECS, MAS, public research organizations
8.	Develop a proposal on advancing the statistical system of research organizations, regardless of the organization's entity	Government decree	2008	2008–2010	MECS, National Statistical Office of Mongolia, research organizations
II. Adopting an effective national innovation system					
9.	Implementing innovation activities, amend the legal documents supporting innovation activities, and coordinate the activities	Legal document drafts	2008	2008–2010	MECS, MoIC, other ministries MAS, research organizations
10.	Implementing activities to establish national innovation infrastructure	Rules and regulations	2009	2009–2010	MECS, MoIC, MoF, other
11.	Develop a program to develop an innovation infrastructure in the S&T sector	Program draft	2009–2010	2009–2010	MECS, MAS, research organizations
12.	Organize an exhibition of innovation products and technologies, develop a proposal to enhance the Government support on innovation activities	Draft Government decree	Every two years	2008–2010	MECS, MoIC, MoF, other
13.	Develop the system to train specialists in innovation activities	Draft order by the Minister of Education, Culture and Science	2008	2009–2010	MECS
III. Establishing a legal environment and a system to utilize and protect R&D results					
14.	Develop a draft law on the protection of government financed R&D results	Draft Law	2009	2009–2010	MECS, Intellectual Property Organization of Mongolia

15.	Develop a program on establishing S&T information network	Program draft	2007–2008	2007–2010	MECS, Intellectual Property Organization of Mongolia, National S&T Foundation
16.	Training personnel to specialize in intellectual property activities (innovation manager; patent researcher, lawyer, judge, and evaluator)	Program draft	2008	2008–2010	MECS, Intellectual Property Organization of Mongolia, National S&T Foundation
IV. Reform the economy based on technological innovation					
17.	Develop a proposal on S&T and innovation development with the participation of science and business representatives	Report submission to the Government	2007	2008–2010	MECS, MoIC, MoF, other
18.	Develop a proposal on tax reduction of imports and exports of high–technology products	Report submission to the Government	2008	2009–2010	MECS, MoIC, MoF, other
19.	Develop a plan on certification of innovation products in consistent with international standards	Draft plan	2009	2009–2010	MoIC, MoF, National Center of Standardi–zation and Metrology
20.	Develop a strategic plan on technologies	Strategic targeted programs drafts	2008–2009	2007–2010	MECS, MoIC, MoF, other
21.	• Develop a methodology to measure innovation activities and to set indicators to evaluate those activities • Establish a monitoring and evaluation system on economic impact of innovation activities	Proposal to the Government	2008–2009	2007–2010	MECS, MoF, MAS, other
22.	Develop a proposal on improving innovation statistics and indicators	Report submission to the Government	2008	2008–2010	MECS, MoF, National Statistical Office of Mongolia, MAS, other

23.	Monitor and focus on the objectives and performance indicators of the II stage (2011–2015) of the Master plan actions	Make changes and revisions in the action plan	2009–2010	from 2011	MECS, MoF, MAS, other
24.	Develop an action and activity plan for the period 2011–2015	Action plan draft	2010	from 2011	MECS, MoF, MAS, other
V. Enhance the S&T international cooperation					
25.	Develop a proposal on increasing the official aid assistance and investment – from foreign countries and international organizations – on the development of S&T priorities of Mongolia	Government decree draft	2007	2008–2010	MECS, MoF
26.	Identify the main areas of international S&T collaboration • The areas of S&T collaboration with foreign countries and regions • Conduct a research on researchers who are studying and/or working abroad, and input this information in a database network • Improve the laboratory capacity • Train young researchers	Order by the Minister of Education, Culture and Science	2007–2008	2008–2010	MECS, MoIC, MAS, research organizations
27.	Develop a proposal on providing financial and taxation stimuli for the adoption of advanced technologies in the form of foreign investment; establishing a joint factory; purchasing of license, know–how, and equipment	Law drafts	2008–2009	2009–2010	MECS, MoIC, MoF, Mongolian Tax Administration

ANNEX B. Restructuring legal environment for innovation activities[1]

In the I stage of the implementation of Master plan, it is planned to amend the S&T law, Law on technology transfer and General law of taxation, and consequently, initiate Innovation law aimed to promote innovation activities and restructuring a legal environment for innovation activities. The amendments are as follows:

1. S&T law:

- Include the concept of "national innovation system," "innovation," "innovation activities," "innovation infrastructure"
- Government financed S&T results to be owned by the implemented organization unless it does not contradict to other laws, agreements, and contracts
- Include the concept of small and medium innovation enterprises; define the Government's role in supporting them
- Legal status of the national research center laboratory.

