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## Luxembourg First National Technology Foresight Foresight Brief No. 099

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**Type:** National foresight exercise

**Organizer:** National Research Fund ([www.fnr.lu](http://www.fnr.lu)), CM-International (Phase 1), VDITZ - Future Technologies Division ([www.zt-consulting.de](http://www.zt-consulting.de)) and Z\_punkt The Foresight Company ([www.z-punkt.de](http://www.z-punkt.de)) (Phase 2)

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### Purpose

In the context of the Lisbon strategy and the Barcelona targets, the Luxembourg government intends to increase the level of public spending on R&D from about 50M€ in 2005 to 220 M€ by 2009 and to concentrate the budget increase on a limited number of promising research areas on the basis of clearly stated strategic and operational objectives. The purpose of the first national foresight in Luxembourg, conducted in 2006-2007, was to inform policy-makers and provide direction for the definition of these national research priorities.

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### Luxembourg's Innovation and S&T Policy at a Turning Point

The fact that Luxembourg is a very prosperous country relying mainly on a very competitive service sector and especially on the high-performing financial sector has led, up to recent years, to a neglect of innovation policy. The innovation expenditure in Luxembourg, the country with the highest GDP per capita in Europe, is only 68% of the EU average and Luxembourg displays significant weaknesses in innovation performance – contrasting with the economic performance of the country.

Luxembourg's gross expenditure on R&D reached 1.78% of GDP in 2003 – one of the lowest ratios in the OECD area. As for industrial R&D, policy was for a long time dominated by the steel industry. A key feature of the Luxembourg research landscape today is still the important role played by the private sector which contributed to 89% of total R&D expenditure in 2003. Moreover, almost two-thirds of private expenditures are made by just a few companies such as Goodyear and Delphi, major players in the automotive component industry.

By contrast, the public research system in Luxembourg is relatively young, and in some respects, remains under-developed. The creation of new institutions, such as the University of Luxembourg in 2003 or the National Research Fund (FNR) in 1999, and new infrastructures, such as the City of Science planned for 2011, illustrates the rapid changes the research landscape is facing. Despite the high increase between 2000 and 2005, the level of public R&D expenditure is still very low and reached 0.3% of total R&D expenditure in 2005.

However, innovation policy has been at a turning point since the adoption of the first national innovation programme in 2005. In the context of the government's strong commitment to the Lisbon strategy and the Barcelona targets and in view of conditions for long-term economic growth becoming less favourable – rising unemployment, changes in the economy's sectoral structure – the following objectives were set: raising investments in R&D to 3% of GDP, strengthening innovation particularly in SMEs and fostering entrepreneurship, as well as increasing the number of graduates in science and engineering.



Furthermore, the Luxembourg government announced its intention to increase the level of public spending on R&D from about 50 M€ in 2005 to 220 M€ by 2009 and to concentrate the budget increase on a limited number of promising research areas on the basis of clearly stated strategic and operational objectives.

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## Foresight as a Tool to Inform S&T Policy

With the recognition of the role of research and innovation and of a strong national research base in contributing towards the future development of the country, the first national technology foresight was launched in the beginning of 2006 with the aim to provide part of the basis for:

- identifying national research priorities in the public sector with short-term and/or long-term socio-economic interest for Luxembourg;
- assisting the development of outstanding centres of science and technology excellence in Luxembourg;
- ensuring the specialization of public research centre (CRP) facilities into centres with a limited number of specific areas of high level expertise;
- determining appropriate investment levels through support instruments such as the FNR programmes.

The foresight was conducted as a participative process mobilising more than 300 stakeholders from industry, academia, civil society and policy-makers in workshops and interviews. In Phase I of the foresight (Jan.-Sept. 2006), the current situation of the Luxembourg research landscape was analysed (impact and success of existing public research programmes, policy instruments, public research actors, etc.), as well as international R&D trends in order to identify possible promising areas for public research. Phase II of the foresight exercise (Oct. 2006-June 2007), focused upon a set of six thematic fields (ICT; physical sciences and engineering; law, economy and finance; environmental sciences; life sciences; social sciences and humanities) with the aim of defining national priorities for research funding allowing tackling major socio-economic and environmental challenges to be faced by Luxembourg in the next 10 years.

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## Major Challenges to be Faced by Luxembourg in the Next 10 Years

The following challenges – to be faced by Luxembourg in the next ten years – were identified in a one-day workshop involving stakeholders from Luxembourg society, business and research at the beginning of the 2<sup>nd</sup> phase of the Foresight.

### Societal changes:

- Adapting the educational system to the societal and economic needs of a multilingual and multicultural society.
- Avoiding “parallel societies” and strengthening social, economic, political and cultural participation of immigrants.

