

COVER STORY



Called Burj Dubai until its inauguration, the Burj Khalifa Tower in Dubai (United Arab Emirates) became in May 2009 the highest human structure ever built. In particular, it is supported by Luxembourg steel.



RESEARCH AND INNOVATION

BE INNOVATIVE OR BE NO MORE ...

Whether for large multinational companies or for local SMEs, innovation is vital to remain competitive and to seize new opportunities. In Luxembourg, public and private players are working together to bring innovative approaches to the forefront. But even if much has already been achieved, there is still room to develop new models and ideas for creating value.

Text: Georges Briol

Thousands of tons of steel «Made in Luxembourg» (not found anywhere else in the world) in the bowels of New York's One World Trade Center and the Burj Khalifa in Dubai. New processes to produce paints based no longer on petroleum, but on vegetable oil, to tackle new markets ... Two examples, among hundreds, which show - if it were needed - how much innovation allows

companies, whether multinational (such as ArcelorMittal) or nationally (like *Peintures Robin*), to stay in the game in an increasingly competitive economic environment.

We have come a long way from the nineteenth-century when French writer Gustave Flaubert, saw innovation as «always dangerous»: innovating now appears more than ever to be key to the success of any, including small, business. Contrary to widespread belief, this approach is not just the prerogative of large companies, with significant financial and human resources and endowed with hyper-sophisticated, modern research laboratories. This is rather good for a country like Luxembourg, whose economy is largely made up of smaller entities.

Moreover, in the recent «Next-generation family businesses» study conducted by Deloitte's in 19 European, Middle Eastern and African countries during the spring of 2016, of about one hundred representatives of family businesses preparing to commence operations, innovation was one of the top 3 priorities for 76% of respondents. ▶



€375 million in aid over eight years

Between 2009, the date when the law of 5th June 2009 for the promotion of research, development and innovation came into force and 2017, the date when this law was modernised, the Ministry of the Economy paid a total of EUR 375 million in the form of the various aid schemes, providing financial support to 655 projects related to innovation and research. Thanks to this aid, the companies concerned were able to invest more than one billion euros in Luxembourg. In 2016 alone, 80 RDI projects or programmes were provided co-financing by the Ministry of the Economy, with a total of more than 33 million euros in aid. SMEs accounted for more than half (53%) of these projects. Six of these ministry-supported projects were the result of public-private collaborations: three of these projects were completed with LIST and the other three with the University.



01.

The term «innovation» appears no fewer than 29 times in the programme of the current coalition government in place since December 2013 (it had been already mentioned 26 times in that of the previous government, in 2009). The document indicates, «the future of Luxembourg is built in niches of competence, ‘grey matter’ now being our primary ‘natural resource’».

The executive intends to ensure - jointly with all other partners in Luxembourg’s research sector - that research and innovation policy complies with two major objectives: contribute to the creation of economic wealth by stimulating competitiveness and growth through innovation; and to solving current social problems (education, integration and social cohesion, preservation of the natural and human environment ...)

INNOVATE TOO IN ORGANISATION AND PROCESSES

By «innovation», Luxembourg’s legislature means «*Any new product, service, process, method or organization resulting from the application of innovative ideas or research and development efforts*». Neither does not it neglect «organisational innovation» (which involves the implementation of new organizational methods in business practices, the orga-

nisation of the workplace or the external relations of the company), nor «process innovation» (linked to the implementation of new or substantially improved production or distribution methods, which imply significant changes of a technical, material or software nature).

These definitions appear in the text of the very recent law dated May 17, 2017, governing research, development and innovation aid schemes. This text succeeded one dating back to 2009 and which was, until then, the reference in the field.

This new law of 2017 has three specific objectives: the encouragement of partnerships between private sector companies and public research laboratories (by renewing incentives such as an increase in the maximum rate of aid applied to collaborative research and development (R & D) projects); support for the development of state-of-the-art innovation capacities in Luxembourg’s fields of excellence, with particular emphasis on setting up joint public-private research infrastructure; and finally simplifying access to aid, as part of the government’s efforts to this end.

Thus, Luxembourg legislators’ ambitions are to increase the R & D expenditure of private companies from 0.71% of GDP (according to Eurostat 2013 forecast data) to a minimum 1.4% of GDP by 2020 with



Photo: Emmanuel Claude / Focalize

02.

an interim target of 1.1% for 2017. At the same time, legislators want to double the number of collaborative projects involving companies and public research organizations. An average of ten were registered annually for the period 2011-2013: the goal is to reach twenty or so R & D collaborative projects by 2020.

