



Knowledge-based Estonia

ESTONIAN RESEARCH AND DEVELOPMENT STRATEGY 2002–2006

research • technology • innovation





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Estonian Strategy for Research and Development 2002–2006

Tallinn 2002

The Strategy was prepared by a working group with participation from the Ministry of Education, Ministry of Economic Affairs and the Estonian Academy of Sciences. The members were Rein Vaikmäe (Ministry of Education, Adviser on Research Policy, Raul Malmstein (Ministry of Economic Affairs, Deputy Secretary-General), Kitty Kubo (Ministry of Economic Affairs, Head, Technology and Innovation Division), Jüri Engelbrecht (Estonian Academy of Sciences, President), Rein Küttner (Tallinn Technical University, Professor), Alar Kolk (Estonian Technology Agency, Director), Katrin Männik (Ministry of Economic Affairs, Technology and Innovation Division, Senior Specialist) and Tea Danilov (Ministry of Economic Affairs, Economic Policy Division, Expert).

The draft of the Strategy was discussed during the 24.10.2000 and 28.11.2000 Cabinet sessions of the Government. On 07.12.2000, Prime Minister Mart Laar presented the basic principles of the Strategy to the Riigikogu, and this was followed by a general debate on the topic. During January and February 2001, there was an extensive public debate on the Strategy, with participation by the universities, research and development institutions, private enterprise and specialty associations. The working group then amended the Strategy, taking into account the proposals that had been made, and on 08.05.2001 the final version of the document was again discussed by the Government in its Cabinet session, where it was approved and sent to the Riigikogu. In autumn 2001, the Riigikogu Cultural Sub-Committee reviewed the document, also involving the Riigikogu factions and the Strategy working group in the process. At this stage, as well, a number of amendments were made to the document.

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Foreword by the Prime Minister

The development of Estonia during the last decade has been dazzlingly rapid. During the ten-year independence period, Estonia has built up a stable monetary system; open markets and privatisation have invited foreign investment. These, in turn, have fed economic growth, enabling the upgrading of infrastructure, as well as the creation and introduction of more efficient and economical products and services.

Studies conducted over recent years emphasise the stable macroeconomic environment in Estonia and provide a positive assessment of both Estonia's competitiveness and future development opportunities. Estonia has become an investment-based economy that is quite active in implementing new skills and technologies.

To date, our competitive advantages have been a cheaper workforce and lower costs, compared to the developed countries. Efforts to improve the quality of life and the human environment, together with the desire to catch up with the developed countries as soon as possible, will force Estonia to give up these cost-based advantages in the future. With the average salary increasing, Estonia will rapidly lose its attraction as an outsourcing country. If we expect in the future to have economic growth that is comparable with the current growth, or even slightly greater, we must find new sources of support.

However, there is definitely no one and only "magic cure". It is clear, however, in the circumstances of the more or less uniform global availability of capital and means of production, incomes will increase in the open economy of Estonia only if we rely on the greater efficiency of human activity. By creating increasingly more competitive products and services, while using less labour and materials per unit, our standard of living will improve and we will have more to sell on the world market. An increase in productivity is the primary basis for the future economic growth of Estonia.

We need to convert to an innovation-based economy. The "Knowledge-based Estonia" strategy, therefore, sees the following as Estonia's important resources: high-quality human capital, efficiently functioning education and innovation systems that support research and development, implementation of new knowledge in the interests of both cultural as well as social and economic development. In order to ensure long-term sustainable growth, Estonia must create an environment which is better able to support the creation of new knowledge, and the resulting introduction of innovative solutions, in the whole of society.

Being a small country, Estonia cannot compete simultaneously and equally successfully in all areas. It is important to focus on the development of the existing advantages and the more important future needs. Also, it is quite clear that the human resources currently available in Estonia and the funds invested in research and development are not sufficient to create internationally competitive innovative solutions.



We need more effective cooperation between research institutions and enterprises, which would allow for a more efficient moulding of knowledge into new innovative products and services. Equally important is comprehensive integration into the international networks of cultural, research and economic cooperation. The implementation of the ideas drafted in the Strategy is at least as fundamental for increasing the competitiveness of the Estonian economy, and ensuring sustainability, as is accession to the European Union and NATO. It is only in this manner that we will be able to avoid becoming an insignificant borderland in Europe.

Shaping a knowledge-based Estonia and the identification of the future development priorities of research and the economy requires stability, which can be provided only through a systematic analysis of the long-term development opportunities of the state, as well as open discussion, so that uniform widely-accepted long-term visions of the future can be formed.

In preparing and approving the strategy, the Riigikogu and the Government of the Republic have shaped a uniform understanding of the foundations of the future competitiveness of Estonia, focusing on supporting the development of a knowledge-based society. Implementation of the strategy will now depend on specific activities by all of us.

Estonia has the opportunity to be successful in the world – by being Estonia. Small nations and countries have had to suffer much throughout history. Now we have an opportunity to transform our disadvantages into advantages and establish ourselves in the world, making the best use of our small size. Our task is to do things, using our smallness, that are impossible for the large and the strong. In progressing in this manner, Estonia will be able to secure itself a better future.



Mart Laar
Prime Minister

In Tallinn, on 9 January 2002



Basic principles

In the Estonian Strategy for Research and Development, a future Estonia is seen as a knowledge-based society where the sources of economic and labour force competitiveness, and improvement in the quality of life, stem from research directed towards the search for new knowledge, the application of knowledge and skills, and the development of human capital. In a knowledge-based society, research and development are valued highly as one of the preconditions for the functioning and development of all of society.

The present strategy for Research and Development, and Innovation (RD&I) defines the aims, opportunities and principles for promoting RD&I in Estonia, and is a basis for RD&I organization and activities in the coming years. This document determines the framework and extent of support measures for the public sector until 2006. The principles of the strategy will be reviewed and updated by the Government every three years, on the basis of proposals submitted by the Research and Development Council (TAN). Any substantial changes to the strategy will be submitted to the Riigikogu (parliament) for approval.

On the basis of this strategy, annual RD&I action plans will be compiled which define specific programmes and measures for promoting RD&I according to the strategy objectives. The planning of RD&I development is based on the following principles:

- The educational and RD&I systems will ensure that new knowledge is created and applied, that the general level of knowledge increases in the interests of Estonia's social, economic and cultural development.
- RD&I related to Estonian national culture and environment, as well as that aimed at economic development, will be ensured, as well as research related to the statehood of Estonia, sustainable development of society and national security.
- Investments into RD&I are at least on the level of the average for the European Union (EU).
- The results achieved by Estonian researchers are a part of world science. As a result of international cooperation, the transfer of know-how into the Estonian economy and society functions efficiently.
- Political decisions, legal regulation and a support structure aided by the state create favourable conditions for the private sector to participate in RD&I.

During recent years, Estonia has undergone huge social and economic changes, resulting in the modification of the economic structure and an accompanying demand for results from RD&I. The promotion of RD&I will provide for an increase in added value in the economy and put Estonia on the path of long-term sustainable development. Therefore, the needs of the economy and the social sphere, as well as societal problems, should be taken into account and become a basis for the planning of RD&I activities.

Currently, the needs of society and the actual supply of RD&I are not yet in alignment to the required extent. This is demonstrated by the unbalanced distribution in total RD&I expenditure between basic and applied research, and technological developmental activity, as well as by the low level of cooperation between the research and business sectors, which has not encouraged the orientation of research projects towards cost-effective results. An important bottleneck is the fact that enterprises rarely participate in developmental activities.