2. Law on technology transfer

- To allow the transfer of government financed intellectual property rights to a third party, with the permissions from the implementing entity and sponsor

3. General law of taxation

- To allow the value added and other tax exemptions of organizations that procure new technologies and equipments aimed to promote innovation activities

4. Law supporting innovation activities

- Objectives of the Law
- Key concepts (government policy on innovation, innovation activity, innovation, program to support innovation, innovation project, innovation infrastructure, innovation organization, technology incubator, innovation foundation)
- Objectives and core issues of government policy on innovation
- Principles of government policy on innovation
- The approaches of government support on innovation
- Parties in the innovation activities
- The role of government agencies and organizations in the implementation of government policy on innovation
- Innovation programs
- Funding innovation activities
- Government contract to produce innovation products and services
- International collaboration on innovation activities

1 *Strategy of the Russian Federation to develop science and innovation for the period to 2010 (2005)*

ANNEX C. Models of National Innovation System (NIS) development and distinctive features of innovation policy implementation of other countries

I. Conceptual approaches to NIS development

Theoretical frameworks and models of NIS development can be classified as follows:

1. Market – evolutionary

This scenario assumes a "natural" establishment of NIS.

Under this scenario government policy follows two tasks:

1) Continuous government support on training science workforce and support on basic and applied researches as the producer of "public well–being" and environment which is necessary for establishing a NIS market environment.
2) Reducing the obstacles en route for innovation and establishing stimuli of private sector demand on innovation activities. This includes improving the legal environment of innovation, and increasing technology and innovation investments through taxation incentives.

The aspect of this approach is that government refuses to establish an institutional structure of a new NIS. Under this strategy, the Government policy should be directed toward improved effectiveness of government budget expenditures.

The most likely turns of events under this scenario are: preservation of "compressed" education and basic science system; development of "corporate science" segment which concentrates on a limited numbers of large transnational corporations; establishment of a network of small enterprises.

Main risks: sectors of NIS will remain uncoordinated (lack of interactions between government and non–government sectors of education and basic research due to absence of applied researches), increased dependence on of economy on foreign technologies; obsolete of technologies, increase in drift of skilled workforce to other countries.

2. Market – radical

This scenario suggests a more accelerated approach of the first scenario. Its essence is that the Government is responsible for funding the R&D's that are essential for the Government functions. Here the system of government–financed R&D is radically changed, and funding is distributed based on project tender competitions. At the same time, the remaining financial resources are utilized to support industrial R&D and innovation activities which should stimulate the demands of private sectors in innovation activities.

This method is likely to cause: rapid decrease in the Government–financed research areas, orientation of funding sources from different sectors – sector and abroad; accelerated increase in R&D expenditure of private sectors; increase in number of divisions that are in charge of R&D.

Main risks: possible extinction of government–financed basic researches, decline in S&T personnel, slow development of innovation firms that generate valuable innovation products and technologies.

3. Institutional structural

This approach is based on an assumption that the current elements of NIS are effective, only, there is a lack of a mechanism that links them. Therefore, the rationale of this scenario is to establish and develop the missing elements.

The most likely turns of events under this scenario: broader innovation infrastructure; development of new fragmented elements of NIS; increased dependence of NIS on government support; distribution of government budget in many areas.

Main risks: Adopting innovation institutions of foreign countries will not lead to successful establishment of highly competitive NIS; possible errors when identifying and developing the framework of elements of NIS; producing new forms of various elements could have a negative impact on improving the quality of already established elements of NIS.

4. Innovation – active

This scenario is based a concept that offer creates demand, and industry's low demand on innovation is caused by the lack offers on of innovation product. In this case, it is essential to increase expenditures on commercialization of advanced technologies.

Main risks: Absence of demand on advanced commercial technologies – due to out–of–date technologies in industrial sectors, advanced technologies are less adaptable; introducing new technologies could lead to decelerate the development of higher technologies.

5. "Knowledge – active"

Although it is similar to the previous approach, this scenario has more emphasis on the beginning cycle of innovation and innovation education. The basis of this approach – intensive investment in human capital in order to create an "innovation human," who will lean towards innovation and new knowledge, regardless of where he is working – industry, science, government, etc.. This should solve the issue of demand–offer link, and creates the need to establish various innovation institutes.

Main risks: The process of training innovation specialists takes time; even more time could be required to train personnel to the extend where they are able to effectively govern an organization. This scenario is more effective in the long run.

II. Characteristics of innovation policy in other countries

Innovation policy of a country, as rule, does not comply to a particular theoretical model. Usually, it consists of set of activities in different directions which depend on the country's distinctive features.