- Reforming the social security system: coping with rising unemployment, cross-border interrelations of the social systems and population ageing as well as adapting to new family models.
- Increasing the efficiency of the health care system and health promotion, as well as counteracting the increase of chronic diseases due to population ageing, “unhealthy” nutritional habits and environmental problems.

### Competitiveness and Sustainable Economic Growth:

- Minimizing the economic risks associated with Luxembourg’s specialization in financial services.
- Developing new “competence niches” based on expertise and efficiency as distinguished from former “sovereignty niches” based on regulatory advantages – in particular in emerging fields such as biotechnologies and services (e.g. logistics).
- Reconciling ecological and economic imperatives (“ecological issues as new business opportunities”).
- Building scientific excellence, developing, attracting and retaining highly skilled domestic and foreign human resources.
- Improving the transportation and logistics infrastructure.
- Coping with high land prices and the scarcity of real estate.
- Adapting to European integration and the changing notion of national sovereignty.

### Environmental Challenges:

- Reducing energy consumption, increasing energy efficiency and diversifying the energy mix.
- Facing water scarcity, promoting a sustainable water management and coping with the increasing risk of floods due to urbanisation.
- Coping with the impacts of climate change.

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## National Research Priorities for Luxembourg Public Research

### Innovation in Services

Research related to innovation in general and innovation in services in particular is expected to contribute to consolidating and improving Luxembourg’s current international competitiveness in financial and business services, on the one hand, and to support diversifying the Luxembourg economy and improving Luxembourg’s innovation capacity, on the other. In particular, the following lines of research were identified:

- *Performance and Development of all Financial Systems:* with a focus on the investment fund industry and the traditional private banking activity.
- *Fostering the Economic and Legal Framework for Innovation:* determination of the right balance between European harmonisation and intergovernmental competition (esp. regarding investment fund law, contract law, com-

pany and commercial laws, but also employment protection legislation and intellectual property rights).

- *Business Service Design and Innovation*: development and improvement of new, innovative and high added-value (e-)services (business model innovation, business process efficiency – and flexibility and business service regulation compliance). Beyond business services, e-government, e-administration, e-learning and e-health applications were deemed as important.
- *Information Security and Trust Management*: contributing to consolidating Luxembourg's reputation as a safe harbour for information – esp. for the banking and broadcasting industry. Research areas like identity and risk management, privacy as well as digital rights management have top priority.
- *Telecommunications and Multimedia*: supporting the development of more convenient personalised services and improving the ICT infrastructures for the aggregation and distribution of content – including (multilingual) multimedia applications.

#### **Sustainable Resource Management in Luxembourg**

The importance of research contributing to building a sustainable society and economy in Luxembourg was highlighted – not least in order to cope with the environmental challenges to be faced by Luxembourg in the next 10 years. Moreover, given the country's size and the related opportunity to being able to implement a systematic, holistic and transdisciplinary approach to sustainability, the vision was developed to make Luxembourg a showcase for regional sustainability. In particular, the following lines of research were identified:

- *Managing Sustainable Development*: monitoring and analysis tools for the use of natural resources for e.g. the water and soil quality, air pollution, etc.; understanding of the energy and material flows in Luxembourg; implementation of ecotechnologies; integration of economic and ecological goals; consumer information models; political consulting; etc.
- *Biodiversity and Ecosystem Functions*: evaluation and monitoring of biodiversity; impacts of climate change and pollution; human-biodiversity interactions; management and conservation; economic relevance of biodiversity; etc.
- *Sustainable Management of Water Resources*: water pollution; water scarcity; flood risk; impact of climate change and of new agricultural practices; risk assessment and management; remediation of polluted ground water; etc.
- *Sustainable Uses and Sources of Energy*: increasing energy efficiency and reducing Luxembourg's economic dependencies on energy imports; increasing the share of regenerative and renewable energy sources (esp. biomass energy); energy efficient concepts for buildings; recovery and co-generation in industrial processes; etc.

- *Sustainable Agro-Systems Management*: adaptation of Luxembourg's agricultural sector to expected climate change and EU regulations; sustainable farming; water and soil protection; healthy nutrition; consumer education and behaviour; etc.
- *Spatial and Urban Development*: urbanisation; metropolitanisation; spatial aspects of social exclusion; transport and mobility; local and regional governance; etc.

#### **New Functional and Intelligent Materials and Surfaces, and New Sensing Applications**

Developing novel knowledge-based materials and surfaces with tailored properties and functions in various applications is seen as a field of great future importance offering a wide range of technological, scientific, and economic opportunities. It is recommended to focus on application-oriented research activities, building on intense collaboration between public and private research sectors.

Among the targets are: synthesis, analysis and processing technologies for high performance and multifunctional or intelligent materials and surfaces on the basis of polymers, semiconductors, composites, ceramics, metals and nanostructured materials. Research on new sensing applications based on new sensing effects is deemed as very promising for Luxembourg as there is a high market potential for new low-cost sensors, for instance, in the automotive sector, but also in the health, environmental and biotechnology sectors.