EXPENDITURE ON RESEARCH MULTIPLIED BY 12 SINCE 2000

These aims, for the least ambitious, are part of the Europe 2020 strategy for economic policy coordination, which succeeded, in 2010, the Lisbon Strategy established 10 years earlier.

Rolled out by the European Union, this Europe 2020 strategy is designed to enhance growth and jobs by focusing on «smart, sustainable and inclusive growth to overcome the structural weaknesses of the European economy, to improve competitiveness and productivity and lay the foundations for a sustainable social market economy».

This means very precise numerical objectives in terms of employment, energy policy, education, poverty and exclusion, and R & D. Here, Brussels has set the bar very high: to ensure that 3% of EU GDP is invested in research and development.

At last count, in 2015, the measured rate was just over 2%. The bar set by Luxembourg is a little ▶

01. Over the past four decades, the research and innovation system has become solidly based with the gradual establishment of public actors to complement and support already established private initiatives.

02. In their policy of economic diversification and their promotion and support efforts, successive Luxembourg governments have targeted a few key sectors (like Health sciences and technology) that are sources of innovation and sustainable development.



INTERVIEW
VINCENT HEIN
Economist, IDEA Foundation asbl

“ A framework for innovation ”

What is your view on Luxembourg's research and innovation policy in the past few years?

"It is a widely shared political priority and is based on three pillars. Firstly, the construction of a public research centre around the University and the three research centres (LIST, LIH, LISER). Thus, public (nominal) research spending has increased 12-fold in 15 years.

Secondly, support for businesses' R & D activities via direct support mechanisms, reinforced this year, which represent around 15% of private research expenditure. Finally, this policy is based on a more "qualitative" management aiming to encourage collaboration between the public and private sectors (PPPs, clusters) and to create a favourable framework for the development of innovative activities (training and attraction of talent, digital infrastructures, IP etc.)."

What are the country's strengths in this area?

"Luxembourg offers an environment conducive to innovation, thanks to the international anchoring of companies, the mobility of qualified assets, the specialisation in niches with an elevated level of knowledge and technology. Business R&D expenditure as a percentage of GDP is often mentioned as a weakness, a sectoral analysis shows that, in fact, the industries which carry

out the bulk of private research in the world, invest more in Luxembourg than the European average. In addition, the country is at a level very close to the European "innovation leaders". Finally, poles of excellence are emerging in public research (ICT, medicine, engineering sciences, etc.)."

What are conversely the points that should be improved?

"After very strong growth, the public research sector has entered a consolidation phase. The size of the country could "impose" upon it a selection of the most strategic research sectors to support economic diversification. International research projects and cooperation between the public and private sectors must also continue to be encouraged. Promoting the integration of PhD students into the labour market will also be a road to follow."



INTERVIEW
ÉTIENNE SCHNEIDER
Deputy Prime Minister,
Minister of the Economy

“ We are often precursors ”

What are the current government's goals in promoting research and innovation?

"Research and innovation are key elements in the country's economic development and diversification strategy. Indeed, we are banking on a knowledge economy and we want to attract highly technological activities to Luxembourg. Innovation is also at the heart of the "Rifkin" strategy of the Third Industrial Revolution, which the government has chosen as a general direction for the country's development and through which we will prepare Luxembourg for future challenges."

How do these objectives translate into reality?

"In May this year, the new law on aid for research and innovation for businesses came into force. We have chosen to transpose all the opportunities offered by the European framework to encourage companies to increase their R & D spending, to boost their innovation efforts and to encourage partnerships between private companies and public research centres. In addition to the various support provided for innovation and research, we have also succeeded in setting up a successful and diversified start-up ecosystem, which is based on a network of public and private incubators for young companies and on a highly developed technological environment."

Can Luxembourg boast of being particularly well advanced in terms of innovation compared to other countries?

"Many projects in which the Grand Duchy has taken the lead in the European Union certainly tend to prove that we are often forerunners when it comes to leveraging innovative technologies. In this sense, I would like to stress that the European "high performance computing" project was born from an initiative taken by Luxembourg. In addition, together with France and Germany we have set up the first common experimental site for automated and connected driving, a technology of the future at the intersection of mobility and digitalisation. Thanks to the SpaceResources.lu initiative, the Grand Duchy has once again taken on a pioneering role in Europe. Research and innovation are essential for advancing technologies that will make space resource extraction practical and Luxembourg offers the economic environment and the necessary legal framework."