In order to contribute as much as possible, through RD&I, to the development of the Estonian economy, to improving the quality of life and increasing social wellbeing, **the strategic objectives of Estonian RD&I are the following:**

- **updating the knowledge pool**
- **increasing the competitiveness of enterprises.**

In order to continuously update the knowledge pool, the level of scientific research must be raised. The criteria for the level of scientific research are international acceptance of results and competitiveness. An important factor is the applicability of scientific results.

A precondition for achieving an increase in competitiveness for enterprises on the basis of updated knowledge is the development of integration mechanisms between research, developmental activity and enterprise, which encourage the application of research results in enterprises and in society as a whole. The transfer of knowledge into the economy and society will only be possible when a corresponding integration mechanism exists and functions effectively.

The precondition for achieving the desired results is the existence of highly qualified and motivated specialists, and the development of human capital.

Since no small country can manage to be successful in all areas of RD&I or solve all RD&I problems simultaneously, the present strategy defines the key areas and foresees an increase of resources for these areas. For the implementation of the stated objectives and the vision for the future, the **key areas** for Estonian RD&I are the following:

- user-friendly information technologies and development of the information society
- biomedicine
- materials' technologies.

In order to develop these key areas, national programmes will be compiled and launched.

In order to achieve technological renewal in the economy and an increase in added value, attention will be paid during the development of the key areas to creating cooperation between traditional industry and the so-called new economy, and to the technological updating of Estonia's traditional industrial sectors. The emphasis will be in promoting innovation in the information technology, biomedical and materials technology sectors and applying these in traditional industry. The capacity of the traditional industrial sector to adopt and implement modern technologies will be increased.

In parallel to the development of key areas, the continuity and promotion of research related to the Estonian language, national culture and history, statehood, the sustainable development of society, the everyday living environment, nature protection and the sustainable use of natural resources, will be ensured.

In order to realize the RD&I objectives, work should continue on the adoption of effective RD&I financing mechanisms and financing proportions, for the development of human capital and the formation of integration mechanisms between research, development and business. International cooperation must be further developed and public awareness should be increased regarding the opportunities provided by RD&I.

In order to realize the objectives of the strategy, it is intended that by 2006, total expenditure on RD&I will be 1.5% of GDP, which will enable us to move towards the average EU level (1.9% of GDP, in 2000). With the help of state investments, the priority is for private capital to become more involved in developmental activities, after which the main function of the state will be to finance research.

The in-service training system will be shaped as an essential tool in developing human capital. As the role of engineers and other specialists with technical background is decisive in the application of developmental work and innovation, the priority in in-service training is to initiate a mandatory in-service training system for specialists in this field.

In order to raise public awareness in RD&I and to enhance the innovation capacity of enterprises, and also to develop cooperation between research and development institutions and enterprises, the state will launch programmes aimed at stimulating technological transfer and raising competences in managing innovation. A more competent management of innovation and a higher appreciation of innovation will enable an increase of investments into RD&I.

In order to develop an integration mechanism between research, development and business, the state will create favourable conditions for cooperation between public and private organizations and research and development institutions in different fields. Estonian centres of excellence in research and competence centres will be developed, research and technological parks will be built and developed, as well as innovation centres.

International cooperation in RD&I will be stimulated. It is important for a small country with limited resources to have access to additional resources and to be able to participate in the opportunities provided by international research infrastructures. Supporting Estonian enterprises and research institutions in their participation in EU RD&I programmes means the possibility of large-scale implementation of research results in the resolution of enterprises' technological problems.



Introduction

1. The needs and opportunities of a society in planning its economic and social development, in conditions of limited resources, can only be unified when there are clearly defined objectives, opportunities and principles, and there are qualitative and quantitative targets aimed at implementing the objectives. The task of the state in the field of RD&I is, on the one hand, to create conditions in order to acquire new knowledge, but on the other hand, to promote implementation of knowledge in the interests of society. In order to fulfil its role, the state needs a strategy, which will provide the basis for RD&I organization in the coming years, and where the framework and extent of public sector support measures until 2006 are determined.
2. This RD&I strategy is focused on the development of society by means of technological development and innovation, and on the underlying research activities. The RD&I strategy is closely related to the Estonian education strategy "Learning Estonia"¹ and other educational and economic-political documents.
3. The preparative work for the Estonian RD&I strategy began in 1998 and in the autumn of the same year, at the initiative of the Research and Development Council (TAN), and guided mainly by the Estonian Academy of Sciences, the first version of the strategy was completed, entitled "Knowledge-centred Estonia", which was approved, together with several remarks, by the Government on January 26, 1999. Taking into account the basic principles of this document, the Ministry of Education, the Ministry of Economic Affairs and the Academy of Sciences have compiled a new Estonian RD&I strategy. In preparing the current version of the strategy, account was taken of the changed economic situation both in Estonia and internationally, as well as of educational and economic policy orientations of RD&I in Estonia and the European Union.
4. The aim of the present document is to confirm the basic principles of the Government in the field of RD&I. The strategy principles will be reviewed and updated by the Government every three years, based on proposals by the Research and Development Council. Any substantial changes in strategy will be submitted for approval to the Riigikogu. The R&D Council also supervises the implementation of the strategy, and keeps the Government informed. On the basis of the strategy, annual action plans are compiled for RD&I, where specific measures and programmes are defined in order to promote RD&I according to the objectives outlined in the strategy. The Ministry of Education and the Ministry of Economic Affairs are responsible for the implementation of the strategy.
5. The RD&I strategy is the basis for the organization of RD&I on the state level. The strategy provides guidelines and motivation to enterprises and research institutions for their long-term planning and organization. The strategy also provides information to the public at large on the benefits for society generally from RD&I developments.
6. From the European integration viewpoint the RD&I strategy is an indicator for the European Union (EU) and international organizations regarding Estonia's maturity and the accordance of its policy orientations to EU development priorities in moving towards a knowledge-based economy. In Europe, the need for a common RD&I strategy has been stated and the RD&I documents of EU member states and candidate countries are considered as essential components of such a strategy. By raising the level of R&D and increasing its intensity, as well as the innovative capacity of enterprises, Estonia will be ready to effectively participate in international RD&I cooperation, including the planned European Research Area. By improving the functioning of the national innovation system, we are also supporting the competitiveness of our enterprises in the competition of the European common market.