The following are the directions of innovation policy in other countries:

Innovation policy directions	Specifics	Countries
Optimizing the structure of NIS	Optimizing administration and planning of NIS	Japan, Norway, India, Chile
	Optimizing government funding in the science and innovation sectors	USA, France, UK, Denmark, Norway, Sweden, Taiwan, Australia
	Developing basic research	UK, Sweden, Slovakia
Stimulating local industry–science innovation collaboration	Stimulating symmetrical contact between universities and business enterprises	USA, Finland
	Large government investments in science and innovation sectors and attracting capital from private sectors	Israel, Finland
	Stimulating innovation activities in private sectors by attracting foreign capital in the innovation sector	UK, Ireland, China, S. Korea, Malaysia, India, Israel
	Stimulating innovation initiatives of science sector	Germany, Japan, New Zealand, Denmark
Integration into international network of innovation	Complex integration	Finland, Israel, Holland, China
	Technological specialization	S. Korea, Malaysia, Singapore, Taiwan, India
Developing local innovation network	Establishing favorable conditions for developing a link in the innovation sector	USA, Norway, Ireland
	Stimulating initiatives of national regions	France, Germany, Finland
Establishing NIS	Restructuring government sector of science	Bulgaria, Poland, Lithuania
	Initiate integration of science and education	Lithuania, Estonia, Czech Republic
	Attracting SMEs in innovation activities	Romania, Czech Republic
	Setting priority export areas in technology sector	Czech Republic, Romania, Chile, Turkey

ANNEX D. Comparative review of S&T development documents and strategies of other countries

1. Japan

Title: "Science and Technology Basic Plan 2004"

Comments: The first S&T basic plan of Japan (1996–2000) was successfully implemented where governmental expenditure on R&D was estimated as around 17 trillion yen for the five-year period. In December of 2000, S&T council of Japan has recommended to prepare and implement second basic plan. Consequently, in January of 2001, Prime Minister of Japan has ordered the implementation of this plan.

Implementation period: 2001–2005

Document contents: S&T policy document of Japan comprises of three major parts.

1. Basic Concepts
2. Basic Policies
3. Missions of the Council for Science and Technology Policy

Vision:
- A nation contributing to the world by creation and utilization of scientific knowledge
- A nation with international competitiveness and ability of sustainable development
- A nation securing safety and quality of life

Guiding strategy:
- Promotion of Basic Researches
- Prioritization of R&D on national/social subjects

Activity framework: Basic plan focuses on 8 S&T areas; each area contains 5-year objectives and activities

- Life science
- Information and telecommunications
- The environmental sciences
- Nanotechnology and materials science/technology
- Energy
- Manufacturing technology
- Infrastructure
- Frontier — outer space and the oceans

Funding: the total amount of the Governmental R&D expenditure is estimated about 24 trillion yen in the fiscal year 2001–2005, or approximately 220 billion US$. This is equivalent to 21% of total R&D expenditure. Japan's R&D expenditure equaled to 3.35% of their GDP.

The implementing organization: S&T Council

Implementation management: Prime Minister is the head of the S&T Council. The council is responsible for evaluation of S&T policies of each ministry and for developing basic policies and implementing measures. The council, also, requests submission of implementation plans and continuously examines how to implement R&D activities in Japan.

2. Estonia

Title: Assessment of the Estonian Research Development Technology and Innovation Funding System

Comments: Nearly all of funding for S&T activities of Estonia derive from government budget. The document emphasized that S&T funding system is the main critical issue of the sector. Thus, R&D and innovation funding assessment has been conducted by University of Manchester.

Implementation period: 2002–2006

Document contents:

- Methodology
- The Estonian Research Development Technology and Innovation Funding system
- Problems and options for change
- Scenarios

Vision: Estonia is knowledge–based society, the success and prosperity of which crucially depend on research, innovation and knowledge related skills

Guiding strategy:

- increase in the state financing;
- increased participation of private and oversees capital;
- ensuring the effectiveness, transparency and social and economic benefits of public funding for research.

Activity framework: within the framework of R&D, technology, and innovation funding system.

The implementing organization: Research and Innovation Funding Council, Ministry of Education and Research, Ministry of Economy and Communication.

Implementation management: R&D Council of Estonian government is responsible for providing strategic recommendations, implementing government R&D objectives, and advising on budget planning and its distribution. Ministry of Education and Research, and Ministry of Economy and Communication are responsible for the implementation of this document.

