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**Monitoring and analysis of policies
and public financing instruments
conducive to higher levels of R&D investments
The “POLICY MIX” Project**

Country Review Luxembourg

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Introduction and Policy mix concept

The policy mix project

This report is one of the 31 country reviews produced as internal working papers for the research project “Monitoring and analysis of policies and public financing instruments conducive to higher levels of R&D investments” (Contract DG-RTD-2005-M-01-02, signed on 23 December 2005). This project is a research project conducted for DG Research, to serve as support for policy developments in Europe, notably in the framework of CREST activities. It does not form part of the ERAWATCH project, but the working documents are made available on ERAWATCH webpages for the purpose of steering a debate on the policy mix concept.

The “Policy Mix” project is run by a consortium of 7 partners:

- UNU-MERIT (The Netherlands), consortium leader
- Technopolis (The Netherlands)
- PREST – University of Manchester (United Kingdom)
- ZEW (Germany)
- Joanneum Research (Austria)
- Wiseguys Ltd. (United Kingdom)
- INTRASOFT International (Luxembourg).

Each country review is produced by an individual author, and provides expert’s view on the policy mix in the country. This report is not approved by the Commission or national authorities, and is produced under the responsibility of its author.

The role of country reviews is to provide an exploratory analysis of the current policy mixes in place in all countries and detect the most important areas of interactions between instruments as well as new modes of policy governance that are particularly adapted (or detrimental) for the building of policy mixes. They provide analytical material for the analysis of the policy mix concept and its implementation in Europe. This material will be used as background for further reports of the project and for the construction of a tool for policy-makers (to be made available in late 2007 and 2008).

The policy mix concept

The country reviews are based on the methodological framework produced by the consortium to frame the “policy mix” concept. They have been implemented on the basis of expert assessments derived from the analysis of National Innovation Systems characteristics and policy mix settings, using key information sources such as Trendchart and ERAWATCH reports, OECD reviews, and national sources, among which the National Reform Programmes.

In this work, the “policy mix for R&D” is defined by the consortium as: **“the combination of policy instruments, which interact to influence the quantity and quality of R&D investments in public and private sectors.”**

In this definition, policy instruments are: “all programmes, organisations, rules and regulations with an active involvement of the public sector, which intentionally or unintentionally affect R&D investments”. This usually involves some public funding, but not always, as e.g. regulatory changes affect R&D investments without the intervention of public funds.

Interactions refer to: “the fact that the influence of one policy instrument is modified by the co-existence of other policy instruments in the policy mix”.

Influences on R&D investments are: “influences on R&D investments are either direct (in this case we consider instruments from the field of R&D policy) or indirect (in that case we consider all policy instruments from any policy field which indirectly impact on R&D investments)”.

Structure of the report

The report is structured along the following questions.

First, in section 1, and in order to place the policy mix in context, the general challenges faced by the National Innovation System (NIS) are analysed by the expert. The view is here not restricted to the challenges with regard to raising R&D investments, but rather encompasses all the conditions that directly or indirectly affect the functioning of the NIS and R&D expenditures. These context conditions are very important for the discussion of the relevance of the policy mix later on.

Second, the stated main objectives and priorities of R&D policy in the country are spelled out in section 2, as well as their evolution over the last ca. five years. This discussion is based on White Papers and official documents, i.e. on published policy statements. The reality of these objectives compared to actual working of policy instruments will appear in section 5.

The third section provides an expert assessment and critical analysis of a possible gap or convergence between the NIS challenges and the main policy objectives and priorities stated before.

Section 4 presents the policy mix in place, following the above definition, i.e. policy instruments affecting R&D activities in the private and in the public sector, either directly for instruments from the R&D policy domain, but also indirectly for instruments outside the R&D domain which are of particular relevance to R&D activities. A typology of instruments is used, to categorise the R&D-specific and non-R&D specific instruments. A short description of each instrument is provided: aim, nature, target group, budget.

Then, section 5 discusses whether there is a gap between the main policy objectives and priorities stated in section 2, and the instruments in place. This is done by

comparing the set of objectives with the set of instruments at work. When individual evaluations of programmes or policy instruments are available, their results are used if they shed light on contribution of these instruments towards the policy objectives.

Section 6 discusses the orientation of the policy mix, indicating priorities amongst various possible routes to increase R&D investments. Policy instruments are categorised under 6 different routes according to their relevance, and this categorisation is followed by a discussion on the range of instruments affecting each route, missing instruments, routes that are not addressed by instruments, possible redundancies or overlaps, etc.

Section 7 provides another view on the policy mix, focusing on the relative importance of each types of instruments. The aim is to get a picture of the policy mix, the balance between (sets of) instruments, and the relative weight between them.

From section 8 onwards, the review turns to the crucial question of policy governance. That section discusses the emergence of the policy mix through examination of the following question: how did the set of R&D policy instruments arrive ? What is the rationale behind them, what were the driving force behind their establishment, and how is this evolving recently. A crucial question relates to the existence of some consideration of possible interactions when establishing new or suppressing existing instruments. The section tries to establish whether the policy design process is incremental or radical, analytical or non-analytical. From this, that section discusses if the policy mix is a “construct” or an “ex post” reality.

The next section, section 9, focuses on the governance of the system of R&D policy instruments take place. It examines the key question of interactions, i.e. whether there is a form of co-ordination between R&D policy and policy instruments from outside the R&D domain, and the existing mechanisms that favour or hinder such interactions.

The final section, section 10, deals with the core question of the policy mix concept: it endeavours to discuss interactions between policy instruments to affect R&D expenditure. The section discusses possible positive, neutral and negative effects of R&D policy instruments; both within the R&D policy domain, but also with instruments from other policy domains. In most cases, this takes the form of hypotheses rather than hard evidence.

Feedback welcome

Feedback on this report is gladly received. Individual country reports will not be updated but discussion on policy mixes is welcome during the timeframe of the study (2006-2008). Please send your comments to:

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1. National Innovation Systems Challenges

Only since the establishment of the University of Luxembourg in 2003 has the Grand Duchy had the full complement of elements needed for a National Innovation System (NIS). With the oldest of these elements implemented only twenty-two years ago, Luxembourg can use its “late adopter” advantage to profit from the experiences of other nations in climbing its NIS learning curve. A chronology of the major elements is provided in Table 1.1.

Table 1.1 Chronology of Luxembourg’s National Innovation System

Year	Element
1984	Creation of Luxinnovation
1987	Framework law on public sector research Creation of Public Research Centre Henri Tudor Creation of Public Research Centre Gabriel Lippmann
1988	Creation of Public Research Centre Santé
1989	CEPS/INSTEAD becomes public study centre
1993	Creation of private R&D incentive scheme
1998	Launch of business incubator Technoport Schlassgoart
1999	Creation of the National Research Fund (FNR) Foundation of the Ministry of Culture, Higher Education and Research
2003	Law on the establishment of the University of Luxembourg Foundation of the University of Luxembourg
2005	Full membership in the European Space Agency
2005	National Plan for Innovation and Full Employment 2005-2008

On the other hand, there *is* a learning curve to climb and Luxembourg’s successful ascent is by no means guaranteed. Realizing an effective National Innovation System means forming the parts into a functioning whole characterized by good governance, sound strategies, well defined objectives, cooperation between the parts and measurable benefits to national prosperity. Succeeding in this process presents Luxembourg’s main NIS challenge.

The second challenge is developing a culture of good governance, evaluation and measurement of the instruments making up Luxembourg’s NIS. Appendix B provides an assessment of Luxembourg’s approach to appraisal from 2005. While an OECD national innovation policy review and a Foresight study of the National Research Fund are a beginning, their recommendations will need to be implemented and, again, there will be a learning curve.

The third challenge is including the dominant services sector¹ as a stakeholder in and contributor to Luxembourg’s NIS. Luxembourg has a vibrant financial services industry, a pioneering media business, cutting edge logistics capabilities and numerous

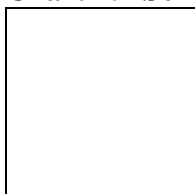
¹ Defined by NACE guidelines as: wholesale trade; transport, storage and communication; financial intermediation; computer, R&D and other business activities.

SMEs that have been established to fill niche needs of the financial sector and of the EU institutions present in Luxembourg.² Despite the importance of this sector:

- The services industry is generally not included in evaluations of Luxembourg's R&D and innovative accomplishments and capacities. Banks, for instance, do not hire scientists, apply for patents or publish articles in journals. Neither do they request R&D grants or become members of Networks of Excellence and EU consortia.
- The services sector is under-represented in planning national R&D priorities, compared to its importance to the economy. This is apparent in the programme menu of the National Research Fund³. Few sector executives are members of NIS administrative and advisory boards, whose private sector participants tend to be from manufacturing and industrial companies⁴.

It should be noted that such inclusion would constitute a paradigm shift not only for Luxembourg but also for standard methods of identifying and analyzing R&D and innovation. In support of such a shift, the report "Can We Measure and Compare Innovation in Services" (Kanerva et al., 2006) studies service sector innovation in Europe. It places Luxembourg second only to Sweden among European countries in their Service Sector Innovation Index.

Chart 1.1 Services Sector Innovation Index (SSII)



Source: Kanerva et al. 2006, in Trend Chart.