1 The Estonian education strategy "Learning Estonia" was approved by the Government on October 30, 2001.

1. Role of research & development and innovation in modern society

1. RD&I activities support the preservation of the state and the nation, and the orientation of the economy and society towards sustainable development.
2. Research, as a part of culture, has a central role in developing people's intellectual capacities, in satisfying the thirst for knowledge and in creating preconditions for producing material benefits, for the development of society and a rise in the education level.
3. Economic globalisation, rapid technological development and the development of an information society have presented a serious challenge to RD&I. In the increased competition between countries, success is determined by the speed of development and application of new technologies, the speedy implementation of technologies elaborated elsewhere and the availability of a labour force with the needed qualifications. This, in turn, presupposes improving the quality of education, an increase in investments in the RD&I sector, and the development of a flexible and effective support system.
4. In a successful and competitive economy, one of the primary forces of RD&I is market and social demand. Therefore, research work should essentially be based on the needs of the society, and concentrate more on application-focused research and development. For R&D activities to become more efficient, however, a knowledge pool is needed, supplemented continuously by basic research. Basic research in all research areas ensures the development of intellectual potential and knowledge.
5. A globalising and open society where success is related, to a great extent, to technological development, sets increasingly more demands on its members. Fulfilling the tasks set by society depends considerably on the wellbeing of all members and their readiness to participate in such implementation. Therefore research addressing the social sphere has a special importance both for identifying and preventing possible risks, and in ensuring the mental and physical health of society.
6. Higher education is the foundation of RD&I. The state commissioning of student places in higher education should take account of RD&I strategic objectives and key areas, which will help to ensure that in all areas that are essential for society, a new generation of researchers and highly qualified specialists will emerge. When building a society based on knowledge and skills, academic higher education should be based on high-level scientific research.
7. In order to fully apply in society the possibilities that stem from RD&I, information on new research as well as consumer needs must be constantly available to enterprises, researchers and the public. In order to enable members of society to participate in the public debate on the application of research results, the level of RD&I-related awareness as well as scientific education, should be raised.
8. The governments of developed countries rely increasingly in their decision-making on scientifically well-founded advice. In order to enhance the effectiveness of political decision-making and its credibility, decisions made in all essential areas for society should be based on scientific research and analysis.
9. The implementation of RD&I results often brings about rapid changes in society, to which individuals and institutions have difficulties in adapting. Therefore, researchers have a social responsibility to monitor and evaluate developments in science and technology, helping society prepare for change and to make practical use of the opportunities related to these changes.

2. Role of the state in promoting research & development and innovation

1. The activity of the state in promoting RD&I proceeds from the understanding that the state's development is based on knowledge and skills. The wellbeing of society and long-term economic growth, with the economic use of resources, is achievable mainly through RD&I and by developing human capital. It is important for the state that RD&I and the innovation system ensure a rapid transfer of technological solutions, either developed in our country or elsewhere, into new products and services.
2. The social and economic benefits stemming from RD&I are expressed in the spread of knowledge and skills and in the changing of the economic and employment structure. As a result, the international competitiveness of the state and the wellbeing of society will increase.
3. As the market does not create investments in RD&I in an optimal way for society, and does not guarantee an extensive application of research results in production, the state has to perform several different roles, being at the same time investor, catalyst as well as regulator. The state is the main investor in creating a pool of knowledge that takes account of society's needs, thereby ensuring reproduction of new knowledge and skills. The state is the catalyst of innovation processes, accelerating the application of new knowledge and skills and encouraging enterprises to develop and implement new technologies. The state as the regulator creates a favourable environment for the development of RD&I and ensures consumer security in the field of implementation of new technologies.
4. Performing different roles presupposes several specific actions from the state, with the primary ones being:
 - setting strategic targets, in order to acquire and apply new knowledge, and checking that such targets have been met
 - integrating activity plans to ensure well-balanced development in the fields of economic development, education and RD&I
 - creating favourable conditions, by means of policies and legislation, for the private sector to be able to participate in RD&I
 - ensuring financing for fundamental and applied research, and the necessary infrastructure
 - developing integration mechanisms between R&D and the business sector, and supporting their efficient functioning
 - launching national programmes in order to implement RD&I priorities.
5. From the viewpoint of the state of Estonia, the following principles are essential when planning RD&I.
 - The education and RD&I systems ensure the creation and application of new knowledge and a general increase in knowledge in the interests of the social, economic and cultural development of Estonia.
 - R&D related to Estonian national culture and environment, to economic development, is ensured, as is research related to the statehood of Estonia, the sustainable development of society and national security.
 - Investments into RD&I are at least on the level of the average for the European Union.
 - The results achieved by Estonian researchers are a part of world science. As a result of international cooperation, the transfer of know-how into the Estonian economy and society functions efficiently.

3. Research & development and innovation systems in Estonia

3.1. The national organization of research and development

1. The national structure for research and development has undergone several changes during the last decade. During the process of R&D and higher education reform, which started at the beginning of the 1990s, a mechanism for decision-making has been developed, institutional reform has been carried out, a financing system has been created, and corresponding legislation to support the functioning of the system has been drafted. The activity of research institutions has been reorganized, and internal and international evaluation of research areas has been carried out. Post-graduate education has essentially been brought into accordance with international criteria.
2. In 1994, the Organization of Research Act was adopted in the Riigikogu (parliament) and in 1997, the Organization of Research and Development Act was adopted as an updated version. This law provides the bases for the new structure, organization and financing of the research and development system, as well as for state surveillance. At the beginning of 2001, the Riigikogu approved the Amendment Act for the aforementioned Act (full text of the Act: RT I 2001, 43, 237).
3. During the period 1996–1998, the majority of the former Academy of Sciences research institutes were merged with the universities. In 1990 the Estonian Research and Development Council (TAN) – the strategic advisory body to the Government in research and development issues – was founded, as well as two special-purpose foundations: the Estonian Science Foundation (ETF) and the Estonian Innovation Foundation (EIF). The Estonian Innovation Foundation has since been restructured into the Estonian Technology Agency (ESTAG), as a sub-unit of the Enterprise Development Foundation (EAS) which is under the jurisdiction of the Ministry of Economic Affairs. In 1997, the Research Competency Council (TKN) was established, and in the same year, the Archimedes Foundation was founded by the Ministry of Education. The national structure of research and development, complete with the functions of the different institutions, may be found in Appendix 2.
4. The current emphasis is on raising the effectiveness of the RD&I system by a clearer delineation of functions between the various parts of the system, and by improving mutual cooperation. One of the most significant of such changes is the reform of the Research and Development Council (TAN), initiated in 2000 and completed by autumn 2001, as well as the launching of ESTAG under the competence of the Ministry of Economic Affairs. An effective organizing structure for RD&I is a precondition for an increase in state budget allocations, and their efficient use by the Estonian RD&I system.
5. The lack of public consensus regarding long-term RD&I development, and the general under-financing of this field from the state budget, have emphasized the need for a research and development (including financing) strategy. A diversification of the currently insufficient supporting instruments for technological development and innovation is necessary, in order to be able to cover the entire process – from initial concept to finished product.



3.2. Support structures for innovation

1. Various support structures for innovation have been created in Estonia in recent years, with the aim to strengthen the ties between research and business, as well as to create new research-intensive enterprises and to support their growth.
2. Support structures are currently being developed in Tallinn and Tartu, where they constitute important intermediary links in the commercialisation of knowledge, and support the foundation and development of new, research-intensive enterprises.
3. SA Tartu Teaduspark (Tartu Research Park Foundation) has been functioning since 1992, focusing mainly on assisting the development of research-intensive enterprises, creating and developing the required infrastructure and network of services. The PHARE SPP pilot project contributed considerably to the development of Tartu Research Park. As a result, incubation opportunities improved and the scale of services was diversified.
4. SA Tallinna Tehnikaülikooli Innovatsioonikeskus (Tallinn Technical University Innovation Centre Foundation, TIK) was founded in 1998, with the aim of linking the research and development results of the University to the technological needs of industrial enterprises. It is planned to further develop the centre by establishing Tallinn Technology Park as a part of the Tallinn Technical University Technology Village concept.
5. A regional innovation centre has been created within the framework of a PHARE SPP pilot project in Jõhvi, in order to contribute to a better use of the Ida-Virumaa industrial region's potential and to assist in transferring technologies into a region where local research and development resources are limited. Within the framework of PHARE 2000 ESC, an Oil Shale Development Centre is being created on the basis of the Tallinn Technical University Oil Shale Institute which is situated in Ida-Virumaa. The aim is to coordinate research in the field of oil shale and to help the region's oil shale cluster to develop innovative products, services and processes.
6. Within the framework of the 1996 PHARE project for higher education and science reform (HESR), centres of competence were founded by the University of Tartu and Tallinn Technical University. In order to encourage technological development and increase contacts between research and the business sector, there are currently plans to launch a programme of technological development centres.
7. Despite these already operating functions, the innovation support system in Estonia can hardly be considered sufficient. In order to achieve a more effective cooperation between research and business – and the creation of innovative enterprise on the basis of research results – the continued, systematic development of support structures is needed, including infrastructure and support service development, and the launch of relevant support programmes.