3. Maldives

Title: Republic of Maldives Science and Technology Master Plan

Although Republic of Maldives have a population of only 400,000, the Ministry of Communication and S&T has developed S&T Master plan with 600,000 US$ assistance from ADB.

Implementation period: 2001–2010

Document contents: The S&T Master Plan contains three main parts.

- Goals methodology and participants
- Analyses of S&T capacity and needs
- Programme alternatives

Activity framework: This plan focuses on the development of the following economic and social sectors with support of S&T sector.

- Information technology
- Telecommunications
- Fisheries
- Education
- Health
- Tourism
- Transport
- Energy

Funding: The document contains 23 programs with different timeframe, funding amount, and implementing organizations. Some programs do not require additional funding, only regulatory changes. Additional funding to execute all the programs totaled approximately US$4.5 million.

Implementing organization: Ministry of Communication, Science and Technology, other ministries, universities, and research institutes and centers.

Implementation management: Maldives S&T Master plan was developed with consideration of sector stakeholders' (research organizations, NGO's, and industry) suggestions. Consequently, the stakeholders have their stake the implementation of the programs.

4. Russian Federation

Title: Strategy of the Russian federation to develop science and innovation for the period to 2010

Comments: Compared to policy documents of other countries, this was the most comprehensive plan. The plan contained specific objectives with detailed action plans and programs each of which contained certain output results and indicators.

Implementation period: 2005–2010

Document contents:

- Current situation and issues
- A mechanism to resolve current issues
- Distribution of tasks to implement strategies
- Critical issues
- Strategy implementation period and stages
- Science and innovation sector development funding
- Implementation progress monitoring

Vision: Russian R&D will have a capacity to meet the demands of national security, and will be a globally competitive nation

Implementation strategy: The strategic document of Russia has two proposed action scenarios: 1) Inertia scenario 2) Active scenario

Inertia scenario's strategy consists of 1) Supporting R&D that facilitates development of technologies of economic importance, and 2) enhancing import technologies. Strategies of active scenario include improving competitive level of critical sectors of R&D, establishing an effective innovation system, modifying technologies of economic sectors by supporting the development of national technology priorities.

Activity framework:
R&D capacity, National innovation system, Intellectual property rights utilization, and Technology innovation

Funding: The plan proposes two scenarios of funding

1st scenario (minimum level)

2004	2005	2006	2007	2008	2009	2010
55,3	64,0	77,7	92,4	112,9	137,2	160,8

2nd scenario (feasible scenario)

2004	2005	2006	2007	2008	2009	2010
55,3	64,0	88,2	116,5	146,5	179,7	194,6

Implementing organization: Ministry of Education and Science, other ministries

Implementation management: Ministry of Education and Science will be the coordinating and monitoring organization of activities.

5. Philippines

Title: The National Science and Technology Plan for 2002–2020

Implementation period: 2002–2020

Document contents: The document is comprised of seven parts

- Planning environment
- Assessment of past S&T plans
- Visions for Philippine S&T
- Goals for Philippine S&T
- Strategies for S&T
- Long–term area thrusts
- Programs for 2002–2004

Vision: The following S&T states are envisioned for the Philippines at the end of each plan period

- By 2004, S&T shall have contributed significantly to the enhancement of national productivity and competitiveness, and to the solution of pressing national problems.
- By 2010, the Philippines shall have carved some niches and become a world–class knowledge provider and user in selected S&T areas; it shall also have developed a vibrant Filipino S&T culture.
- By 2020, the Philippines shall have developed a wide range of globally competitive products and services which have high technology content.

Guiding concepts: Addressing pressing national problems; Development of human resources; Provision of support to industry particularly SMEs; Accelerating technology transfer and utilization; Building/upgrading of S&T infrastructure; Strengthening of government–industry–academe–civil society in international linkages; improvement of S&T governance; Promotion/popularization of S&T.

S&T areas: Agriculture, forestry and natural resources; Health/medical sciences; Biotechnology; Information and communications technology; Microelectronics; Materials science and engineering; Earth and marine sciences; Fisheries and aquaculture; Environment; Natural disaster mitigation; Energy; Manufacturing and process engineering.

Funding:

	2000–01	2004	2010	2020
% of private sector R&D expenditures to total national R&D expenditures	22%	25%	30%	40%
% of total R&D expenditures to GDP	0.15%	0.30%	1.00%	2.00%

Implementing organization: S&T Coordinating Council

Implementation management: The S&T Coordination Council consists of government and industry representatives. The council is responsible for coordinating and implementation of the plan, and annually reports to the president the progress of implementation and the final results.