Photo: SES Astra

03.

lower than the European average: the country, in its own Luxembourg 2020 plan, aims for an investment level of between 2.3% and 2.6% of GDP, one-third of which must be provided by the public sector. However, in 2015, this level of «global» investment was only 1.31% of GDP, placing Luxembourg in 16th position in the EU.

Even so, in 2015, the amount of domestic R & D spending reached 670 million euros, which represents an average annual increase of 4.2% since 2000. Over this period, growth in public research spending has been multiplied by 12, from 28 to 329 million euros.

But that is not enough to claim satisfactory overall figures. Public sector expenditure amounts to 0.64% of GDP (compared with 0.71% in the European Union), while private expenditure is limited to 0.67% of GDP (compared with an EU average of 1.3% of GDP).

Moreover, as pointed out by the IDEA Foundation in its «Idea of the month No 18» published last September and devoted to RDI (research, development and innovation), the proportion of R & D personnel (5,600 people) employed in Luxembourg (1.49%) is also below the European average (1.97%).

“The government maintains its long-term goal of raising government spending on research to the equivalent of 1% of GDP, “ says the government programme of December 2013. “The performance contracts concluded, or to be

03. Created in 1985 in Luxembourg with the support of the Luxembourg government, the European Satellite Company, still based in the Grand Duchy, is today the leading satellite operator in the world.

04. A lot of Luxembourgish organisations participated in research and innovation projects. If big companies are among the largest beneficiaries, small entities and startups are also involved.



Photo: Financialtribune.com

04.

concluded, with beneficiaries will guarantee an efficient and targeted use of the funds made available by the State. The Government will adjust the interface between public research and private research funding instruments to promote research and innovation projects and programmes in support of the different priority sectors in the economy.”

LUXEMBOURG IS A EUROPEAN TEACHERS' PET

Does this mean that the situation is hopelessly catastrophic in the Grand Duchy, as the Europe 2020 objectives are clearly out of reach? Not necessarily.

Firstly, statistics do not necessarily reflect a true picture of the reality on the ground and they can, depending on the parameters selected, show something else. For example, comparing just the industrial sector, R & D expenditure is far from negligible in Luxembourg, amounting to 7.2% of industrial added value in 2013, putting the country in 5th place among the EU 28 (where the average is 5.6%).

Additionally, Luxembourg companies, often integrated in large international groups, are quite likely to be innovative and creative, while benefiting from the results of R & D work carried out abroad which does not appear in national statistics.

Moreover, although innovation and R & D may be closely linked, they are not necessarily so. Inno-

vation is, of course, often the result of research and development efforts, but it can also be expressed and developed in other ways.

This explains why Luxembourg, ranked so modestly among its European peers in terms of R & D, is in a much better position when it comes to focusing on only those aspects related to innovation. This is demonstrated by several indicators.

According to the latest data available from Eurostat, Luxembourg is one of the best students in terms of innovation: the highest proportion of innovative firms in the European Union during the period 2012-2014 were recorded in Germany (67% of all companies), Luxembourg (65.1%) and Belgium (64.2%). This concerns companies in the commercial sector with more than 10 employees, i.e. 1,750 companies in the Grand Duchy, of which 1,140 introduced, between 2012 and 2014, innovations in terms of products, processes, marketing or organisation. At European level, almost half (49.1%) of companies indicated that they carried out some form of innovation activity during the 2012-2014 period.

In June 2017, in the latest edition of the innovation scoreboard published by the European Commission, Luxembourg is also in a rather advantageous position. Behind a group of seven countries considered to be the most innovative (Switzerland, Sweden, ►



Proof of Concept: from theory to practice

As part of the Luxembourg 2020 national plan for smart, sustainable and inclusive growth, presented in April 2014, the Proof of Concept (POC) programme, aimed at encouraging the conversion of the fruits of research into economically viable innovations, was formally implemented. During the pilot period between 2013-2014, five projects (three concerning information and communication technologies, one for the biomedical sciences and material sciences), out of 11 proposals submitted, were selected. According to figures published by the FNR in June 2017, since 2015, no less than 20 projects have been selected, of which 10 have been completed, representing an investment of 3 million euros from the National Research Fund. Of these 10 projects, four have led to the creation of spin-offs, with some fifteen jobs at the end of the day.