3.3. Current situation in research and development

1. The situation in research and development is characterised by the following indicators: the volume and structure of research and development, human capital, the number of patent applications and success in international cooperation. The indicators for research and development volume and structure are the funds invested into the sector and their distribution between basic research, applied research, and development, as well as the distribution of investment between the public and the private sectors. The indicator for human capital is the share of researchers and engineers within the labour force.
2. In Estonia, total expenditure during the period 1995-1998 on research and development remained at 0.6% of GDP. In 1999, expenditure increased to 0.76% of the GDP. Using international comparisons, it can be seen that this indicator is very low, forming only 40% of the average for EU member states (1.9% of GDP in 2000), and being on the same level as Portugal (0.6% of GDP, 1998). The actual increase in total expenditure for Estonian research and development has remained modest, at an average of 4.3% annually (according to 1995 fixed prices).
3. Comparing the sources for financing research and development, the main research and development investor in Estonia for the entire period under observation has been the public sector. In 1999, the share of the public sector in total expenditure on research and development in Estonia was 76%, while the corresponding average for EU member states is 34% (2000).
4. However, public sector expenditure (0.57% of GDP in 1999) on research and development in Estonia is still lower than the EU member state average (0.65% of GDP in 2000). On average, 90% of state budget research and development funds have been allocated during the period under observation to research only, whereas state support for development and the stimulation of innovation has been limited.
5. The total expenditure on Estonian research and development was divided between the various categories of research and development in 1999 as follows: 49.8% to basic research, 34.5% to applied research and 15.7% to technological development, with the resulting ratio of 1.0:0.7:0.3. Consequently the financing of research and development is not proportionally divided between basic research, applied research and technological development. This means that there is insufficient stimulus for the application of knowledge within the economy or for development activity in enterprises. In developed countries, the ratios are the opposite, with the emphasis on developmental activities.
6. The share of researchers and engineers has decreased in Estonia recently. In 1999, there were 4.3 researchers and engineers per 1000 workers in Estonia. The EU average is 5.1 (1997). The share of researchers according to the scientific field was the following: natural sciences 31%, technical sciences 17.8%, humanities 17.4%, social sciences 15.3%, medical sciences 11% and agricultural sciences 7%.
7. The structure of Estonian researchers according to their speciality and age (43% of all researchers are over 50, 2000), and the qualifications of researchers in some fields, do not correspond to the task of developing the competitiveness of the Estonian economy. There is a particular lack of highly qualified engineers in technological fields related to the development of new products and services, including the IT sector. Such a situation is diminishing Estonia's attractiveness to foreign investors, for whom interest lies in the quality of the local labour force and the condition of the infrastructure.

8. One of the indicators for the innovative capacity of enterprises, and the basis for assessing long-term competitiveness, is the expenditure by enterprises on research and development. The development intensity of Estonian enterprises is low – expenditure by enterprises on research and development was only 0.19% of GDP in 1999 (1.25% of GDP in the EU, 2000), and 24% of the total expenditure on research and development.
9. The motivation for existing highly qualified researchers and engineers to apply their knowledge in business is low, and there is also a lack of state measures to stimulate interest. Cooperation between researchers and enterprises is not sufficiently intensive. In 1998, only 0.66 researchers and engineers per 1000 workers were employed in Estonian enterprises. In 1999, this ratio decreased to 0.54. The corresponding EU indicator is 2.5 (1997).
10. There is considerable scientific potential in Estonia, witnessed by the numerous publications in the international specialised press, and active international cooperation. 54.6% of the articles published in international journals by Estonian authors are a result of international cooperation. Estonia has successfully participated in the EU research and development framework programmes. According to the preliminary results (as of July 1, 2001) of the open project competition for the EU research and development 5th Framework Programme in 1999, 425 project applications were made with Estonian participation, and of these, 24.2% were successful. Such a rate of success is comparable to the EU member state average. As to other international RD&I cooperation and information networks, Estonia is a full member of COST, EUREKA and GEANT, and belongs to the Innovation Relay Centre (IRC) network.
11. State financing of research and development, with its orientation to research, has ensured a high level of basic research in some specialities, but the link between the creation of new knowledge and the consequent development of new technologies has remained weak. The level of patent applications, which characterizes technological innovation, is very low in Estonia. The number of patent applications per 10 000 inhabitants is 0.1 in Estonia, whereas the EU average is 2.5. The transfer of ideas and knowledge created by research into competitive products and services on the market requires more than the current level of attention and effort by the state.

3.4. Societal and economic demand for research and development, and innovation

1. During recent years, Estonia has undergone huge social and economic changes, resulting in a changed economic structure, complete with a demand for RD&I results. Previously, the traditional RD&I tasks were the promotion of national values and the protection of the natural environment. However, after the re-establishment of independence, the consideration of economic needs has come to the forefront as a tool for achieving an increase in social wellbeing.
2. The demand for RD&I will not occur of its own accord in society, nor will it create an applicable supply. Therefore the state should be capable of identifying and acknowledging both existing and future demands.
3. There are primarily three types of needs determining the new and additional demands for RD&I that have accompanied the transition to a market economy:
 - the needs of traditional industrial branches and enterprises;
 - the needs of new high technology economic branches;
 - the needs of the social sphere.
4. The emergence of the demand-related supply of RD&I presumes greater emphasis on applied research, and development and support for the mechanisms of technological transfer.
5. The needs of society and the actual supply of RD&I are currently not sufficiently in alignment. This is shown both by the unbalanced division of RD&I total expenditure between fundamental research, applied research, and technological development, and also by the low level of cooperation between research and the business sector, all of which has not encouraged the orientation of research projects towards cost-effective results. The Government and the business sector are not fully aware of the possible and necessary role of RD&I.



4. Vision

Estonia is a knowledge-based society where new knowledge, the application of knowledge and skills, as well as the development of human capital, constitute the source of economic and labour force competitiveness and an enhanced quality of life.

Estonia has preserved its identity, supporting research and promoting national and intellectual values.

Cooperation between the state, the private and the third sector is based on the recognition of common objectives and striving for their achievement. Openness and innovation have turned Estonia into an appreciated international cooperation partner.