	Japan	Estonia	Maldives	Russian Federation	Philippines
Vision	▪ A nation contributing to the world by creation and utilization of scientific knowledge ▪ A nation with international competitiveness and ability of sustainable development ▪ A nation securing safety and quality of life	Estonia is knowledge–based society, the success and prosperity of which crucially depend on research, innovation and knowledge related skills	n/a	Russian R&D will have a capacity to meet the demands of national security, and will be a globally competitive nation	▪ By 2004, S&T shall have contributed significantly to the enhancement of national productivity and competitiveness, and to the solution of pressing national problems. ▪ By 2010, the Philippines shall have carved some niches and become a world–class knowledge provider and user in selected S&T areas; it shall also have developed a vibrant Filipino S&T culture. ▪ By 2020, the Philippines shall have developed a wide range of globally competitive products and services which have high technology content.
Goals	▪ strategic priority setting in S&T ▪ S&T system reform to create excellent achievement ▪ internationalization of S&T activities	▪ to update the knowledge pool ▪ to increase the competitiveness of enterprises	n/a	▪ Increase R&D expenditure: up to 2% of GDP ▪ Strengthening the prestige of science in Russia ▪ Enhancing patent activities, improving R&D results ▪ Sustainable growth in numbers of small innovation enterprises ▪ Enhancing innovation activities in the economy ▪ Increase the numbers of innovation products	▪ World–class universities in S&T ▪ A well developed S&T–based SME sector ▪ Internationally recognized Filipino scientists and engineers ▪ The Philippines as a model in S&T management and governance
Implementation period	2001–2005	2002–2006	2001–2010	2005–2010	2002–2010

Implementing organization	Council for Science and Technology Policy	Research and Innovation Funding Council, Ministry of Education and Research, Ministry of Economy and Communication	Ministry of Communication, Science and Technology, other Ministries, universities, and research organizations	Ministry of Education and Science, other ministries	S&T Coordinating Council
Document contents	1. Basic Concepts 2. Basic Policies 3. Missions of the Council for Science and Technology Policy	1. Methodology 2. The Estonian Research Development Technology and Innovation Funding system 3. Problems and options for change 4. Scenarios	1. Goals methodology and participants 2. Analyses of S&T capacity and needs 3. Programme alternatives	1. Current situation and issues 2. A mechanism to resolve current issues 3. Distribution of tasks to implement strategies 4. Critical issues 5. Strategy implementation period and stages 6. Science and innovation sector development funding 7. Implementation progress monitoring	1. Planning environment 2. Assessment of past S&T plans 3. Visions for Philippine S&T 4. Goals for Philippine S&T 5. Strategies for S&T 6. Long–term area thrusts 7. Programs for 2002–2004
R&D expenditure as a percentage of GDP	3.35%	0.7%	n/a	1.28%	0.15%

Framework	▪ Life science ▪ Information and telecommunications ▪ The environmental sciences ▪ Nanotechnology and materials science/ technology ▪ Energy ▪ Manufacturing technology ▪ Infrastructure ▪ Frontier — outer space and the oceans	Research Development Technology and Innovation Funding System	▪ Information technology ▪ Telecommuni–cations ▪ Fisheries ▪ Education ▪ Health ▪ Tourism ▪ Transport ▪ Energy	▪ R&D capacity ▪ National innovation system ▪ Intellectual property rights utilization ▪ Technology innovation	▪ Agriculture, forestry and natural resources ▪ Health/medical sciences ▪ Biotechnology ▪ Information and communications technology ▪ Microelectronics ▪ Materials science and engineering ▪ Earth and marine sciences ▪ Fisheries and aquaculture ▪ Environment ▪ Natural disaster mitigation ▪ Energy ▪ Manufacturing and process engineering
Priority areas	▪ Life science ▪ Information and telecommunications ▪ The environmental sciences ▪ Nanotechnology and materials	▪ IT ▪ Biomedicine ▪ materials technologies	▪ Information technology ▪ Telecommunications ▪ Fisheries ▪ Education ▪ Health ▪ Tourism ▪ Transport ▪ Energy	▪ Information and telecommunications technology and electronics ▪ New materials and chemical technology ▪ New transportation technology ▪ Technologies of living systems ▪ Ecology ▪ Energy technology	▪ Agriculture, forestry and natural resources ▪ Health/medical sciences ▪ Biotechnology ▪ Information and communications technology ▪ Microelectronics ▪ Materials science and engineering ▪ Earth and marine sciences ▪ Fisheries and aquaculture ▪ Environment ▪ Natural disaster mitigation ▪ Energy ▪ Manufacturing and process engineering

science policy studies

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Educational, Scientific and
Cultural Organization