05. In 2015, the major players in research and innovation – the List, the University of Luxembourg, the FNR and Luxinnovation – moved to the Cité des Sciences, Recherche et de l'Innovation in Esch-Belval, with the aim of improving synergies and (re-)creating a competitive spirit conducive to the development of new ideas in the heart of a real «campus» that now houses around forty start-ups and the innovation and research centres of foreign companies.



Photo: Université du Luxembourg

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Denmark, Finland, the Netherlands, Great Britain and Germany), Luxembourg is among the «leaders» of the second group, that of «notable innovators».

The «strengths» identified by the European Commission include the quality of intellectual capital and the attractiveness of the research system (two criteria for which Luxembourg ranks first among the 28 EU countries), but also an environment deemed favourable to innovation (4th place). On the other hand, the weakness of funding and support mechanisms (16th), the level of business investment (17th) and above all the meagre level of cooperation between private and public players (20th) are singled out.

A WELL CONSOLIDATED ECOSYSTEM

Perhaps the country suffers, in the circumstances, from the relative youth of its public research system. The creation of the national agency for the promotion of innovation and research, Luxinnovation, dates back only to 1984, whilst the first framework law for research only celebrated its 30th birthday last March 9th. We must then wait for the establishment of the Juncker (CSV)-Polfer (DP) government in August 1999 to see the very first Minister of Research of the history of Luxembourg. This was Erna Hennicot-Schoepges, head of the Ministry of Culture, Higher Education and Research. This same year also saw the creation of the National Research Fund (NRF).

Fortunately, over the years, the country has largely made up for this late start and started to catch up, to the extent that in 2015 the Organisation for Economic Co-operation and Development (OECD) drew attention to the efforts made over recent years by Luxembourg to improve the performance of its national research-innovation system. Today, a map of the actors involved in innovation is, necessarily, subject to very frequent change. Historically, the national system of research-innovation was first built upon the arrival of multinational groups that developed research and development activities in the country.

Certainly, some major technological advances have already marked the history of Luxembourg and sometimes even before the advent of the twentieth century. In 1881, for example, in the village of Rosport, along the German border, a Luxembourgish engineer, Henri Tudor, invented the lead-acid battery using a technique which, even today, constitutes one of the technological standards in the global electric accumulator industry. It was also at the end of the 19th century that the first innovative processes in the iron and steel industry were developed, and this sector of activity has, over the years, produced an almost perpetual bubbling of ideas.

The discovery by English engineers Sidney G. Thomas and Percy Gilchrist of a revolutionary pro-



06.

cess (the Thomas Process) in 1879 marked a decisive step in the emergence of the iron and steel industry in Luxembourg. Less than a month after the first full-scale demonstration of this new technique allowing the conversion of so-called «phosphoric» pig iron into steel, two Luxembourgish engineers went to Britain to negotiate – and obtain – the acquisition of an operating license.

Not only did this pillar of the national economy quickly reap the benefits of this innovation, but it did the same for the... agriculture sector. This, because the slag produced by the Thomas process, once crushed, turned out to be a plentiful and cheap fertiliser considered the best in the world. In a little less than a century, the iron industry supplied the 120,000 ha of cultivated land in the Grand Duchy with 25,000 to 30,000 tons of phosphate fertiliser per year. In no other country in the world has agriculture been so dependent or benefited so much from the iron and steel industry. Whilst no other «invention» has had such an influence in the iron industry, many others have nevertheless improved the sector.

One example is the oxygen steel manufacturing process developed in the late 1950s by Paul Metz, one of the great grandsons of Auguste Metz, the founder, in 1838, of the limited partnership Auguste Metz and Co, which became, through successive mergers, Arbed in 1911. ▶

06. At the end of the 18th, beginning of the 19th century, Gray beams are exported all over the world. The Differdange plant, which invented the process, is the first in the world to roll these beams



INTERVIEW
JEAN-LUC DOUCET
CEO, Ferro-Tech

“ A major asset for an enterprise ”

How did the problem of innovation arise for you?