5. Objectives and key areas for the promotion of research & development and innovation

5.1. Objectives

1. The overall purpose for action by the Estonian state is to enhance the quality of life for Estonia's population and to improve social wellbeing in society. The intensification of RD&I-related activity, together with purposeful planning, will significantly contribute to the achievement of this objective, because of the resulting greater proportion of added-value in the economy and the positioning of Estonia on the way to long-term sustainable development.
2. The continual updating of knowledge is the precondition for developmental activity and for the implementation of knowledge by means of innovative products and services that enhance the competitiveness of enterprises. Innovative products and services support economic growth and thereby result in an increase in the actual incomes in society and a better quality of life. Updated knowledge and increasingly intensive development are the foundation, in addition to the entrepreneurial aspect, for technological renewal and better social conditions.
3. According to the overall objectives of the Estonian state, the strategic objectives for Estonian RD&I are the following:
 - updating the pool of knowledge
 - increasing the competitiveness of enterprises.
4. The main precondition for achieving the stated objectives is the existence of highly qualified and motivated specialists and the development of human capital, which must be ensured by the educational system.
5. In the process of continuously updating the pool of knowledge, the main focus is on raising the quality and level of scientific research. The criteria for the level of research are international acceptance, competitiveness and applicability.
6. The precondition for achieving a greater competitiveness in enterprises on the basis of updated knowledge is the development of an integration mechanism between the research and business sectors, which will enhance the application of research results in enterprises and in society as a whole. An efficient cooperation between research, developmental activity and business will ensure the availability of research results and the most recent know-how and their transfer to the economy, as well as an increased flow of qualified researchers, engineers and technicians between research and development institutions and industries. This will enhance the awareness of research and development institutions regarding the actual needs of industry and the business sector for new technologies and for qualified researchers and engineers.
7. In striving towards the strategic objectives, the principles are as follows:
 - socially balanced development of society
 - sustainable development in everyday life and the natural environment
 - scientific ethics.
8. It is important to note that the observance of scientific ethics contributes to the improvement of the quality of scientific studies, ensuring the impartial attitude of researchers towards research results and the use of all available sources in order to obtain truthful information. Ethical standards in society help to minimize the risks related to the development of research and technology, excluding the misuse or abuse of technology. A wider dissemination of an objective way of thinking, based on scientific ethics, will help ensure that decision-making in the public sector is open, scientifically-based, taking into account generally accepted criteria.

5.2. Key areas

1. No small nation can manage to be successful in all areas of RD&I or to solve all RD&I problems simultaneously. The present strategy, therefore, will define the key areas and foresee an increase in the share of state resources (both human and material resources) allocated to these areas.
2. The Estonian RD&I key areas have been defined taking into account specific opportunities for development in Estonia, the existing research potential, the existing economic structure and international orientations in the field of RD&I.
3. In the implementation of planned objectives and visions for future, the key areas are the following:
 - user-friendly information technologies and development of the information society
 - biomedicine
 - materials' technologies.

User-friendly information technologies (IT) and development of the information society

Objective To promote the development of the information society where access to information, and opportunities for its use in everyday life, is ensured for everyone, and the development of IT applications in enterprises is encouraged.

Justification The wider use of IT within society opens up opportunities for communication, study and work, and creates new orientations for enterprises, thereby enhancing the effectiveness of both the public sector as well as the entire economy, and improving the quality of life for individuals.

The implementation of IT in Estonia has developed with significant speed, society views IT favourably, and in a short period of time the required technological infrastructure has been developed.

IT offers numerous opportunities for enterprises and organizations (including state bodies), enabling them to organize their activities in a more efficient and user-friendly manner, which creates a basis for the development of a knowledge-based economy and an e-state.

Information society technologies allow qualitative new approaches in education, create new knowledge and provide dissemination from research into the economy. The IT contribution is important in preserving and researching cultural heritage and in developing linguistic and speech technologies.

Biomedicine

Objective To encourage the unification of clinical medicine and molecular biology research, whereby the resulting application should be used to improve public health and to develop enterprise in the biotechnology field.

Justification The possibilities of clinical medicine often remain limited in resolving the fundamental problems in medicine. The breakthrough in decoding the human genome has brought success in diagnosing disease, identifying environmental influences on human health and in developing cures. The contribution of biomedicine is even more important in preventing diseases and promoting healthy lifestyles. Research in genomics and proteomics extend the opportunities for new applications.

In Estonia, biomedical applications with a notable scientific potential include diagnosis and cure for diseases, application of biomedical technology, identification of risk factors for diseases, developing drugs and innovative platforms in environmental technology.

The applications of biomedicine offer possibilities for the establishment and development of high technology industries. Development of this key sector will extend the Estonian biotechnological sector and increase its international competitiveness.

Materials' technologies

Objective To encourage the use of new materials and equipment, and the development of related applied research and enterprise based on materials technologies.

Justification Materials research integrates and synthesizes the achievements and possibilities of various scientific fields, in the creation and implementation of new high technology materials, and is therefore a discipline with a key position.

Estonian researchers have world-ranking competency in optical memory materials, biomaterials, semi-conductor materials, various types of sensors, nanotechnologies, laser technologies, computer design of materials, creation of new composite materials and functional surface covers, as well as methods of materials' study and equipment development. Therefore in such niche-specific and research-intensive areas, any existing or future small or medium sized high technology enterprise could experience significant success in Estonia.

New materials research and technological solutions must ensure the competitiveness of Estonian enterprises in many research-intensive areas (electronics, machine and instrument production, communications, medicine, energy systems, national defence, etc.) and ensure economical management.



4. In parallel with the development of the key areas, the following will also be ensured:
 - the continuity and promotion of research related to the Estonian people, language, national culture and history
 - the continuity and promotion of research related to Estonian statehood and the sustainable development of society, as well as ensuring national security
 - the continuity and promotion of research related to the everyday environment and nature protection, the sustainable use of natural resources, and the development of rural areas.
5. In order to identify more precisely the best opportunities for Estonia in key areas, studies will be continuously undertaken to analyse existing preconditions and the cost-effectiveness of results. The Ministry of Economic Affairs and the Ministry of Education, in cooperation with research and development institutions and business representatives, will compile and launch national programmes for the development of key areas.
6. Bringing the key areas in line with the European Union's RD&I priorities will encourage active participation by Estonian researchers and enterprises in international RD&I cooperation and will enable us to obtain additional financing for the achievement of national priorities.
7. In developing high technology industry in key areas, attention will be paid to strengthening the cooperation between traditional industry and the so-called new economy, as well as to the technological updating of traditional industrial branches in Estonia. The application of the innovations created in the information, biomedical and materials technologies sectors will be encouraged in traditional industries.
8. In order to achieve technological renewal in the economy and the growth of added value, the capacity of traditional industrial branches to apply modern technologies should be increased. As a result of this adaptation, added value will grow, and the knowledge and skills will be increased that allow consequent independent development activity.
9. In supporting technological transfer, attention should be paid to the involvement of foreign investment, which is the main channel for international technological transfer.

6. Implementation of objectives

6.1. Financing research and development

1. The precondition for implementing the objectives of the RD&I strategy is to develop an efficiently functioning financing system, as well as the existence of financial means. In order to achieve the strategy objectives, it has been planned that by 2006, total R&D expenditure will form 1.5% of GDP, which will be a move towards the average EU level (1.9% of GDP in 2000). Looking to the future, in order to achieve social and economic cohesion with the EU, we need to follow the long-term (10 year) strategic objective fixed by the European Council at the Lisbon Summit in 2000, that is, to become the most competitive and dynamic knowledge-based economic area in the world, which can also be characterized by an average expenditure on research and development of 3% of GDP.
2. The strategic principles for financing research and development up to 2006 are the following:
 - a significant increase in the state financing of research and development, especially for technological development and innovation
 - the more active participation of private and foreign capital in the implementation and financing of research and development
 - ensuring the effectiveness, transparency and social and economic results of the use of state allocations, by means of more efficiency in the state structures for research and development.
3. In financing research and development, the importance of the public sector and, in the long term, that of the private sector should increase, so that by 2010, private sector financing of research and development should exceed state expenditure. A financing strategy corresponding to the objectives and orientations is presented in Appendix 3, and this contains, in addition to state financing foreseen for research and development in 2001–2006, the actual state budget financing for 1998–2000.
4. The current ratio of financing, where research expenditure makes up 90% and the development expenditure 10% of the state's total expenditure on research and development, should become 60% and 40%, respectively, by 2006. By means of increasing state investments, more private capital should be involved in developmental activity, so that eventually the main function for the state will be to finance research.
5. State expenditures on RD&I will be financed, in addition to state budgetary means, also through the EU pre-structural and the future structural funds, where the use of the funds is planned on the basis of the current strategy in the Estonian National Development Programme.
6. The need for state financing is different for research and for developmental activity. The main function of the state is to finance research with the aim of raising the level of the scientific basis needed for the development of society, and to ensure the continuity of knowledge. The state financing system should also orient scientific results towards applications that correspond to social and economic demands. In supporting technological development and innovation, however, the state is the initiator of market-based relations and financing mechanisms. The aim of state investments is to achieve the awareness and interest of the private sector towards development and innovation, and thereby an increased participation of the private sector in financing development. In order to ensure the participation of the private sector, the state must create a favourable infrastructure and business environment for technological development and innovation, and support technology-intensive enterprises.