#### **Biomedical Sciences**

Research in biomedical sciences is expected to contribute to improving public health, quality of life, and health care delivery as well as to coping with the health challenges. Furthermore, this research priority aims to render Luxembourg research in life sciences internationally competitive and to stimulate the establishment of a biomedical industry in Luxembourg over the next 5 to 10 years. Following research issues were highlighted:

##### *Public Health:*

- *Health Information and Promotion* (esp. addressing life style diseases and mental health issues);
- *Environmental Health*: indoor and outdoor pollution; occupational health; reducing the use of antibiotics; traceability and labelling of industrial/food products; etc.
- *Assessment and improvement of the healthcare system*: quality, health economics, etc.
- *Regenerative Medicine and Tissue Engineering* for age-related diseases deemed as a promising new area of research expected to significantly improve the therapeutic arsenal of so far untreated severe diseases. Tissue engineering in combination with the development of novel materials for bio-devices is also expected to lead to new medical devices and diagnostic tools.

- *Translational research programmes* consisting of multidisciplinary teams which foster the collaboration between scientists, engineers and clinicians and hence accelerate the basic research concepts towards clinical application.

### **Labour Market, Educational Requirements and Social Security**

Long-term research contributing to improving the match between labour supply and labour demand – especially in view of a rising unemployment rate, demographic ageing and changes in the sectoral structure of the economy – was identified as a national research priority. In particular, the following research issues were highlighted:

- *Understanding Labour Supply and Demand:* incentives for work participation; work qualifications and motivations of cross-border workers; consequences of an ageing population and a shrinking workforce; hiring behaviour of private and public organisations; etc.
- *Social System and Welfare:* labour market transitions and social security, new work and social protection models, gender issues, impact of cross-border and immigrant workforce on the economy, etc.
- *Educational / Qualification Issues:* determinants of educational achievement/failure, individual learning paths, transition from education system to labour market, life-long learning, effectiveness of educational system, etc.

### **Identities, Diversity and Integration**

Research on identity, ethnic, cultural, and language diversity and integration addresses characteristics which distinguish Luxembourg from its neighbours making it a test bed of European integration – and of social studies. The following re-

search issues are expected to contribute to understanding the dynamics of change of the Luxembourg society:

- Luxembourg history(ies), language(s) and culture(s);
- role of education and language in identity building;
- family and individual identities in a multicultural society;
- migration and social cohesion;
- intergenerational relations;
- Federative Multilingualism;
- education;
- political participation and representation;
- etc.

### **Technology Platforms**

The following specific technology platforms, allowing for the cost-efficient and expert use of expensive equipment and infrastructure, were highlighted in the foresight as necessary conditions for leveraging research in several domains:

- *Modelling and Simulation:* high performance scientific computing and powerful computation infrastructure for material sciences, environmental sciences (e.g. modelling in climate change and resource management) and life sciences (e.g. bioinformatics).
- *Central Information Infrastructure* acquiring and managing scientific information (scientific literature, publication licences, searchable databases) housed at the National Library; digitisation and meta-data association.
- *Biobanks and esp. Tissue Bank* for supporting biomedical research, systematically collecting samples of human tissue, cells or body fluids based on state-of-the-art protocols for collecting, conditioning and storing biological material, and guaranteeing its traceability through association of anonymous donor data.
- *Proteomics, Genomics, Bioinformatics, etc.*

## **New Public Research Programmes Expected in 2008**

The FNR Foresight exercise contributed to promoting a – new – foresight culture in Luxembourg. The six national research priorities identified serve as a basis for FNR recommendations to the Ministry of Culture, Higher Education and Research concerning the selection of national research priorities. They should lead to new public research programmes to be launched at the beginning of 2008. However, in order to be able to im-

plement these research priorities, further structural challenges – regarding, for instance, the absorption capacity of the Luxembourg research system, the legal framework for research, etc. – need to be addressed in the near future. Moreover, although the foresight provides the general directions for the next ten years, it is expected that these priorities will still need to be revisited during the course of the next decade in order to ensure alignment with unforeseen trends.

## **Sources and References**

FNR Foresight Final Report, National Priorities for Public Research and Other Findings (2007), [www.fnrforesight.lu](http://www.fnrforesight.lu)

**About the EFMN:** Policy Professionals dealing with RTD, Innovation and Economic Development increasingly recognize a need to base decisions on broadly based participative processes of deliberation and consultation with stakeholders. One of the most important tools they apply is FORESIGHT. The EFMN or European Foresight Monitoring Network supports policy professionals by monitoring and analyzing Foresight activities in the European Union, its neighbours and the world. The EFMN helps those involved in policy development to stay up to date on current practice in Foresight. It helps them to tap into a network of know-how and experience on issues related to the day to day design, management and execution of Foresight and Foresight related processes.