“We were facing a situation, as a family-size company, where we were competing with global structures. In this context, we had to distinguish ourselves, both in terms of the quality of our services and the innovation we can bring to the products we offer. For example, we have developed a rolling vehicle that integrates three machines into one:

a locomotive, a stabiliser and a tamping machine. Normally, in order for the stabiliser and tamping machine to work, we must add a means of traction to carry ballast. Ours has enough power to tow 3,000 tons. This innovation, unique in the world, required some 10 million euro in investments.”

How do you implement such innovative approaches?

“This is, for us, thinking about customer satisfaction which goes hand in hand with an improvement in our services that we wish to continue. This concerns both quality as well as safety and well-being at work.”

Does innovation call for innovation? Should this become an ongoing process?

“Without a doubt, yes. Innovation is clearly a major asset for a company today, not only to meet today's challenges, but also to prepare for those of tomorrow.”



INTERVIEW
RAYMOND SCHADECK
 President, Luxinnovation

“All companies, even small ones, can innovate”

Is innovation a scary concept for businesses, especially small and medium ones?

"Most SMEs are actually already innovative. Otherwise, they would, for the most part, still be there. But not all businesses are necessarily aware of it. It is therefore important to demystify the notion of innovation and, at the same time, to make sure that innovation is practiced consciously and voluntarily. Indeed, innovation covers much broader areas than one can imagine, and this approach is certainly not limited to large technology companies and research laboratories. Any company, even small, and without a research department, can innovate. It is not just about bringing new products or services to the market, but it also includes any kind of voluntary and conscious approach to improving its internal efficiency and operations."

Is innovation simply «nice to have» or a vital necessity for businesses?

"From what we can observe, the companies that considered innovation to be just "nice to have" are the ones that subsequently experienced the greatest difficulties. In the long run, only companies that see innovation as an integral part of their overall management achieve lasting success."

How can we make more companies innovate?

"Luxinnovation wants companies to introduce innovation as an integral part of their management and to make it a systematic and voluntary process. To this end, the Innovation Agency offers companies three performance and innovation programmes specifically developed for national SMEs: Fit 4 Innovation, Fit 4 Growth and Fit 4 Digital. Fit 4 Innovation enables SMEs to improve their competitiveness by playing on, at the same time, optimising sales, increasing productivity and increasing customer satisfaction in terms of quality and deadlines; Fit 4 Growth aids in the development and implementation of innovation projects; and finally Fit 4 Digital helps SMEs to take the step of digital transformation. The Fit 4 Innovation program, for example, has, for the last three years, enabled more than 30 companies to take concrete steps following the elaboration of a precise diagnosis of their situation, that is to say, a 360° analysis of their structure and activity. The cumulative return on investment for all these companies is close to 500%."



Photo: Pierre Guersing

07.

Iron and steel is obviously not the only industry to have brought innovation to the highest levels. But it was especially after the Second World War that things began to accelerate, with the arrival of the American giant Goodyear. In 1949, the tire manufacturer established its first factory on the site of the old ironworks at Colmar-Berg.

In the following decade, it developed a technical centre and an innovation centre which, even today, allow it to remain a leader in the field. The announcement, at the end of summer 2017, of a \$ 95 million investment (about 80 million euros) to build a «generation 4.0», ultra-modern, highly-automated plant in Dudelange perpetuates the continuity.

Other major international groups have made Luxembourg their platform for development and innovation: automotive sensors and safety accessories produced by IEE in Contern; the highly sophisticated protective clothing developed by DuPont, also in Contern; billions of tungsten carbide ballpoint pens made by Ceratizit in Mamer, which today account for 45% of the world market ...

Over the past four decades, the research and innovation system has become solidly based with the gradual establishment of public actors to complement and support already established private initiatives. The innovation and research support policy really began in June 1981 with the government's decision to adopt a strategy to stimulate and

07. The tire manufacturer Goodyear, established on the site of the old ironworks at Colmar-Berg has developed a technical centre and an innovation centre which, even today, allow it to remain a leader in the field.

08. It is in Luxembourg, for example, that the future European supercomputer HPC (High Performance Computer) will be built, starting in 2018, having the power to make a million billion operations per second for the benefit of generation 4.0 industries.



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co-finance R&D of Luxembourg's industrial and service companies.

Less than two years later, the National Credit and Investment Company (NCIC) introduced the innovation loan formula as one of its business support tools. At around the same time, in 1982, the Federation of Industrialists in Luxembourg (Fedil) launched an industrial innovation prize, awarded every two years.