7. In financing RD&I, a diversity of financing measures should be achieved, ensuring the continuity and flexibility of financing. State financing of research and development is organized through targeted financing, research and development grants, maintenance of the infrastructure, national research and development programmes, and support programmes for innovation.
8. The aim of targeted financing is to ensure a competitive basic structure for scientific research and the continuity of research necessary for Estonia. Financial means are planned for developing new research areas and to obtain the information resources needed for research. The targeted financing of research and development institutions is the responsibility of the Ministry of Education.
9. The purpose of grants is primarily to support high-level initiative research, new ideas and studies. Research grants are financed by the ETF Foundation, from the Ministry of Education's budget.
10. The purpose of the support scheme financed from the budget of the Ministry of Economic Affairs through ESTAG is to raise the competitiveness of enterprises by developing and applying new technologies. Financial criteria are applied that encourage an increased innovation capacity in enterprises, cooperation between enterprises and research institutions, application of scientific results in the economy, creation of strategic partnerships and cross-border cooperation. The support scheme is oriented to product development in enterprises, research with a market potential undertaken in research and development institutions, and preliminary studies for projects.
11. The aim of the support for maintenance and development of infrastructure of research and development institutions is to ensure the rational use of existing infrastructure, and its purposeful development. The financing problems of specific infrastructure (scientific libraries and museums, archives, collections, workshops of scientific instruments, acquisition of scientific equipment and its maintenance, research publishers, etc.) are still in need of a solution. The infrastructure costs of the state research and development institutions are covered by the budget of the Ministry under which the institution belongs.
12. National research and development programmes are foreseen for the purposeful and systematic development of key areas, as well as to contribute to the solutions of other problems that are relevant for the development of the economy and society.
13. Support programmes for innovation are targeted at eliminating obstacles existing within the national innovation system and to raise the innovative capacity of both enterprises and research and development institutions. The support programmes that are prepared and implemented from the budget of the Ministry of Economic Affairs through ESTAG stimulate cooperation between enterprises and research and development institutions, contribute to the raising of innovation-related awareness and innovation management competence, support technological transfers, etc.
14. In 2002, in cooperation between the Ministry of Economic Affairs, ESTAG and the Credit and Export Guarantee Foundation (KredEx), the concept of risk capital and guarantee schemes for technological transfer will be elaborated as mechanisms to motivate the application of research and development results for small and medium enterprises who start in this field. The aim is to create preconditions for the creation and development of technology-intensive enterprises and to enhance the competitiveness of small and medium enterprises.
15. In order to motivate the private sector into increasing its participation in investing into RD&I, the Ministry of Economic Affairs, in cooperation with other relevant ministries, is preparing proposals and recommendations for the use of additional measures supporting market-oriented research and development and for increasing the effectiveness of the innovation system.

16. In order to solve the financing problems of research and achieve more cost-effective final results, it is not sufficient to increase state allocations. The financing of single innovation projects should clearly be distinguished from the so-called general support for research, and private capital should be involved to a greater extent. The involvement of private capital will enhance the market-orientation of planned and implemented projects.
17. In order to achieve significant participation by the private sector in financing developmental activity, the financing of research and development should be based on the applicability of research, and be oriented to support innovation. An increase by research and development institutions of the number of studies with market potential, and cooperation with enterprises in order to implement research results, will increase the motivation of enterprises to finance developmental activities.

6.2. Development of human capital

1. The keywords of a knowledge-based society are an innovative way of thinking and lifelong learning. According to the Estonian education strategy “Learning Estonia”, the necessary preconditions will be created within the educational system to generate and value new ideas. The basis of the educational strategy is the vision of a learning society as a network consisting of people, who learn all life long, and of learning organizations. This subsection of the RD&I strategy will further develop and supplement the positions and planned activities expressed in the educational strategy, from the viewpoint of RD&I. The Ministry of Education is responsible for the implementation of the activities described in this subsection.
2. In developing an in-service training system in cooperation between the state, the business sector and professional associations, lifelong learning will be possible for the representatives of all sectors at all educational levels. As engineers and other specialists with technical education have a decisive role in implementing developmental activity and innovation, the first priority for continuous training is to launch a system of mandatory in-service training for specialists in this field.
3. In order to ensure the emergence of the next generation of young researchers and the training of highly qualified specialists for the business and public sectors, the number of Master’s and doctoral studies financed by the state will be increased primarily in areas which support the achievement of the objectives in the present strategy, and the development of the areas which are defined within this strategy. Where there are no study facilities for certain specialities, and if their development is not cost-effective in Estonia, the training of such specialists abroad should be supported.
4. In order for universities to perform the task of institutions of research and development, the conditions of their infrastructure should be improved, and the minimum cost of a student place should be set at a level which enables the university to provide a modern education.
5. In order to motivate young researchers and to ensure their academic career, a scheme to involve PhD graduates and postdoctors in the RD&I system will be developed. The inclusion of postdoctors from other countries in Estonian research groups will be supported.
6. In order to enhance the efficiency of post-graduate study, the Ministry of Education, in cooperation with the Ministry of Economic Affairs, will elaborate a concept for involving centres of excellence and competence centres in post-graduate studies. The concept will be developed during 2002.
7. By means of implementing a system of multi-aspect courses and modules, the capacity of university students and researchers to manage projects, and acquire competency in management and business, will be supported in universities. Students and researchers will therefore be encouraged to tie their research areas to the solutions of problems faced by the economy and society, and to seek implementation opportunities for the results of their research activities.

6.3. Increasing the effectiveness of the research and development, and innovation systems

6.3.1. Raising awareness and enhancing competency in research and development, and innovation

1. In order that knowledge and research and development be valued in society, regular popularisation of knowledge is needed. In order to create interest in sciences and to introduce sciences to a wider public, the state will support the foundation and functioning of centres that introduce research activities to the public.
2. In order to ensure targeted development of knowledge and research and development, the regular collection, preservation, processing and making available of scientific information is needed.
3. To raise awareness in society about the role of development and innovation as areas ensuring economic growth and wellbeing, the state, at the initiative of ESTAG, will launch a support programme. Better awareness and appreciation of innovation will enable us to achieve increasing investments into RD&I.
4. Training will be launched for both enterprise managers and researchers in the field of RD&I management, and to stimulate partnership between industry and the knowledge source. A competence-raising programme will be elaborated in the field of RD&I management. As a result, the awareness of research and development institutions about the need of industry for new technologies, for qualified researchers and engineers, will be enhanced, as well as the capacity of enterprises to develop and implement new technologies, and to manage technological changes.