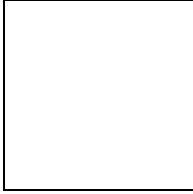
In comparison to its SSII rating, Luxembourg ranks squarely in the middle of the traditional Summary Innovation Index (see below).

² These include the European Court of Justice, the European Investment Bank, the European Court of Auditors, Euratom, the Office of Publications, the European Statistical Office (EUROSTAT), and the European Parliament Secretariat.

³ See Appendix E.

⁴ Exceptions are a transportation company executive on CRP Henri Tudor's administrative board and a bank executive on the board of the FNR.

Chart 1.2 Summary Innovation Index (SII) 2005



Source: European Innovation Scorecard

2. Objectives and priorities of R&D policy

In 2005, the government of Luxembourg published its “National Plan for Innovation and Full Employment 2005-2008” (see Appendix A for the full text). Most recently an implementation plan for the 2005 plan was presented, “Implementation Plan 2006 of the National Plan for Innovation and Full Employment.”⁵ The latter, also termed the National Reform Programme or NRP, represents substantial efforts on the part of Luxembourg’s ministries to tackle difficult issues and develop workable solutions. Objectives from the National Plan 2005 include:

- Increase private sector R&D investment by developing research infrastructures in selected areas, attracting companies from abroad and considering fiscal incentives for R&D
- Increase researchers by facilitating immigration of researchers and encouraging more interest in science in primary schools
- Increase R&D activities by: coordinating public research through having public research centres focus on specific fields; increasing public contributions to private R&D projects; creating new instruments to stimulate R&D, especially for SMEs
- Create greater synergies between the public and private sectors by: developing competency centres at the City of Science; coordinating public and private financing instruments; involving public research centres in cluster groups⁶
- Facilitate innovation by: promoting R&D and innovation investments, developing intellectual property awareness; encouraging national and international cooperation between business and the research centres; assisting SME start-up and growth.

More specific policies that support these objectives are detailed in the Implementation Plan and are included in the tables used in this report. In addition to innovation issues, the plan addresses economic issues of inflation, a budget deficit and unemployment, the environment and Kyoto commitments and infrastructure needs.

Synthesizing the two national plans and a body of external assessments, Luxembourg’s current R&D policy priorities are identified as:

1. Building the University of Luxembourg. First and foremost, the task of developing the university and meeting its objective to be internationally recognized for research in its selected niches is an R&D policy priority. The capstone of Luxembourg’s NIS, attracting renowned research faculty and exceptional students is fundamental to achieving this goal.

2. Doubling public funding of civil R&D from 0.3% to 0.6-0.7% of GDP by 2009, depending on the state of the economy. This represents the government’s commitment

⁵ The version of 12 October 2006 referenced by this report is provisional and not yet approved by the government. Note this can also be referred to as the National Reform Programme (NRP).

⁶ Luxinnovation, the national agency for the promotion of innovation and research, is the organiser of cluster groups on ICT, surface treatments and new materials and aerospace.

towards meeting the Barcelona objectives. Given Luxembourg's relative prosperity, the issue will not be providing the funding but having the entities and programmes in place to use the funding optimally.

3. Strengthening the governance of and establishing strategies, goals and accompanying success criteria for the public research system. The commitment to these objectives is evidenced by the recently completed OECD Country Review of Luxembourg's Innovation System and the Foresight study being undertaken of the FNR, both of which have been done at the government's request.

4. Establishing the "City of Science" in Belval Ouest to create a critical mass of researchers from the University and PRCs as well as competence centres shared by public and private researchers. This is a massive project that is not expected to be fully completed for nearly a decade.

5. Realizing the potential of Luxembourg's full membership in the European Space Agency. Significant resources were spent to become a full ESA member. Luxembourg now needs to increase its aerospace cluster activities. This is a particular priority because of the desirable economic diversity an expanded aerospace sector would provide.

3. Coherence between NIS challenges and R&D objectives and priorities

The table below recaps the challenges and priorities enumerated in Sections 1 and 2 of this report.

Table 3.1 R&D Priorities and NIS Challenges

Priorities	Challenges
Establishing University of Luxembourg	Climbing the learning curve of a completed NIS
Doubling funding of public R&D	Developing a culture of governance, evaluation and measurement
Strengthening governance of NIS	Including the services sector in NIS
Building the City of Science	
Leveraging ESA membership	

Even without the enumeration of NIS policy instruments given in Section 4, it is apparent that the first two priorities in particular work in support of the primary challenge, that of fully realizing an NIS that has been capped with the creation of a national university. The objective to strengthen governance will also help to meet this challenge.

The third challenge, including the services sector in the R&D policy mix, while flagged by the OECD report on Luxembourg's innovation policy (OECD, 2006), and noted as an issue by Trend Chart (Kanerva et al, 2006), has not yet really begin to be addressed. However, if this challenge can become the subject of discussion among the relevant actors and consensus is developed, the inclusion of more services sector representatives in NIS governance initiatives and niche identification could be a first step.

Finally, building the City of Science will create a critical mass among the main public R&D actors in Luxembourg that will assist in harmonizing their efforts and encourage fruitful interactions. The City of Science will also be the location for the centres of competence that will promote cooperation between private and public sector R&D. Luxembourg's recent ESA membership will also increase both public and private aerospace R&D. Thus while these priorities are not listed among Luxembourg's main challenges, they do form important components of Luxembourg's NIS.

4. Composition of the policy mix for R&D

With the announcement of the National Plan for Innovation in 2005 and the provisional Implementation Plan of 2006 (NRP), Luxembourg's policy mix can be divided into policies that are currently in place and policies that are planned for execution in the near future. Although conclusions about the potential effectiveness of the latter group can be made, this assumes the policies will actually be launched and achieve their objectives. For the purpose of this report both current and planned policy instruments are considered.

Following is a brief summary of existing policy instruments. For a more complete description, see Appendix E.

4.1 Luxinnovation.

Luxinnovation was founded in 1984 to support R&D and innovation through a wide range of services, with a particular focus on small- and medium-sized enterprises (SMEs). It became an Economic Interest Group (EIG) in 1998 and is a "first stop shop" for entrepreneurs as well as providing services to established companies. Its portfolio includes:

- Cluster programmes
- Participation in EU framework and ESA programmes
- Entrepreneurial support
- Luxembourg Portal for Innovation and Research (www.innovation.pubic.lu)
- European Trend Chart on Innovation.

4.2. Public research centres/Centres de Recherche Public

Begun after the Framework Law of 1987, there are three public research centres—Henri Tudor, Gabriel Lippmann and Santé.

Public Research Centre Henri Tudor's domains include:

- Information and communication technologies
- Industrial technologies and materials
- Environmental technologies
- Health care technologies.

At year end 2005, Tudor had a staff of 265, 13% of whom had doctorate and 70% of whom had masters degrees. For the same year, Tudor lists 62 publications, 7 in environmental technologies, 21 in industrial technologies and 34 in information technologies. It had a budget of €2,550,000, making it the largest PRC with the strongest links to the private sector.

Public Research Centre Gabriel Lippmann's focus is applied scientific research and technological development. It employs more than 110 researchers, teacher-researchers and post graduate students in its three departments:⁷

- LAM, Materials Analysis Laboratory, with a NanoSIMS
- CREBS, Unit for Research on the Environment and Biotechnology.
- CREDI, Unit for the Research, Study and Development of IT.

An automotive equipment laboratory (LEA) is also under consideration for development.

Public Research Centre Santé is linked to the National Health Laboratory and is under the joint supervision of the Ministry of Culture, Higher Education and Research and the Ministry of Health. In 2004, the most recent year for which figures are available, PRC Santé employed 101 staff, with 31 fellowship researchers and 17 fellowship students. Its activities are divided into a research institute, a health institute and a biotechnology institute. Santé has both national and international partners, including the WHO.

CEPS/INSTEAD undertakes studies on population, poverty and socio/economic policies, using their extensive statistical databases. The OECD sees CEPS/INSTEAD as providing "one of the very few large infrastructures in the social sciences in Europe" (OECD, 2006). It has well developed international relationships that include the US and Russia and works with organizations including the World Bank and the EU/EUROSTAT.

4.3 Business Incubators

In 1998, PRC Henri Tudor created the Technoport Schlassgroat, in Esch-sur-Alzette. The Technoport currently provides affordable office space with support services for 16 high tech start-ups. The incubator ECOSTART was launched in nearby Foetz in 2003. Its space is filled and an extension is under construction. A third incubator, "Op der Hei" in Hosingen in the north of the country was also launched in 2005 and the City of Science will also include an incubator.

4.4. National Research Fund (FNR)

The FNR is in charge of funding to promote research and technological development at the national level. Its Board, along with a Scientific Council, suggests programmes to the government and then disperses funding based on proposals received from the three PRCs, the University of Luxembourg, CEPS/INSTEAD and "public institutions authorized to undertake research activities". The FNR recently completed a Foresight exercise for the purpose of identifying research domains and programmes. Governance is also an issue being addressed.

⁷A fourth department, The Economic Law Laboratory, has been merged with the University of Luxembourg.

