

RESEARCH & INNOVATION SMART SPECIALISATION STRATEGY (RIS3)



JUNE 2024



THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG

Responsible publisher: Ministry of the Economy
19-21 boulevard Royal
L-2449 Luxembourg

Authors: Mario Grotz
Ernest Boever
Gabriel Crean

Creation and design: Studio Polenta

Publication: Luxembourg, August 2024

PREFACE



This new Luxembourg research and innovation Smart Specialisation Strategy is the third in a series, following those of 2013 and 2017.

This strategy has been elaborated in a particular global, European and national context, in view of the increasingly turbulent geopolitical landscape and the accelerating impacts of global warming. A particular attention has been paid to the Luxembourg economic and innovation framework in two key priority areas for the Government: the Luxembourg transition towards climate neutrality by 2050 and its leadership in the digital transformation. This has been facilitated by a benchmarking of Luxembourg's position in both the global digital race for economic growth and the global transition towards climate neutrality and industry net zero.

Looking to the future, Luxembourg's digital data and infrastructure should be considered as critical competitiveness enablers. In addition, the need to strengthen our economic resilience and autonomy is of growing importance.

In the coming years, the Ministry of the Economy and the Government will therefore make significant investments in digital assets, in particular in supercomputing and quantum computing capabilities and an Artificial Intelligence ecosystem for start-ups, SMEs, and industry. This will both underpin and impact all strategic sectors of our economy. In parallel, my services actively collaborate with the European Commission and related taskforces to increase the resilience of our critical infrastructures and supply chains. Finally, this Luxembourg innovation ambition will be implemented whilst maintaining momentum for our accelerating green transition to climate neutrality.

Lex Delles

Minister of the Economy,
SME, Energy and Tourism

CONTENT

1. **Introduction** p. 06

2. **National Context** p. 07

- 2.1 Global positioning of Luxembourg p. 09
- 2.2 Positioning in the digital economy p. 09
- 2.3 Positioning in the green economy p. 10
- 2.4 Economic context p. 10
- 2.5 Research and Innovation Landscape p. 11
- 2.6 Summary p. 13

3. **Smart specialisation vision and priorities** p. 12

- 3.1 Third Research and innovation smart specialisation strategy: background strategic landscape p. 14
- 3.2 National economic priority sectors p. 15
- 3.3 Smart Specialisation priority sectors p. 24

4.	Smart specialisation policy instruments	p.21
	4.1 Luxembourg innovation delivery instruments supporting knowledge generation, diffusion and exploitation	p. 26
	4.2 Ongoing policy experimentation and optimization	p. 29
	4.3 Smart specialisation investment programme	p. 31

5.	Smart specialisation governance	p. 26
	5.1 National innovation governance landscape	p. 33
	5.2 Smart specialisation governance structure	p. 34
	5.3 Smart Specialisation Monitoring and Evaluation	p. 35

6.	Outlook	p. 36
-----------	----------------	-------

1. INTRODUCTION

Smart specialisation strategy (S3) is now globally recognised as a European Union (EU) developed place-based and context specific approach to allow EU member states and its regions to boost innovation and develop their own specific competitive advantages¹. The European roots of Smart Specialisation have gradually grown beyond our EU borders and has started inspiring several countries and regions around the world.

This document details the third Luxembourg research and innovation Smart Specialisation Strategy (3rd RIS3) following those of the 2nd RIS3 in 2017 and the first RIS3 in 2013. The Luxembourg government is cognisant that this 3rd RIS3 cycle occurs within a particular global, European, and national context. The world and economies globally, are buffeted by strong headwinds arising from the increasingly turbulent geopolitical landscape, global warming, the continued disruption of global supply chains, the ongoing direct economic impacts to European industry of the Russian war on the Ukraine and most recently, the multiple conflicts in the Middle East.

It was therefore considered even more important to ensure an updated and specific Luxembourg context to this 3rd RIS3 cycle, to enable a place-based approach to prioritising the state's research and innovation investments in specific competitive areas to address current and future challenges.

Chapter 2 provides an overview of the current economic and innovation context of Luxembourg against the above global background, but within the unique place setting of Luxembourg at the heart of the European Union and, where Luxembourg remains the most open market in the European Union. A particular attention in this new RIS3 has been paid to the Luxembourg economic and innovation setting in two key priority areas for the government: the Luxembourg transition towards climate neutrality by

2050 and its leadership of the digital transformation in an increasingly digitised global economy and society. In addition, for the first time, a benchmarking of Luxembourg's position in both the global digital race for economic growth and the new global transition towards climate neutrality and net zero is presented.