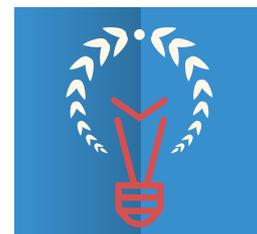
The 1984 creation of Luxinnovation, the national agency to promote innovation and research, was the cornerstone of a national building for research, development and innovation policy. Three years later, the law of 9 March 1987 is another milestone, since it organised both technological research and development in the public sector, the transfer of technology and scientific and technological cooperation between private companies and the public sector. In particular, it laid the foundation to create four public research centres: the Henri Tudor PRC in the field of industrial, environmental and computer engineering; the Gabriel Lippmann PRC for natural sciences, biotechnology, materials, law, economics and information, communication and organisation technologies; the Health PRC created in 1988 for ... health and finally the CEPS/Instead, created in 1989, for everything related to socio-economic studies.

The birth, in 2003, of the University of Luxembourg, obviously marks another important turning

point in the development of the ecosystem, by contributing the missing link: basic research. In the same year, the Ecostart business and innovation centre was set up in Foetz, adding to the Schlassgoart Technoport, the very first business incubator, a reception and innovation centre created in 1998 as part of the Henri Tudor PRC.

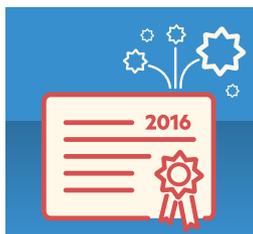
Since then, this entire organisation has been largely remodelled to better respond to market developments and to the actions of one other. In this context, 2015 was, undoubtedly, a vintage year, seeing the creation of the Luxembourg Institute of Science and Technology (List), a merger of Henri Tudor and Gabriel Lippmann PRCs; the creation of the Luxembourg Institute of Health (LIH), bringing together the Health CRP and the Integrated BioBank of Luxembourg (IBBL) and a redefinition of the CEPS/Instead missions, which became the Luxembourg Institute of Socio-Economic Research (Liser).

In the same year, the major players in research and innovation - the List, the University of Luxembourg, the FNR and Luxinnovation - moved to the *Cité des Sciences, Recherche et de l'Innovation* in Esch-Belval, with the aim of improving synergies and (re-)creating a competitive spirit conducive to the development of new ideas in the heart of a real «campus» which had already housed the «new Technoport» (grouping the activities of Technoport Schlassgoart and the Ecostart Business and ►



Innovation rewarded

There were 68 on the starting lineup to apply for the 2017 Craftsmanship Innovation Award. Of the 12 finalists selected, Annen Plus was crowned on November 23rd. It had developed, thanks to digitalisation, a wooden construction system, without screws or nails, and reusable on different constructions, in the spirit of the circular economy. By coincidence: the day before, FEDIL also rewarded innovation by awarding its Environmental Award 2017 in the "eco-innovative start-up" category to Ama Munda Technologies, who designed and built a mobile unit to extract water and fertilisers from manure and the digestate byproduct of biogas. Ama Munda who also received the Industry Award at the People's Vote Projects one day earlier at the Luxembourg Sustainability Forum. It should be noted that the Federation of Industrialists also awards an Innovation Prize every two years. The last winner, in 2016, was Tarkett for the use of digital printing technologies to produce PVC floor coverings.



Patents: a record year in 2016

"The patent, a fundamental support for innovation and competitiveness": with these words the Minister of the Economy Étienne Schneider introduced the brochure "Innovation Patents - a Guide for Applicants" published in January 2016. "A dynamic economy, based on innovation, must be able to rely on an effective intellectual property system. In this sense, intellectual property must offer appropriate tools to protect and enhance the results of creation and the research and development activities of innovative companies in a wide range of fields." In 2016, a record number of 249 patents were issued in Luxembourg. Nearly 1,200 have been since 2010. At the Benelux scale, of the 23,000 registered trademarks and designs, just over 1,100 (less than 5%) have been registered by Luxembourg companies or individuals. A share that is only 1.25% when looking at the figures for Community applications (1,700 "Luxembourg" applications out of a total of 136,000).



09.

Innovation Centres) since 2012. It now houses around forty start-ups and the innovation and research centres of foreign companies.