4.5 Ministry of Culture, Higher Education and Research

Formed in 1999, the ministry has two departments involved in Luxembourg's R&D policy mix, the Department for Research and Innovation and the Department of Higher Education, which is primarily responsible for the University. A large number of the components of Luxembourg's NIS are under its responsibility.

4.6 University of Luxembourg

After years of working to build consensus, the government passed legislation to establish a university in August 2003. The University's primary focus is intended to be research in a limited number of areas in which it can achieve excellence. They are:

- Security and reliability of information technology
- Material science
- Life sciences
- European and business law⁸
- Finance⁹
- Educational science
- Luxembourg studies.

While concentrating on the masters and doctoral levels, the university also offers undergraduate programmes with a requirement that students spend some time abroad. In keeping with Luxembourg's culture, university studies are multilingual, French/German/English. There are three faculties: Science, Technology and Communications; Law, Economics and Finance; Humanities, Arts and Educational Science.

4.7 European Space Agency

Luxembourg became a full member of the European Space Agency (ESA) in 2005. ESA has programmes created especially so that member country SMEs can participate and develop aerospace competencies. Membership leverages the presence of SES Global/SES Astra and a small cadre of niche companies.

4.8 Ministry of the Economy and Foreign Trade

To encourage companies to expand R&D activities, the Ministry of the Economy and Foreign Trade administers an R&D incentive scheme that co-finances R&D investments of industrial companies and service providers. Grants cover up to 75% for fundamental research, up to 50% for industrial research and up to 25% for pre-competitive development. The amount is increased for SMEs, projects involving cross border co-operation and activities in the less developed southern, eastern and northern regions. There is also a department that focuses in IPR and supports patent applications.

⁸ European law studies take advantage of the European Court of Justice's presence in Luxembourg.

⁹ Includes the Luxembourg School of Finance.

8. Societe Nationale de Credit et d'Investissement (SNCI)

The SNCI co-finances loans that cover on average 25% of the investment in fixed assets of industrial projects, and up to 75% of the eligible investment incurred by young craftsmen, traders, hoteliers or restaurant owners starting out in business for the first time.

Most recently SNCI has created the programme CD-PME, which grants equity loans and, exceptionally, takes participating interests in Luxembourg based SMEs. The financing granted by CD-PME is in principle of limited duration with a maximum of ten years. The amount of the financing cannot exceed 50% of the financing need or €250.000.

Table 4.1: Policy mix for R&D in 2006

Policy categories	Policy instruments: short description and target group
R&D Domain	
R&D policy generic	National Plan for Innovation and Full Employment 2005-2008 and Implementation Plan of 06/10/12 (NRP). Doubling of R&D targeted spending from 0.3% of GDP to 0.6-0.7% by 2009. Target: Public sector. National Research Fund (FNR) for programmes and funding in ICT, materials, environment and health. Target: Public sector.
R&D policy sectoral	Environmental initiatives in Implementation Plan for renewable resources, energy efficiency, biodiversity, water and meeting Kyoto targets. Target: Public and private sector. ESA membership-related activities. Target: Private sector. ICT, materials and aerospace cluster activities expanded to include public sector. Target: Private and public sectors.
R&D / Innovation policy – Linkage	Luxinnovation GIE, “one stop shop” for entrepreneurs and start-ups. Runs cluster groups and Portal for Innovation and Research. Facilitates participation EU and ESA programmes. Target: Private sector. Public Research Centres (PRCs). Business incubators Technoport and ECOSTART. Target: Private sector.
R&D / Innovation policy – IPR	Ministry of the Economy Department DRI promotes IPR awareness and subsidizes patent applications. Target: Private sector.
R&D specific financial and fiscal policy	Doubling of R&D targeted spending from 0.3% of GDP to 0.6-0.7% by 2009. Target: Public sector.
R&D specific education policy	Development of the University of Luxembourg as research university. Target: Public sector. Programme “Firwat net Fuerschen” (Why Not a Researcher?) targeted at students 15-18 to consider careers in research. Target: Public sector.
R&D specific employment policy	Waiving of work permit requirement for researchers coming to Luxembourg for less than 3 months; expedited work permits for researchers for longer periods, including non-EU nationals. Targeted at public sector and public-private partnerships. Researchers per 1000 employees: 9 in 2008, 10 in 2010.
Finance Domain	
Financial and fiscal policy	Promoting public sector R&D through FNR programmes. Target: Public sector. Promoting private sector research via project grants. Promoting entrepreneurship through new funding programmes like CD-PME, as well as through the Ministries of the Economy and Middle Classes. Target: Private sector.
Macroeconomic policy ¹⁰	Implementation Plan of 06/10/12 (NRP) to reduce the budget deficit, unemployment and inflation including reducing number of civil servants (deficit), stopping automatic wage increases by indexing (inflation) and job training and work programmes (unemployment). Target: Public sector.

¹⁰ For Macroeconomic indicators, see Appendix C.

Human Capital Domain	
Education policy	More emphasis on science for young teachers. CEDIES student bourses and loans. University with niche foci and research emphasis. LIASIT for ICT researchers. Target: Public and private sectors.
Employment policy	Innovation leading to increased employment opportunities ¹¹ . Target: Private sector.
Innovation Domain	
Innovation policy generic	National Plan for Innovation and Full Employment 2005-2008 and Implementation Plan of 06/10/12 (NRP).
Innovation policy sectoral	Joining ESA as full member to develop aerospace sector. Target: Mainly private; some public. LIASIT (Luxembourg Advanced Studies in Information Technology) matches doctoral students with private sector firms to pursue research projects. Promoting entrepreneurship and SMEs in innovative businesses through Luxinnovation, business incubators and financing schemes such as CD-PME. Target: Private sector.
Other policies - industry	PRC Henri Tudor and Gabriel Lippmann. Target: public sector, private/public partnership and regional/international.
Other policies - trade	Permanent Boards of Economic Development in Shanghai and UAE. to promote trade. Frequent missions to other areas. Target: Private sector.
Other policies - defence	N.A.
Other policies – consumer protection	Promotion of ICT security through LuxTrust, PRC Henri Tudor and Gabrielle Lippmann and FNR programme . Target: Both public and private sector.
Other policies – health and safety	PRC Santé. Target: public sector, private/public partnership and regional/international alliances. Target: Public, some private sector..
Other policies - environment	Range of policies in NRP centred on climate change, renewable resources, biodiversity, water and meeting Kyoto emission standards, as well as the Plan for the Protection of Nature (PNFN).. Target: Public and private sectors.
Other policies – regional development	Luxembourg is a participant in a range of regional initiatives including the Luxembourg-Trier-Saarland Innovation Relay Centre. Target: Public and private sectors.
Other policies – competition	Adherence to EU regulations.
Other policies – social security	Maintaining comparatively low cost to workers and companies to continue to attract both Special attention to retaining workers ages 55-64 in Implementation Plan 2006 (NRP). Target: Private sector.

¹¹ While the government has proposed a range of measures to decrease unemployment and retrain long-term unemployed, they have no direct (or indirect) linkages to research or innovation.

5. Coherence between main policy objectives and priorities, and policy instruments

There is substantial coherence between main policy objectives and priorities and policy instruments, especially as laid out in the National Plan of 2005 and the Implementation Plan of 2006 (NRP). In support of this assessment, the OECD recently undertook a Country Review of Luxembourg's Innovation Policy (OECD 2006). A draft version of their report is available and the final version will be released before the end of 2006. This review covered some of the policy objectives, priorities and instruments discussed in this report, but employed a different methodology and framework. Their conclusions, citing Luxembourg's adoption of "state-of-the-art policies based on a sound rationale" also support an assessment of general coherence between objectives, priorities and instruments.

Consequently, while many of the policies proposed in the Implementation Plan of 2006 (NRP) have yet to be put into operation, enough of the existing instruments have proven that they can contribute innovative research and establish and sustain both domestic and international partnerships to have confidence in the future. PRC Henri Tudor is a prime example of an instrument that already meets the priorities of the Plans and is now being proactive in the task of harmonising the missions of the PRCs and linking with the University¹².

Expanding Luxembourg's population of researchers is addressed by the new university's orientation to research, by promoting research as a career choice to young people and by adopting measures to support migration of researchers, with special provisions for non-EU researchers.

To promote R&D in specific sectors, the Implementation Plan (NRP) foresees environmental policies that include measures on climate change/global warming, renewable resources, biodiversity, water, energy efficiency and meeting Kyoto emission standards.

Finally, in terms of innovative entrepreneurship, Luxembourg's business incubators have had some real success stories¹³ and, with expanding support systems such as Luxinnovation and financial options, a fertile framework for start-ups has been created. Increasing attention to issues of IPR by the Ministry of Economy and assistance with patent applications means protection of the results of start-up activity.

¹² The initiative 3C&U. See <http://www.crphl.lu/cms/tudor/publishingfr.nsf/id/JLAK-6RFJZT>.

¹³ See www.technoport.lu.

6. Policy mix instruments and target groups

The following table highlights the target groups of the instruments enumerated in Section 4 and assigns them to various routes ranging from stimulating R&D in the private sector to expanding it in the public sector. To meet its goal of more than doubling the percentage of GDP devoted to R&D by 2009, Luxembourg's government has devised instruments that cover all six routes, although obviously R&D in the private sector can only be incentivized and not mandated. As mentioned previously, there remain overlaps in the public sector between the University and the PRCs and among the PRCs themselves. Also there are three different ministries in charge of separate instruments whose goals are similarly to encourage SME participation in R&D. Finally, there remain issues about whether these instruments will adequately include R&D and innovation in the services sector.