6.3.2. Developing an integration mechanism between research and enterprises

1. It is possible to achieve a transfer of knowledge and technology into society by stimulating partnership between enterprises, developmental activity and research. To achieve this, the RD&I system must create favourable conditions for mutual cooperation between organizations in the public and private sectors, and the research and development institutions in different fields.
2. To create a favourable environment for the creation and development of innovative enterprises and the technological renewal of existing enterprises, research and technological parks should be built and developed, as well as innovation and incubation centres. The purpose is to develop research and/or technological parks with a full set of services in both Tallinn and Tartu, as well as a network of regional innovation and/or incubation centres in those regions where there is sufficient local potential and local initiative, and where the local governments are interested.
3. As one part of the RD&I system, the Ministry of Education will begin the further development of Estonian centres of excellence in research, and the Ministry of Economic Affairs will mainly address the issue of competence centres oriented to developmental activity and the implementation of know-how transfer. The European Research Area concept foresees the development of both large international centres of excellence in research, and, on the basis of smaller local centres of excellence and competence centres, the creation of a pan-European network. The identification of centres of excellence in research and their support, as well as launching the activity of competence centres, will help to create a favourable environment for the stimulation of high level research and development, to join the international network of centres of excellence and competence centres, and to develop a favourable environment for the generation of innovative ideas. At the same time, centres of excellence in research and competence centres are a good basis for stimulating cooperation between research and development institutions and enterprises, as well as for the training of top-level specialists (including post-graduate studies and the effective application of postdoctors).
4. In order to strengthen the partnership between research and business, the state will support cooperation between universities, other research and development institutions and enterprises, also encouraging students and scientists to participate in solving the problems of enterprises and encouraging the enterprises to launch and implement innovative projects. The Ministry of Education and the Ministry of Economic Affairs are responsible for the elaboration of specific solutions and mechanisms for the stimulation of partnerships between research and the business sector.
5. A promising possibility for stimulating technological transfer is support for the creation and development of new high technology and research-intensive spin-off companies that raise the capacity of research and development institutions and universities to develop competitive technologies and to support companies operating on the basis of RD&I. The Ministry of Education and the Ministry of Economic Affairs will, in cooperation, elaborate suitable measures for supporting spin-off companies.

6.4. International cooperation

1. International cooperation in RD&I is important for a small country with limited resources in order to obtain additional resources and to participate in opportunities offered by international research infrastructures. International cooperation is developed by taking into account:
 - the internal development of the science (e.g. physics, biology)
 - cultural ties (e.g. Finno-Ugric languages, archaeology)
 - geographical ties (e.g. cooperation in the Baltic Sea region and Europe)
 - economic ties (e.g. technology).
2. In many scientific fields where Estonia has top level researchers, but local research groups are small, participation in international programmes provides our researchers with the opportunity to carry out studies in research groups that exceed the critical mass needed for scientific activities, also providing access to unique scientific equipment. This is also one way to avoid brain-drain.
3. The Estonian potential for satisfying the need of business and society for technological development is limited. Therefore international technological transfer support to Estonia enables Estonian enterprises to raise their competitiveness by acquiring and adapting modern technologies that have been elaborated elsewhere. International cooperation in the field of technology offers enterprises the opportunity to disseminate the risks associated with technological development activities and to share costs, as well as to have access to know-how and new markets.
4. International cooperation in the field of RD&I has an important role in Estonia's accession to the European Union. As a candidate country, Estonia is actively participating in the development of the common European Research Area and in shaping the basic principles of the EU's 6th Framework Programme for Research and Development.
5. In order to increase the participation level of enterprises, and research and development institutions, in EU research and development framework programmes, the structure of administration on a national level will be made more efficient, and support will be given to carry out stimulating activities.
6. In addition to activities oriented towards the European Union, support is also provided to Estonian enterprises, and research and development institutions, for participation in the programmes of the European Research Foundation, the Committee for Ethics in Research and Technology, the OECD Committee for Research and Technological Policy, for concluding RD&I-related cooperation agreements with other countries, for cooperation within the UNESCO framework, and for concluding bilateral and multilateral agreements between institutions. Participation in the COST, EUREKA and INTAS programmes is also supported, as well as the exchange of researchers and students within the framework of the Erasmus programme, the Foreign Exchange Fund of the Estonian Academy of Sciences, the Marie Curie grants and others.
7. In order to be better informed about development trends in RD&I and to make better use of what is on offer in this field in the leading EU countries, a network of Estonian research and technological attachés will be established in countries of strategic importance. The first step is to create such a position in Brussels for access to the European Commission, and later on, similar positions will be filled in the Nordic countries and in the USA. The experience of other countries, including candidate countries, confirms that such decisions are cost-effective.



Appendix 1

Explanation of terms used

Basic research – theoretical or experimental research with the aim of gaining new knowledge about the basic principles of phenomena and events, without the objective of immediate application of such knowledge.

Centre of competence – a centre where activity is mainly oriented towards applied research, developmental activity and the application of global know-how, thereby aiming to increase the competitiveness of enterprises in the given sector. The centres of competence are administered by universities or university sub-entities.

Evaluation – comparative assessment of the results of research and development. During research evaluation, the level of research is compared internationally, whereas the evaluation of developmental activity and innovation is mainly based on the assessment of the activity's economic outcomes, and is primarily national or enterprise-centred.

Innovation – the implementation of new ideas on the market in order to offer a competitive product or service, to begin using a new or improved technology in industry, services or the public sector.

Support structures for innovation – institutions, which aim to support the commercialisation of the results of research and development. Such support structures include research and technology parks, technological, innovation and incubation centres, etc.

Postdoctor – a scientist with a recently awarded PhD who has won an open competition for a special purpose two-year grant. When applying for the status of postdoctor, the applicant should not be older than 35, and no more than three years should have elapsed since the awarding of the PhD.

Experimental and developmental activity – systematic application of knowledge, based on research and practical experience, with the aim of developing new or improving existing products and services, processes, etc.

Commercialisation – selling an innovative product or process.

Post-graduate study centre – a centre that organises post-graduate study in one or several scientific fields, encompassing various structural units. Such a centre may also be shared between universities.

Applied research – original research in order to obtain new knowledge for the solution of a given practical problem within a relatively short period of time.

Researchers and engineers – all persons with a higher degree or university diploma who are working as professionals in fundamental or applied research, or carrying out experimental and development work. Including managers and administrators who work with planning or organizing scientific and technical aspects.

Centre of excellence in research – a research centre with international recognition in its specific field. A centre of excellence may be comprised of one or several research groups who have clearly defined common research objectives and a management structure. The activity of centres of excellence is primarily focused on fundamental research in fields essential for the development of the country and are also preferably related to doctoral study. The status of centre of excellence, together with additional financing, is accorded by the Ministry of Education.

Research and development institutions – legal entities or institutions whose main statutory activity is research and development.

Research and development – systematic activity, based on a person's creative freedom, for the purpose of obtaining new knowledge, by means of scientific research, about human beings, nature

and society, and their interaction, and the application of such knowledge. Research and development includes three kinds of activity: fundamental research, applied research, and experimental and developmental activity.

Key areas of research and development – generally recognized research and development priority areas, which are important for the development of the Estonian economy and society and, for the development of which, national programmes are compiled and additional resources for implementation are allocated.