INNOVATION AT ALL LEVELS

In their policy of economic diversification and their promotion and support efforts, successive Luxembourg governments have targeted a few key sectors that are sources of innovation and sustainable development. The automotive sector, driven by key companies such as Goodyear, Delphi, Elth and IEE, is perhaps the most «visible», but it is far from being the only one.

Health sciences and technology (particularly in the fields of personalised medicine, diagnosis, bioinformatics and medical informatics); CleanTech (development of renewable energies, waste management, water treatment, eco-building ... all in a «circular» approach aimed at turning potential waste into raw materials for production); and the aerospace sector.

The latter sector, particularly, is very much en vogue nowadays. Initiated and promoted by the Minister of the Economy, Étienne Schneider, the formidable odyssey of «space mining» perfectly illustrates the capacity of the country to innovate by anticipation: by creating the first legal frame-

work relating to the exploitation of future resources extracted directly from heavenly bodies, Luxembourg has donned a tailor-made pioneer suit which suits it perfectly.

The Spaceresources.lu initiative, supported by and working alongside NASA and the European Space Agency, offers the Grand Duchy a new and remarkable visibility.

If Étienne Schneider likes to repeat that Luxembourg takes up more space in space than on earth, we must not forget that the more «traditional» sectors are not resting on their laurels: finance is developing electronic commerce and payment solutions and bringing fintech online; logistics is developing innovative solutions for multimodal transport and green logistics; and «manufacturing» is promoting composite and multifunctional materials, nanomaterials and highly customised production technologies.

All this with the cross-cutting support of information and communication technologies, another area in which Luxembourg expertise excels, particularly in terms of cybersecurity, data protection and the management and exploitation of «big data».

It is in Luxembourg, for example, that the future European supercomputer HPC (High Performance



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Computer) will be built, starting in 2018, having the power to make a million billion operations per second for the benefit of generation 4.0. industries. This project, worth more than 5 billion euros, envisages that in 2023, the supercomputers that Germany, Spain, France, Italy, Luxembourg, the Netherlands and Portugal are committed to building in their own territories, will be directly connected to each other. This is the biggest strategic project envisaged by the European Commission since the birth of the Airbus consortium.

The HPC will also be actively involved in the implementation of another European Framework Programme, Horizon 2020, dedicated to research and innovation. It provides innovative companies and research organisations with facilities to participate in international RDI projects co-financed by the EU. For the period 2014–2020, the budget allocated is more than 80 billion euros.

According to figures provided by the Ministry of Higher Education and Research in its 2016 annual report, since the launch of the Horizon 2020 programme, no fewer than 64 Luxembourgish organisations participated in 141 projects and obtained total funding of 43.19. million euros, including 33 new projects, for 12.9 million euros, in the first nine months of 2016 alone.

The University of Luxembourg (68 projects submitted, including 8 selected), the List, Goodyear, ArcelorMittal and Creos (the owner and manager of the main electricity grid and natural gas pipelines in Luxembourg) are among the largest beneficiaries, but small entities such as the start-up MyScienceWork (which developed the first free access digital science platform, compiling more than 30 million scientific publications, for research institutions) are also involved. According to the Ministry, nearly a quarter (21%) of the funding obtained by Luxembourgish actors since 2014 has been to the credit of SMEs.

Luxembourg's success rate is 15.96%, which places Luxembourg in 4th place among the countries participating in the Horizon 2020 programme. Further proof that the country need not be ashamed of its situation and that its positioning in terms of research and innovation is not without relevance.

Which is rather good: engaged for a year in the strategic «Rifkin» process of the third industrial revolution, economic actors, both public and private, have made the «innovation economy» one of the pillars of action to ensure the country transitions to a sustainable economic model. The revolution is on the march and nothing will stop it ... ●

09. Technoport has been set-up back in June 2012 as the result of the merge between the former Technoport, a technology-oriented business incubator launched by the Public Research Center Henri Tudor back in 1998, and Ecostart I and II, business support infrastructures developed since 2004 by the Ministry of the Economy and Foreign Trade. Technoport is today a reference model and is ranked in the top 15 global incubators in its category 10. The formidable odyssey of «space mining» perfectly illustrates the capacity of the country to innovate by anticipation: by creating the first legal framework relating to the exploitation of future resources extracted directly from heavenly bodies, Luxembourg has donned a tailor-made pioneer suit which suits it perfectly