Table 6.1: Policy instruments and broad routes to increase R&D investments

Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
R&D Domain							
R&D policy generic	National Plan for Innovation and Full Employment 2005-2008 and Implementation Plan of 06/10/12 Doubling of R&D targeted spending from 0.3% of GDP to 0.6-0.7% by 2009. National Research Fund for programmes and funding in ICT, materials, environment and health.	XX XX	XX XX	XX XX	XX XX	XX X	XX XX
R&D policy sectoral	Environmental initiatives for renewable resources, energy efficiency, biodiversity, water and meeting Kyoto targets. ESA membership-related activities. ICT, materials and aerospace cluster activities expanded to include public sector.	XX X	X X		X	X XX	X X
R&D / Innovation policy – Linkage	Luxinnovation GIE, “one stop shop” for entrepreneurs and start-ups. Runs cluster groups and Portal for Innovation and Research. Facilitates participation EU and ESA programmes.	XX	X	X	XX		

	Public Research Centres (PRC). Business incubators Technoport and ECOSTART.	XX			X	XX	XX
Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
R&D / Innovation policy – IPR	Ministry of the Economy support of patent process and IPR awareness	XX	XX	X	XX		X
R&D specific financial and fiscal policy	Doubling of public R&D targeted spending from 0.3% of GDP to 0.6-0.7% by 2009	X			X	XX	XX
R&D specific education policy	Development of the University of Luxembourg as research university. Programme “Firwat net Fuerschen” (Why Not a Researcher?)	X X	X		X	XX	XX X
R&D specific employment policy	Waiving of work permit requirement for researchers coming to Luxembourg for less than 3 months; expedited work permits for researchers for longer periods, including non-EU nationals. Researchers per 1000 employees: 9 in 2008, 10 in 2010.	X	XX		XX	XX	XX

Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
Finance Domain							
Financial and fiscal policy	Promoting public sector R&D through FNR programmes. Promoting private sector research via project grants. Promoting entrepreneurship through new funding programmes like CD-PME, as well as through the Ministries of the Economy and Middle Classes.	XX XX	XX	X	XX	X X	XX
Macroeconomic policy	Reduce the budget deficit, unemployment and inflation including reducing number of civil servants (deficit), stopping automatic wage increases by indexing (inflation) and job training and work programmes (unemployment)	X	X	X	XX		

Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
Human Capital Domain							
Education policy	More emphasis on science for young teachers. CEDIES student stipends and loans. University with niche foci and research emphasis. LIASIT for ICT researchers.	X X	XX	X		X	XX
Employment policy	Innovation leading to increased employment opportunities	XX	X	X	X	X	
Innovation Domain							
Innovation policy generic	National Plan for Innovation and Full Employment 2005-2008 and Implementation Plan of 06/10/12	XX	XX	XX	XX	XX	XX
Innovation policy sectoral	Joining ESA as full member to more fully develop aerospace sector. LIASIT matches doctoral students with private sector to pursue research projects. Promoting entrepreneurship and SMEs through Luxinnovation, business incubators and financing schemes such as CD-PME..	XX XX	X XX	X X		XX XX X	X

Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
Other policies – industry	PRC Henri Tudor and Gabriel Lippman.			X		XX	XX
Other policies – trade	Permanent Boards of Economic Development in Shanghai and UAE. To promote trade. Frequent missions to other areas..				XX		
Other policies – defence	N.A.						
Other policies – consumer protection	Promotion of ICT security through LuxTrust, PRC Henri Tudor and Gabrielle Lippmann and FNR programme.					X	XX
Other policies – health and safety	PRC Santé. Target: public sector, private/public partnership and regional/international alliances..					XX	XX
Other policies – environment	Range of policies centred on climate change, renewable resources, biodiversity, water and meeting Kyoto Accord emission standards, as well as the Plan for the Protection of Nature (PNFN)...	XX				XX	XX
Other policies – regional development	Luxembourg-Trier-Saarland Innovation Relay Centre					X	X

Policy categories	Policy instruments	ROUTE 1: promote establishment of new indigenous R&D-performing firms	ROUTE 2: stimulate greater R&D investment in R&D-performing firms	ROUTE 3: stimulate R&D investments in firms non-performing R&D	ROUTE 4: attract R&D-performing firms from abroad	ROUTE 5: increasing extramural R&D carried out in cooperation with public sector	ROUTE 6: increase R&D in public sector
Other policies - competition	Adherence to EU regulations.				X		
Other policies – social security	Maintaining comparatively low cost to workers and companies to continue to attract both Special attention to retaining workers ages 55-64	XX			XX		

7. Balance within R&D policy mix

The following assessment evaluates chief R&D policy instruments according to the following criteria:

- a) overall contribution to increase of private R&D expenditures
- b) impact on specific aspects of the NIS or R&D performers
- c) public attention/attention by policy makers
- d) volume of public funding involved
- e) beneficiary of a shift in public funding

Table 7.1: Assessment of ‘importance’ of R&D policy instruments

Instruments	Funding In €	Criteria				
		A	B	C	D	E
Increase amount of public R&D spending	140M (2007) 185M (2008)	XX	XX	XX	XX	XX
University of Luxembourg ¹⁴ from Implementation Plan Budget from MCESR budget	72M (2009) 44M (2005) 86M (2010)	X	XX	XX	XX	XX
PRC Henri Tudor	22.6M (2005)	X	XX	X	X	XX
PRC Gabriel Lippmann	5.3M ¹⁵ (2004)	X	XX			XX
PRC Sante	NA (2005)	X	XX			XX
Luxinnovation	NA	X	XX			
Ministry of Economy grants	12M (2005)	XX	X	X		
SNCI – loans	72M ¹⁶ (2005)	X			X	X
ECOSTART business incubator expansion	4.8M (2005)		X	X		
National Research Fund (FNR)	49M (2005)		XX	XX	XX	XX

Note that funding information was not available for a number of instruments. In addition, funding is not a factor in assessing the importance of other instruments, such as the policy of increasing the number of researchers by facilitating work permits for non-EU researchers.

Finally, public funding for R&D must be seen in the context of the amount of private sector R&D done in Luxembourg. In 2003, private R&D spending amounted to €381 million, compared to €45 million public sector spending. It also highlights the importance of the government’s commitment to significantly increase its budget in public R&D.

¹⁴ Note it is not possible to determine how much of the University’s budget is for research and how much is for general educational activities, administrative overheads, etc.

¹⁵ Contribution from the state.

¹⁶ Of which €1.6M start-ups loans and €4.9M innovation loans.

8. Emergence of R&D policy mix

Until the establishment of the University in 2003, the emergence of R&D policy instruments in Luxembourg had been incremental (see the chronology in Table 1.1). Some of the instruments were a normal outgrowth of existing ones, such as establishing a Ministry of Culture, Higher Education and Research in 1999. Others can be perceived as the result of increasing awareness of the R&D/innovation link and its relation to competitiveness for knowledge economies. The establishment of business incubators and programmes supporting entrepreneurship have obvious links to the high tech explosion beginning in the late 1980's.

The National Plan for Innovation and Full Employment of 2005 and its Implementation Plan of 2006 (NRP) marks a change from the incremental to the comprehensive develop of strategies that reflect the existence of a complete NIS. With the proposed policy mix, Luxembourg has moved from being reactive to being proactive.

To support its plans, Luxembourg is also moving to improve mechanisms for governance, measurement and evaluation, beginning with the OECD study and Foresight exercise. The creation of the 3C&U Committee to begin work on harmonising the research centres and the university is another move from the incremental to the coherent and will also improve governance and evaluation.

9. Governance of the policy mix

In terms of governance, research and innovation policy is shared primarily between:

- Ministry of the Economy and Foreign Trade, with its Departments for Research and Innovation and Intellectual Property Rights.
- Ministry of Culture, Higher Education and Research, with its Departments for Research and Innovation and for Higher Education.

Other ministries with roles include:

- Ministry of the Middle Classes, Tourism and Housing
- Ministry of State
- Ministry of Health
- Ministry of Finance

The Implementation Plan of 2006 (NRP) provides a well-coordinated plan. That ministries headed by the different parties that make up the current coalition government have worked together in the national interest to devise the comprehensive Implementation Plan of 2006 is impressive. It is also representative of Luxembourg's tradition of consensus building and inclusion of stakeholders in the planning process.

Compared to the "top down" Implementation Plan, identifying gaps and needs for adjustments to the mix is more of a "bottom up" process. For example:

- The recently established 3C&U Committee will play a central role in identifying issues involved in harmonizing the work of the research centres and the university's research objectives
- Entrepreneurs working with Luxinnovation and the incubators will report on their experiences with the new start-up support measures
- The GLAE aerospace group will make sure any impediments to developing ESA related business are identified.

In conclusion, Luxembourg's size is a prime factor in understanding how governance of the policy mix operates. Actors are accessible and communications are informal as well as formal.