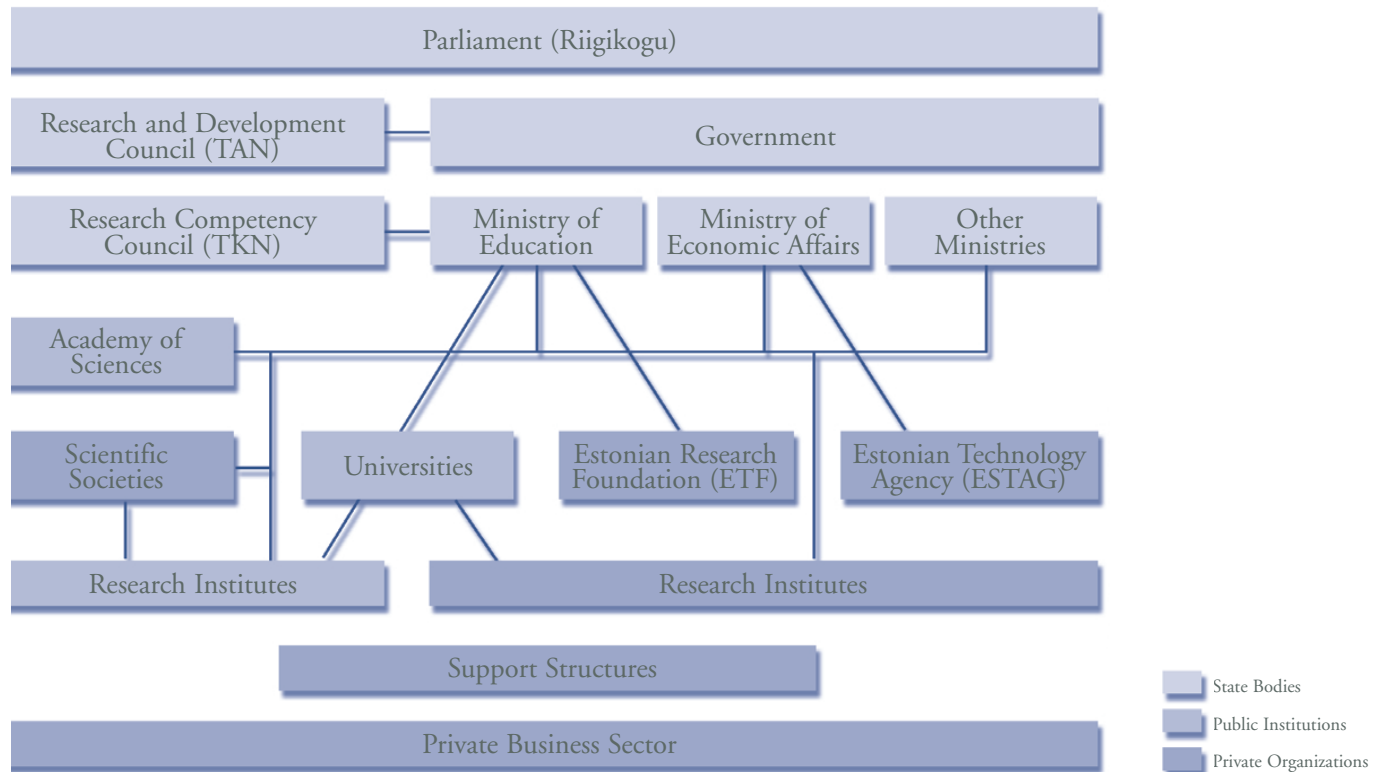
Technology – knowledge, skills and information, which are materially present in machinery and equipment, and immaterially present in human capital.

Technological transfer – the transfer of technology from one user of technology to another, the application of a technology created in one country and/or organization in other organizations and/or countries, in order to bring into use new products, technologies or services. Technological transfer is both transfer between enterprises and the transfer of technology from developmental institutions to production enterprises.



Appendix 2

Organization of Estonian research & development and innovation



In the innovation system, the Riigikogu and the Government are at the highest level, with legislative and executive powers, respectively.

The Research and Development Council (TAN) is a strategy advisory body for the Government in the entire field of RD&I. TAN is chaired by the Prime Minister. According to the Organization of Research and Development Act (RT I 2001, 43, 237), the Research and Development Council has 12 members and its composition is confirmed by the Government for a period of up to three years.

The Ministry of Economic Affairs has a central role in organizing technological development and innovation on a state level, being responsible for the planning, coordination, execution and surveillance of the policies for technology and innovation. The task of ESTAG is to support technological development projects within enterprises and market-oriented research projects in research and development institutions.

The Ministry of Education is responsible for the organization of research and education policy. Institutions advising the Ministry of Education in research and educational issues include the Estonian Academy of Sciences and the Research Competency Council (TKN). The main task of the Estonian Research Foundation (ETF), which functions under the jurisdiction of the Ministry of Education, is to support research projects by means of the allocation of grants.

The Ministry of Education is assisted in carrying out its research and development functions by the Archimedes Foundation which organizes evaluations of Estonian higher education and research, acts as the national contact point for the EU's 5th Framework Programme, coordinates the creation of Estonia's research and development information system, and implements specific projects, with the aim of raising Estonia's capacity for innovation. The Foundation also coordinates exchange programmes for young researchers and students (Marie Curie grants, ERASMUS).

Appendix 3

The financing strategy for research and development, 1998–2006

Research and development expenditure ²

Indicator	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total expenditure on research & development, million EEK	450.9	572.8	600.0	704.3	815.2	1004.4	1343.1	1735.5	2185.5
Total expenditure on research & development, % of GDP ³	0.61	0.76	0.70	0.75	0.80	0.90	1.10	1.30	1.50
Share of public sector in total expenditure on research & development, million EEK	360.1	433.3	444.0	549.3	652.2	803.5	1007.3	1301.6	1529.9
Share of public sector in research & development, %	80	76	74	78	80	80	75	75	70

State budget financing of research and development ^{4,5}

	1998	1999	2000	2001	2002	2003	2004	2005	2006
State budget allocations for research & development, million EEK	312.5	363.8	370.6	430.9	497.5	614.0	714.0	884.0	1014.0
of which, Ministry of Education	278.0	331.0	329.0	357.3	413.3	430.0	460.0	550.0	600.0
of which, Ministry of Economic Affairs	30.0	28.0	37.0	61.4	70.0	170.0	240.0	320.0	400.0
of which, other ministries ⁶	4.5	4.8	4.6	12.2	14.2	14.0	14.0	14.0	14.0

2 The total expenditure on research and development for 1998-1999 is based on final data by the Estonian Statistical Office, the data for 2000 is based on an assessments; the period 2001-2006 is as forecast by the Ministry of Economic Affairs and the Ministry of Education.

3 The absolute values of GDP are from the autumn 2001 forecast by the Ministry of Finance.

4 For 1998-2000, this is the actual state budget funding for research and development, for 2001, as per the state budget, for 2002, the draft state budget, for 2003-2006, planned financing according to the objectives set up within the present strategy (no presumption of state loans); Government allocations for developmental activities for 2001-2002 contain both state budget resources and resources from privatization (except for unspent resources from the previous year);

5 The EU pre-structural funds and future structural funds, and the state's co-financing, are not shown in this table (except for the participation fee, co-financed by the Ministry of Education, for the EU RTD 5th Framework Programme).

In order to develop support structures for innovation in southern Estonia and in Ida-Virumaa, 16.04 mill.

EEK has been allocated within the framework of Phare SPP for 1999–2001(SPP: 11.73 mill. EEK, state budget 4.31 mill. EEK), within the framework of the Phare 2000 programme, 37.44 mill. EEK will be allocated for the period 2002–2002 (Phare: 28.08 mill. EEK, state budget: 9.36 mill. EEK).

6 Other Ministries: Ministry of Culture, Ministry of Agriculture, Ministry of Social Affairs.

For 1998-2000, this is actual expenditure, for 2001-2002, state budget or draft state budget data, respectively (including Ministry internal expenditure, for 2003-2006, assessments (Ministry of Finance).