10. Interactions between policy objectives and instruments

10.1 R&D expenditures affected by interaction among policy instruments include:

- Private sector companies contracting with the PRCs effectively outsource some R&D functions and pay the PRCs for the work.
- The FNR finances projects submitted by the public instruments in response to its programme agenda
- The Ministry of Economics' grant programme means some private sector projects are realised that would otherwise not be pursued for lack of funds.
- LIASIT, which is now part of the university, has researchers working on projects for specific private companies that might not have been undertaken without this instrument serving as a “matchmaker” between researcher and sponsoring company¹⁷.

10.2 There is good work being done by the public instruments whose mission is to undertake R&D, mainly the PRCs and, increasingly, the university, including LIASIT, where there are currently 120 doctoral candidates. Instruments whose purpose is to promote innovation and entrepreneurship are also effective. In particular Luxinnovation and the business incubators have real “success stories” to their credit. Instruments that make new sources of funding available for SMEs are also beneficial, as is the initiative to increase awareness of IPR among businesses.

While there were no policies that could be specifically identified as “neutral,” there are several for which it is “too early to tell.” The first are programmes to raise awareness of research and entrepreneurship among young people. The second are the trade missions in Shanghai and the U.A.E¹⁸.

Negative effects are apparent in the overlaps between various instruments, such as between the University and the PRCs and between the PRCs themselves. Another negative is that instruments largely overlook the dominant services sector in creating funding programmes (the FNR), dispensing Ministry of the Economy grants and deciding R&D and innovation policies generally, with the exception of start-up support programmes that do include services niche SMEs.

However, these effects are difficult to assess with confidence due to the lack of mechanisms for evaluation, which was also noted as one of Luxembourg's challenges.

10.3 The main intersection of direct and indirect R&D policy is in government initiatives that require R&D to realise. Policies relating to the environment are a good example. Programmes addressing climate change, biodiversity, water, energy efficiency and sustainability all need R&D for solutions although they are not directly classified as research-related.

¹⁷For a list of LIASIT projects, see <http://www.liasit.lu/research/research.shtml>

¹⁸It should be noted that China is already a significant trading partner of Luxembourg.

A second example of policy interface is in the establishment of trade missions in Shanghai and the U.A.E. as part of Luxembourg's promoting itself as an attractive location for foreign companies. Foreign companies with operations in Luxembourg account for a significant part of the private R&D and researcher population.

Finally, the Implementation Plan of 2006 (NRP) includes several massive infrastructure projects, such as improvements to Luxembourg's airport. While not even an indirect R&D policy instrument, such infrastructure projects still serve in attracting R&D-performing firms from abroad.

10.4 There is a direct relationship between fiscal incentives for private R&D and start-ups and Ministry of Economy support of patent applications and IRP awareness generally—the former produces the content for the latter.

What promises to be the centre of such interactions in the future is the City of Science, which will gather the three PRCs, the University, business incubators and public/private centres of competence. Co-locating chief R&D actors will create substantial synergies.

10.5 There can be no doubt that Luxembourg's prosperous economy is its most significant instrument both in funding a comprehensive NIS and in attracting and retaining foreign businesses who undertake R&D in the Grand Duchy¹⁹. Luxembourg's fiscal policies offer competitive tax rates and social costs to both employers and employees in comparison with its neighbours.

As mentioned elsewhere, Luxembourg has always been astute about making decisions about the national "course," from being an early supporter of the now European Union to making a successful transition from a contracting steel sector in the 1970's to a now-thriving financial services sector. Recently joining ESA as a full member is part of a strategy designed to increase sectoral diversity.

10.6 A good example of current interaction between R&D and non-R&D policy instruments is in education. Having lacked a national university, Luxembourg students always went abroad to complete their educations and Luxembourg offered generous grants (bourses) and loans to support their studies. While these programmes are still in effect, attending the University of Luxembourg, with its developing culture of research, is now an option and should result in more students involved in R&D. Doctoral candidates have also received special support for projects that are "in the interest of Luxembourg." With designated research faculty at the university, more of these projects can now be done in Luxembourg and in such an environment more students will be interested in participating in research.

¹⁹ Despite increases in unemployment, inflation and a budget deficit, Luxembourg remains prosperous. It has had for a period of years the highest GDP per capita in the world and outperforms its neighbours Belgium, France and Germany by most indicators. See Appendix E for details,

11. References

- Arundel, A & Hollanders, H. (2005). Innovation Strengths and Weaknesses. *European Trend Chart on Innovation*. Retrieved May 29, 2006 from <http://trendchart.cordis.lu/scoreboards/scoreboard2005/pdf/EIS%202005%20Innovation%20Strengths%20and%20Weaknesses.pdf>.
- Bounfour, A. & Edvinsson, L. (2004). Assessing national and regional value creation. *Measuring Business Excellence* 8(1), 55-61.
- Bounfour, A. & Edvinsson, L. (Eds.), (2005) *Intellectual Capital for Communities: Nations, Regions, and Cities*. Oxford: Elsevier.
- Chaminade, C. and Johanson, Ulf (2003). Can guidelines for Intellectual Capital management and reporting be considered without addressing cultural differences? *Journal of Intellectual Capital* 4(4), 528-542.
- Dussain, D. (2005). Annual Innovation Policy Trends and Appraisal Report Luxembourg 2004-2005. *European Trend Chart on Innovation*. Retrieved October 12, 2006 from http://trendchart.cordis.lu/reports/documents/Country_Report_Luxembourg_2005.pdf
- Government of Luxembourg (2006). *Rapport de mise en oeuvre 2006 du plan national pour l'innovation et le plein emploi*. Version provisoire du 12 octobre 2006.
- IMD International (2006). The World Competitiveness Scoreboard 2006. Lausanne. Retrieved June 16, 2005 from <http://www02.imd.ch/documents/wcc/content/overallgraph.pdf>.
- Kanerva, M., Hollanders, H. & Arundel, A (2006) Can We Measure and Compare Innovation in Services? *European Trend Chart on Innovation*. Retrieved October 12, 2006 from http://trendchart.cordis.lu/reports/documents/Can_we_measure_and_compare_innovation_in_services__.doc
- Kerger, R. (2006). Réponse de la délégation luxembourgeoise au questionnaire *Perspectives STI 2006*. Luxembourg: MCESR.
- OECD (2006). *OECD Review of Luxembourg's Innovation Policy*. Final Draft Report 24 May 2006. Paris OECD.
- Thunstrom, U. (2006). *Strategic Evaluation on Innovation and the knowledge based economy in relation to the Structural and Cohesion Funds, for the programming period 2007-2013*. Maastricht: MERIT.

UNESCO Institute for Statistics (2004). *Statistics in Brief: Education in Luxembourg*. Retrieved June 4, 2006 from http://www.uis.unesco.org/profiles/EN/EDU/countryProfile_en.aspx?code=4420.

Appendix A National Action Plan 2005-2008 for Innovation and Full Employment

The Luxembourg “National Plan for Innovation and Full Employment 2005 - 2008”, published in November 2005, sets out how Luxembourg intends to comply with the aims of the EU's revised Lisbon Strategy. In submitting the action plan to the European Commission, Luxembourg fulfils the requirement, set at the time of the re-launch of the Lisbon Strategy, for each country to inform the Commission of the steps it intends to take to achieve the Lisbon goals.

In the field of innovation and research, Luxembourg's national action plan identifies two main guiding principles and defines a number of measures considered relevant in each respective context:

To increase and improve R&D investments, in particular in the private sector, in order to establish a European knowledge area, the following measures are considered essential:

- Reinforcement and extension of physical R&D capacities, to be achieved by: encouraging the extension of private research centres and the development of public research infrastructures in a limited number of advanced sectors reinforcing promotion abroad to encourage the implementation of R&D activities or the creation of research centres considering fiscal incentives for R&D investments.
- Increase human resources in R&D by facilitating the immigration of researchers (including non-EU citizens) training young teachers in order to generate an early interest in sciences.
- Increase of R&D activities, to be achieved by ensuring a coordinated approach to the definition and implementation of public research (leading to a limited number of research fields) encouraging public research centres to specialise in relevant subject areas increasing of public expense in private R&D projects setting up new instruments to stimulate R&D efforts, particularly for SMEs.
- Generation of greater synergies between public and private capacities, to be achieved by developing “competencies centres” involving the private sector, located at the University and at public research centres efficiently coordinating public and private financing instruments involving public research organisations in clusters.

To facilitate innovation in all its forms, the following measures are considered essential:

- Promotion of R&D and innovation investments by means of the launch of the “alliance for innovation” initiative (proactive approach of businesses; pluri-annual innovation programmes)
- Promotion of intellectual property awareness, thus highlighting the importance of intellectual property and rights and improving access to patenting information
- Strengthening national and cross-border cooperation between businesses and research centres by extending the geographical scope of existing technology clusters and regional research centres and by setting up new clusters specialising in other priority areas, while at the same time better promoting European R&D programmes
- Facilitation business set-up and development by extending the accommodation infrastructure for innovative businesses and considering new fiscal incentives for investments by (and in) new innovative businesses
- Work of the (“Start”) network with, SSCI/CD-PME, Luxinnovation and the Chambers of Commerce and of Skilled Crafts
- Creation of the new “ECOSTART III” enterprise and innovation centre in Belval-West.

Appendix B Overall appraisal of tools for policy making and evaluation*

Tool for policy making/evaluation	Criteria and Selection (in bold)
Strategic policy making (national strategies, white papers, etc.) prevalence of evidence based and open consultation procedures	<p>*Almost no background discussion, studies or stakeholder participation</p> <p>**At least some attempt to ensure these activities are systematically pursued</p> <p>***All of the above items are systematically taken into consideration</p>
Existence of coordination mechanisms (high-level councils, inter-ministerial committees, etc.)	<p>*No mechanisms for coordination</p> <p>**Few, rather fragmented and bilateral coordination processes</p> <p>***Well organised coherent system of policy coordination</p>
Systematic review process for innovation policy	<p>*Almost no policy documents and hence little assessment</p> <p>**A few, ad hoc reviews</p> <p>***Systematic policy review</p>
Design and implementation of innovation policy measures	<p>*Very centralised/closed system for designing and implementing policy</p> <p>**Consultation and partnerships exist mainly on an ad hoc basis</p> <p>***Systematic interaction with all stakeholders</p>
Existence of an “evaluation culture” in field of innovation policy	<p>*Rare evaluations of innovation measures only monitoring or auditing.</p> <p>**Evaluations of measures are carried out on an ad hoc basis on the request of specific departments or funding bodies.</p> <p>***Measures are systematically evaluated at key milestones in their implementation.</p>
External versus internal evaluations of innovation policy measures	<p>*Evaluations are carried out internally as a general rule</p> <p>**A share of evaluations are contracted out to independent contractors but this is not a generalised practice.</p> <p>***Evaluations respect good practice criteria (involve systematically external experts, evidence based, quality appraisal of evaluation reports, etc.)</p>
Transparency and publication of results of evaluations	<p>*Little or no transparency concerning results of measures</p> <p>**Evaluations and appraisals are published or debated occasionally</p> <p>***All evaluations are published or discussed in a public forum.</p>

*Produced by Luxinnovation for Trend Chart.

Appendix C Macroeconomic Situation

The tables below provide a comparison between Luxembourg and its neighbours. While it could be argued that a comparison should also be made between Luxembourg and smaller nations such as Iceland, Ireland, Switzerland and Israel, the author believes it is equally appropriate to contrast Luxembourg with neighbouring countries with which it directly competes for business as well as for human and investment capital.

Annual percent change in GDP

Belgium	+2.1	+3.2	+3.7	+0.9	+0.9	+1.3	+2.7	+1.2	+2.0
France	+3.4	+3.2	+4.1	+2.1	+1.3	+0.9	+2.0	+1.5	+1.8
Germany	+2.0	+1.9	+3.1	+1.2	+0.1	-0.2	+1.6	+0.8	+1.2
Luxembourg	+6.8	+7.3	+9.2	+2.2	+2.3	+2.4	+4.4	+3.1	+3.2

Source: IMF *Estimate.

GDP per capita, in euros

Belgium	23,038	24,130	24,654	25,218	25,936	27,238	28,084	29,122
France	22,639	23,774	24,536	25,239	25,676	26,470	27,113	27,954
Germany	24,510	25,095	25,664	26,006	26,217	26,856	27,057	27,551
Luxembourg	43,327	48,526	49,875	51,110	53,235	56,090	58,580	61,391

Source: IMF *Estimate.

It should be noted that, in addition to having the highest GDP per capita in its region, Luxembourg has, for the years above and several before, enjoyed the highest GDP per capita of any country in the world. This is reflected in the high quality of life enjoyed by the country's inhabitants. In fact, according to the World Bank World Development Indicator for poverty, none of Luxembourg's population lives below the poverty level as they define it (UNESCO UIS 2004).

Unemployment, as %

Country	2002	2003	2004	2005	2006*
Belgium	7.3	7.9	7.8	7.9	8.0
France	8.9	9.5	9.7	9.8	9.6
Germany	8.7	9.6	9.2	9.5	9.3
Luxembourg	3.0	3.8	4.4	4.8	5.2

Source: IMF *Estimate.

Luxembourg has the lowest unemployment in the region and provides generous benefits and training to the jobless and attractive incentives to employers for hiring the unemployed. Growth in unemployment reflects an aging population (employers are offered special incentives for hiring unemployed workers over 50). It also reflects a growing pool of workers who lack the skills needed in a knowledge economy.

Inflation, as %

Belgium	0.9	1.1	2.7	2.4	1.6	1.5	1.9	2.3	1.9
France	0.7	0.6	1.8	1.8	1.9	2.2	2.3	1.9	1.8
Germany	0.6	0.6	1.4	1.9	1.3	1.0	1.8	1.7	1.7
Luxembourg	1.0	-0.5	3.2	2.7	2.1	2.0	2.2	2.4	2.7

Source: IMF *Estimate.

While inflation in Luxembourg does not present as positive a picture as the other indicators, it should be understood to be the result of competition for qualified workers as well as soaring real estate prices in response to continuing demand.

Appendix D Human Capital

Luxembourg's population

The most salient fact about Luxembourg's human capital is that it has the highest percentage of resident foreigners of any country in the world. As of 2006, 39.6% of Luxembourg's 474,413 (2006 est.) inhabitants were foreign. At more than 10%, Portuguese are the highest proportion, followed by Italians and immigrants resulting from the conflict in the former Yugoslavia. 8% come from the bordering countries of Belgium, France and Germany. Most recently, there is increasing immigration from Asia and Africa, which adds a welcome diversity to Luxembourg's European mix.

Other characteristics

Luxembourg's population is 18.9% 0-14 years, 66.5% 15-64 years and 14.6% over 65. The population growth rate is 1.23% (2006 est.), which puts it at the high end of developed countries. For instance, the US growth rate is 0.91%, France's is 0.35% and Germany's is -0.02%. The birth rate is 11.94 per 1,000, somewhat higher than the European Union average of 10.00 per 1,000.

Les frontaliers

The second defining characteristic of Luxembourg's human capital is that each working day, more than 115,000 *frontaliers* cross national borders to their jobs in Luxembourg, representing approximately half of the total work force. Approximately 30,000 come from Belgium, 60,000 come from France and 25,000 come from Germany. While it could be argued that these foreign workers should not be included in an assessment of Luxembourg's human capital, on reflection the author believes they should be included the same way that workers from New Jersey, Connecticut, Pennsylvania and upstate New York would be included in an evaluation of New York City's human capital. The only difference is that instead of crossing state lines, *les frontaliers* cross national borders, now free and open following the implementation of the Schengen Agreement.

Education

According to UNESCO's Institute for Statistics, the 2004 gross enrolment rate for pre-primary education is 83%.²⁰ For primary education, the gross enrolment rate is 99%, while for secondary education, enrolment is 95%. However, Luxembourg's tertiary education rates are very low. Only 12% of students continue to tertiary education, which is far below the regional average. While it could be argued that the educational levels of *les frontaliers* are not included in the 12%, as well as that having a university in Luxembourg will also increase this figure over time, the relatively low level higher education among Luxembourg's population is a major issue.

²⁰ Gross enrollment rate is the number of pupils enrolled in a given level of education regardless of age expressed as a percentage of the population in the theoretical age group for that level of education.

Engineers and Scientists

That Luxembourg lags behind some of its competitors in the percentage of its workforce engaged in science and engineering should not be too surprising, given the figure for pursuit of tertiary education cited above as well as the dominance of the services sector. At 5.72%, Luxembourg trails Denmark (6.3%), Ireland (8.55%) and Switzerland (7.78%), although it exceeds the EU average of 5.13%²¹. However, in terms of researchers overall, Luxembourg exceeds its neighbours.

Researchers and research funding, 2003

Country	Researchers per million inhabitants	R&D Expenditure²² as % of GDP
Belgium	3.1	1.9
France	3.2	2.2
Germany	3.3	2.3
Luxembourg	4.3	1.8

Source: UNESCO Institute for Statistics

²¹ EU is all 25 nations. 2004 figures from EUROSTAT.

²² Includes both public and private sectors.

Appendix E Extended Descriptions of R&D Policy Mix Instruments

1 Luxinnovation

Luxinnovation was founded in 1984 to support innovation in a wide range of services, with a particular focus on small- and medium-sized enterprises (SMEs). In 1998 it became an Economic Interest Group (EIG). It advertises itself as a “first stop shop” for entrepreneurs and is in charge of a number of important initiatives for all companies. These include:

1.1 Cluster programmes. In 2001, the Ministry of the Economy launched the organisation of three clusters to promote centres of technological expertise. The clusters are:

- InfoCom Cluster for information and communication technologies.
- SurfMat Cluster for surface treatment and new materials
- AeroSpace Cluster for aeronautics and aerospace technologies.²³

1.2 Participation in EU framework and ESA programmes. Luxinnovation offers advice and information, focussing on financing and partnering, to entities wishing to undertake such projects. It is currently Luxembourg’s designated contact point for the Seventh Framework Programme for Research and Development (FP7).²⁴

1.3 Entrepreneurial support. Luxinnovation is involved in a number of programmes to support start-up businesses. These include the Network for Entrepreneurship, 1, 2, 3 Go and the EU’s Gate2Growth initiative. It also promotes the business incubators described below in Section 4.4.

1.4 Luxembourg Portal for Innovation and Research (www.innovation.public.lu). This portal was started in 2003 as part of the eLuxembourg project. It addresses all aspects of R&D and innovation, both public and private. It includes a directory of Luxembourg companies focusing on their innovative capabilities and a technology exchange.

1.5 European Trend Chart on Innovation. Launched by the EU in 2000, Trend Chart is supported by Luxinnovation, which provides information on the Grand Duchy for this initiative.

2. Public research centres/Centres de Recherche Public

In 1987, Luxembourg passed the Framework Law on public sector research which resulted in the formation of three public research centers: Gabriel Lippmann, Henri Tudor and Santé.

²³ This cluster was formed to leverage Luxembourg’s participation in European Space Agency programmes as well as to support regional co-operation by forming consortia to win business in this sector.

²⁴ See <http://www.luxinnovation.lu/site/content/EN/400/C3880/>

2.1 Public Research Centre Henri Tudor states that its main aim is to promote innovation in both the private and public sectors. This sweepingly broad mission is divided into domains that cover:

- information and communication technologies
- industrial technologies and materials
- environmental technologies
- health care technologies.

Tudor has a complex structure of eight departments, including the Technoport high tech business incubator, discussed in Section 4.4. The other departments are:

- CITI, Centre for IT Innovation
- CR SANTEC, resource Centre for Health Care Technologies
- CRTE, Resource Centre for Environmental Technologies
- CRTI-B, Resource Centre for Information Technologies in Construction
- CVT, Technology Watch Centre
- LTI, Laboratory for Industrial Technologies and Materials
- SITec, Lifelong Learning for Technological Innovations.

Of the 118 projects in which Tudor participated in 2005, 62% were conducted in direct partnership with companies or groups of companies, 52% in partnership with public departments and bodies and 44% in partnership with universities or research centres²⁵. The domain breakdown is provided in Table E.1

Table E.1 Henri Tudor R&D Project Domains

Project domain	% Total
Information technologies	35
Industrial technologies	22
Environmental technologies	14
Health care technologies	11
Training/lifelong learning	8
Technology watch	4
High tech entrepreneurship	2

Source: www.tudor.lu

Tudor is the largest of the PRCs with the most employees and biggest budget. It has the strongest links to the private sector, especially in the area of technology transfer. It does not restrict itself to R&D but also covers standards/measurements/testing, training, consulting and management best practices.

²⁵The total is higher than 100% because the same project may involve partners of more than one type.

2.2. Public Research Centre Gabriel Lippmann

Founded in 1987, PRC Gabriel Lippmann's focus is applied scientific research and technological development. It employs more than 110 researchers, teacher-researchers and post graduate students in its three departments:²⁶

- LAM, Materials Analysis Laboratory.
- CREBS, Unit for Research on the Environment and Biotechnology.
- CREDI, Unit for the Research, Study and Development of IT.

An automotive equipment laboratory (LEA) is also under consideration for development.

LAM's special expertise is the analysis of materials at the atomic level. Supported by the NANO programme of the FNR, LAM became a European centre specialised in the characterization of materials at a nanometric scale. In 2001 the laboratory acquired a NanoSIMS, making it one of five laboratories in the world so equipped. With the NanoSIMS, Gabriel Lippmann has collaborated with more than 100 companies including Alcatel, Honeywell, L'Oreal, Solvay, Goodyear and TDK. LAM is the co-coordinator of the FP6 Network of Excellence "Nanobeams".

CREBS particular foci are:

- Forest and agricultural biotechnology (BIOFAR)
- Aquatic and terrestrial ecosystems (ECOSAT)
- Geo-hydro systems and spatial planning (GEOSAT).

CREBS has about 35 projects that average several man years each. Publications in 2004 totalled 169, including conference proceedings.

CREDI, Lippman's smallest department, looks at ICT, e-commerce and knowledge management. It also offers training in these areas. CREDI works mostly with domestic partners, of whom 11 were private and 10 were public in 2004.

2.3 Public Research Centre Santé

PRC Santé was founded in 1988. It is linked to the National Health Laboratory and is under the joint supervision of the Ministry of Culture, Higher Education and Research and the Ministry de la Santé. In 2004, the most recent year for which figures are available, PRC Santé employed 101 staff, with 31 fellowship researchers and 17 fellowship students. Restructured in 2000, Santé's activities are divided into a research institute, a health institute and biotechnology institute and general administration.

²⁶ A fourth department, The Economic Law Laboratory, has been merged with the University of Luxembourg.

The research units within the research institute include:

- Laboratory of Molecular Biology, Genetics and Modeling (LMBGM)
- Laboratory of Immunogenetics, Allergology and Plant Molecular Biology (STRALUX)
- Laboratory for Neuroscience Research (Norlux)
- Laboratory for Cardiovascular Research
- Laboratory of Haemato-Cancerology and Cellular Therapy
- Laboratory of Retrovirology
- Institute of Immunology²⁷
- Laboratory of Toxicology²⁸

Each unit has both national and international partners, totaling 32 and 88 respectively in 2004. A noteworthy partner of the Institute of Immunology is the WHO.

The Health Institute (CHS) includes:

- Epidemiology and Technology Transfer Services
- Analysis of Health Systems Services
- Centre of Prevention, Research, European Studies and Evaluation, including
 - European Monitoring Centre for Drugs and Drug Addiction
 - European Medicine Evaluation Agency.

2.4 CEPS/INSTEAD

Originally a private, non-profit organization, CEPS/INSTEAD was made into a public institution under the supervision of the Ministère d'Etat in 1989. In 2004, it came under the direction of the Ministry of Culture, Higher Education and Research. CEPS/INSTEAD undertakes studies on population, poverty and socio/economic policies based on their extensive statistical databases. The OECD sees CEPS/INSTEAD as providing “one of the very few large infrastructures in the social sciences in Europe” (OECD, 2006).

CEPS/INSTEAD:

- Produces micro data from field work and micro databases
- Achieves comparability between complex micro data sets from different countries
- Serves as a research institute and a training institute.

CEPS/INSTEAD has established itself as a true international research centre in the social sciences and economics and has an impressive publication record. It has well developed international relationships that include the US and Russia and works with organizations including the World Bank and the EU/EUROSTAT.

²⁷ Associated with the National Health Laboratory.

²⁸ Associated with the National Health Laboratory.

3 Business Incubators

In 1998, PRC Henri Tudor created the Technoport Schlassgroat, in Esch-sur-Alzette. This business incubator was launched with the support of the Ministry of Culture, Higher Education and Research, Ministry of the Economy and Foreign Trade, the European Regional Development Fund and steel producer ARBED/Arcelor.

The Technoport currently provides affordable office space with support services for 16 high tech start ups. It has 3 support programmes:

- Pre-Commercial, for developing a business plan, feasibility study or proof of concept. Complete office infrastructure is provided for free for four months. The application process takes one hour.
- Start-Up, for new companies using the Technoport's infrastructure and support services that include management coaching, marketing support, administrative support, and financing advice.
- High Growth Network, for more established high tech companies, or companies that have successfully outgrown the incubator. There are currently 6 companies in this category.

In addition, in 2003, the Ministry of the Economy and Foreign Trade launched the incubator ECOSTART in nearby Foetz. As of June 2005, five companies filled the space and an extension was under construction. Another incubator, "Op der Hei" in Hosingen in the north of the country was also launched in 2005. It offers affordable space for up to 3 years to entrepreneurs setting up an innovative skilled-craft business or creating an industrial company investing in new production techniques or services. It should be noted that PRC Santé also announced plans to open an incubator targeted at biotechnology companies but this has yet to be implemented.

4. National Research Fund (FNR)

The primary mission of the FNR is to receive, manage and distribute funds to promote research and technological development at the national level. The FNR has considerable scientific, financial and administrative autonomy. It is governed by a Board of Administration and advised by a Scientific Council. The primary task of the Board is to decide on project funding and propose programmes to the government. Table E.2 details the programmes currently administered:

Table E.2 FNR Programmes

Programme	Duration	Budget (€)	Description
SECOM	2000-2007	7,500,000	Security and efficiency of new practices in e-commerce for all socio-economic actors
NANO	2000-2008	6,700,000	New materials and nanotechnology
EAU	2000-2007	5,000,000	Sustainable management of water resources
BIOSAN	2002-2006	6,000,000	Biotechnology and Health
VIVRE	2002-2009	12,000,000	Living tomorrow in Luxembourg
PROVIE	2004-2005	2,500,000	Medical aspects of aging

TRASU	2003-2009	6,000,000	Surface treatment
SECAL	2003-2010	6,000,000	Food safety
INTER	2006-2011	6,000,000	Promotion of International Cooperation
ATTRACT	2007-2012	6,000,000	Opportunities for outstanding young researchers in Luxembourg

Source: www.fnr.lu

By law, beneficiaries of the funding are limited to the 3 PRCs, the University of Luxembourg, CEPS/INSTEAD and “public institutions authorized to undertake research activities”. From 2000-2004, 75% of €43 million funding went to the 3 PRCs (36% to Gabriel Lippmann, 27% to Henri Tudor and 12% to Santé).

In addition to the above programmes, the FNR sponsors certain accompanying measures. These include participation in conferences abroad, organizing conferences in Luxembourg, publication of doctoral theses, preparations of EU projects and promoting the international mobility of researchers. In 2004, the FNR accepted 134 of such proposals and contributed €750,000.

Finally, the FNR represents Luxembourg in international organizations that include:

- European Science Foundation
- European Research Area Networks (ERA-NET)
- European Research Consortium in Informatics and Mathematics (ERCIM)
- International Council for Science (ICSU)
- European Union Research Organisations’ Head of Research Councils (EUROHORCS)
- US National Science Foundation (NSF) USE-MAT (Materials World Network).

The FNR recently completed a Foresight exercise for the purpose of identifying research domains in the public sector of socio-economic interest to Luxembourg and developing new FNR programmes based on these domains. Governance is also an issue being addressed.

5. Ministry of Culture, Higher Education and Research

Formed in 1999, the ministry has two departments involved in Luxembourg’s R&D policy mix.

5.1 Department for Research and Innovation

This department’s responsibilities include:

- Public research policy for scientific and applied research and interministerial co-ordination
- Scientific and technological co-operation and representation at the inter-regional, international and European levels
- National Research Fund (FNR)

- Oversight of and co-ordination of funding for the 3 PRCs, CEPS/INSTEAD and the Virtual Centre for Knowledge in Europe
- Technology transfer and innovation
- Scholarships for training and research
- Co-ordination between Luxembourg and the European Space Agency.

5.2 Department of Higher Education

This is the department with chief responsibility for the University of Luxembourg. It is also involved domestically with introducing post-graduate training and the Bologna process and internationally with the Campus Europa project. It also manages CEDIES, Centre de Documentation et d'Information sur l'Enseignement Supérieur, through which financial support for higher education is provided.

6. University of Luxembourg

After years of working to build consensus, the government passed legislation to establish a university in August 2003. Its founding principles mandate that its primary focus should be research, as opposed to simply educating students, and that it should identify a limited number of niches in which it could achieve excellence. While concentrating on the masters and doctorate levels, the university is also to offer a small number of undergraduate programmes with a requirement that students spend some time abroad. In keeping with Luxembourg's culture, university studies are to be multilingual, French/German/English.

Consequently, the University of Luxembourg has established seven subject areas as having the highest priority:

- Security and reliability of information technology
- Material science
- Life sciences
- European and business law
- Finance
- Educational science
- Luxembourg studies.

Of medium priority are:

- Geodynamics and seismology
- Environmental resources and technologies
- The economy and entrepreneurship
- Social sciences.

Today the University has three faculties, which roughly correspond to the original local educational institutions it incorporated upon its founding:

6.1 Faculty of Science, Technology and Communications (FSTC)

The FSTC incorporates the former IST – Institute Supérieur de Technologie—and offers Bachelors and Masters degrees. Research is focused on computer science, engineering, mathematics, physics and life sciences.

6.2 Faculty of Law, Economics and Finance (DEF)

The DEF incorporates three departments of the former Centre Universitaire, as well as the Luxembourg School of Finance which offers an MS in Finance. It also integrates the Economic Law Laboratory which was previously a unit in PRC Gabriel Lippman. A main objective is to develop programmes that leverage the European Court of Justice's Luxembourg location.

6.3 Faculty of Humanities, Arts and Educational Science (FLSHASE)

FLSHARE incorporates the remaining departments from the Centre Universitaire and the teacher training facility, Institute Supérieur d'Etudes et de Recherches Pédagogiques.

For the 2006-2007 school year, the University of Luxembourg registered 3,168 students, an increase of 12.5% from the previous year, with the largest increase in the Faculty of Law, Economics and Finance. Seventy countries are represented in the student population, of whom 52% are from Luxembourg. 120 doctoral students are preparing their dissertations at the University.

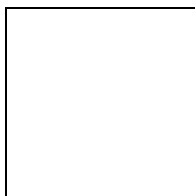
7. Full membership in the European Space Agency

Luxembourg became a full member of the European Space Agency (ESA) in 2005. With full membership, Luxembourg commits to mandatory financial contributions, in exchange for which a country profile for participation in optional programmes can be specified. ESA has special programmes created especially so that member country SMEs can participate and develop aerospace competencies. While Luxembourg may have a limited profile, membership leverages the presence of SES Global/SES Astra and a small cadre of niche companies. Membership provides entrepreneurial opportunities and expansion of the aerospace niche. In addition to Luxinnovation's AeroSpace Cluster (see 1.1 above), another group, the Luxembourg Aeronautics and Space Industry Group, or GLAE, has been formed in order to ensure participation in ESA's procurement processes and to influence NIS policy decisions.

8. Ministry of the Economy and Foreign Trade

Although not part of the chronology of R&D policy mix, the Ministry of the Economy must also be considered an R&D policy instrument, as it oversees initiatives relating to Luxembourg's economic competitiveness. In terms of innovation policy, Ministry of the Economy encourages companies to expand R&D activities and promotes entrepreneurship and firm creation. It also administers an R&D incentive scheme, according to the law of 27 July 1993. The scheme co-finances R&D investments of industrial companies and service providers and covers fundamental research, industrial research and pre-competitive development. Grants cover up to 75% for fundamental research, up to 50% for industrial research and up to 25% for pre-competitive development. The amount is increased for SMEs, projects involving

cross border co-operation and activities in the less developed southern, eastern and northern regions. It has become a main financing instrument for business sector R&D projects, although most of the funding (83%) has gone to the metal and chemical industries. Services industries remain under-represented.



Source: Rapports d'activité du Ministère 2005

In 2005, 18 projects from 16 companies were funded for €12 million, which represented €48.5 million of R&D investment by the companies. Seven of the companies were SMEs.

9. The Espace Entreprises of the Chambre de Commerce

The Chambre de Commerce has established an Espace Entreprises whose chief function is helping entrepreneurs wishing to start their own businesses apply for a business license. The Espace provides all the forms, collects all the required documentation and sends the dossier to the Classes Moyennes, the ministry that actually grants the license. The service is free of charge and efficient.

10. Intellectual Property Rights

As of 2005, Trend Chart reports the government reduced the documentary research cost companies have to cover before obtaining a long term patent in Luxembourg from €90 to €250. The same regulation also allows a tax exemption over two years covering not only national patents but also applications for a European patent to the European Patent Office. Finally, financing of patent-related expenditure and license expenses are eligible for support under the instruments aimed at financing R&D projects (two R&D incentive schemes, innovation loan).

11. Financing and support for private sector R&D

In addition to the grants offered through the Ministry of the Economy for R&D, there are other measures that offer financing either to R&D or to start-up firms.

Societe Nationale de Credit et d'Investissement co-finances loans that cover on average 25% of an investment in fixed assets of industrial projects, and up to 75% of the eligible investment incurred by young craftsmen, traders, hoteliers or restaurant owners starting out in business for the first time. The SNCI also offers what they term "Innovation Loans" for industrial enterprises or "Service providers with a significant impact on economic development" Loans generally finance 25% of the eligible cost of the research. Loans are for 3-5 years and interest rates are low. However, guarantees may be required of the borrower.

The SNCI also offers "Start Up Loans" All expenses incurred during the realization of a given business plan by newly created SMEs or recently taken over SMEs are

eligible. The beneficiary must be able to finance at least 15% of eligible costs. Loans can be from €5,000 to 250,000 without exceeding 40% of eligible costs. Loans can be up to 10 years and interests rates are the SNCI's long term rate plus 1.5%. A personal, solitary and indivisible declaration of surety is required..

Most recently the SNCI has created the program CD-PME, together with five Luxembourg banks. With capital of €2,480,000, the CD-PME grants equity loans and, exceptionally, takes a participating interest in Luxembourg based SMEs. The financing granted by CD-PME is in principle of limited duration with a maximum of ten years. The amount of the financing cannot exceed 50% of the financing need or €250.000.

The law of 30 June 2004 creates a framework of incentives schemes for SMEs, administered by the Ministry of the Middle Classes. The scheme finances fundamental research, industrial research and pre-competitive development activities. The measure is aimed to solve the problem of ineligibility of certain sectors for the R&D incentive scheme of the Ministry of the Economy (see Section 9 above).

The Law of 2004 establishes SICARs – venture capital and private equity companies. The law sets up a legal framework for private equity and venture capital companies in order to increase venture capital, which is generally very limited in Luxembourg.

Venture capital sources include BIP Investment Partners, whose stock is publicly traded. However, more than 60% of their portfolio is invested in large listed Luxembourg companies, e.g., Arcelor. Less than 20% of their portfolio, or slightly more than €70 million, is invested in private equity and even here their investments are in companies such as Cargolux, VOXmobile and IEE, which are not SMEs or start ups. Minimum investment is €2-5million and is made only in partnership with other firms.

Famous for taking a stake in Skype, Mangrove Capital Partners invests very selectively in high tech start-ups, which excludes most Luxembourg ventures. However, Eurefi has 15% of its portfolio of 60 companies invested in Luxembourg SMEs, mostly in the development/expansion rather than the start-up phase. It also invests in SMEs in the French and Belgian regions bordering Luxembourg and is funded by the EU as well as local partners.