In Chapter 3, the very specific Luxembourg background strategic landscape is presented. It is seen that this third RIS3 cycle leverages the very considerable planning and strategizing that has taken place across all parts of Government addressing research and innovation since the publication of the 2nd RIS3 in 2017. In particular, the 2022 "National Space Strategy for 2023 to 2027"², the 2021 Ministry of the Economy roadmap³ "Ons Wirtschaft vu muer" ("Our economy of tomorrow") addressing the challenge of building both a competitive and sustainable economy, the 2019 national data-driven innovation economy strategy⁴, the 2019 strategy on Artificial Intelligence "Artificial Intelligence: a strategic vision for Luxembourg", the 2019 national Research and Innovation Strategy along with elements of the National Energy and Climate Plan (PNEC). It thus integrates a comprehensive Luxembourg whole-of-economy response.

Reflecting best S3 design practice, the framing of this 3rd RIS3 strategy has also benefitted from the broad Nationwide Luxembourg consultation process and strategic foresight activities launched by "Luxembourg Stratégie"⁵. This bottom-up consultation involved over 1000 participants, including representatives from government ministries and administrations, intermediate bodies, trade unions, employers, the Chamber of Deputies, and various thematic observatories. The initiative has confirmed Luxembourg's ambitions in the transition towards climate neutrality by 2050 and European leadership of the digital transformation

1— Over 180 Smart Specialisation Strategies (S3) have been developed, at EU regional and national level.

2— The national space strategy for 2023 to 2027, 13 December 2022, Ministry of the Economy

3— Ons Wirtschaft vu muer, Feuille de route pour une économie compétitive et durable 2025, Juin 2021 ministère de l'Économie.

4— The data-driven innovation strategy for the development of a trusted and sustainable economy in Luxembourg, May 2019, Ministry of the Economy, The Government of the Grand Duchy of Luxembourg

5— Direction de prospective stratégique du ministère de l'Économie. Established 2020.



of the economy and its output have been fed into key aspects of this 3rd RIS3.

The considerable innovation policy experimentation and optimization over the period 2017 to 2023 is detailed in Chapter 4. It is observed that Luxembourg has continued to develop a large range of innovative and efficient policy instruments supportive to different priority sectors; a particular example being the rapid growth of the space economy sector.

Whilst the formal authority for the Luxembourg RIS3 resides within the Ministry of the Economy, the RIS3 governance

builds on the interaction of several different instances of coordination and consultation that include the four principal actors of the Luxembourg innovation economy: government, industry, public research and education actors, and civil society. Chapter 5 details the current Luxembourg innovation governance landscape, the resulting RIS3 governance structure along with the monitoring and evaluation process in place.

Finally, in Chapter 6, an outlook towards the future evolution of the Luxembourg RIS3 is presented recognising that Luxembourg and the European Union have tremendous opportunities but face a globally challenging environment.

2. NATIONAL CONTEXT

The Luxembourg government is cognisant that this 3rd RIS3 cycle occurs within a particular global, European, and national context in a globally challenging environment. It was therefore considered all the more important to ensure an updated and specific Luxembourg context to this 3rd RIS3, to facilitate a place-based approach to prioritising the state's research and innovation investments in specific competitive areas to address current and future challenges.

This chapter provides an overview of the current economic and innovation context of Luxembourg against the above global background, within the unique place setting of Luxembourg at the heart of the European Union and, where Luxembourg remains the most open market in Europe.

A particular attention in this new RIS3 has been paid to the Luxembourg economic and innovation setting in two key priority areas for the government: climate neutrality by 2050 and digital transformation. It is the belief of the Ministry for the Economy that the combined green transition and the digital transformation will play a central and priority role, both in stimulating Luxembourg's economy post global crises, and in best positioning Luxembourg for the future.

This chapter of the 3rd RIS3 therefore contains a benchmarking of Luxembourg's position in both the global digital race for economic growth and the new global transition towards climate neutrality and net zero.



2.1 Global positioning of Luxembourg

IMD World Competitiveness Ranking 2023

Luxembourg was ranked 20th globally amongst 63 countries, and 38th for its economic performance, in the 2023 edition of the IMD World Competitiveness Ranking.

Global Innovation Index 2023

In the 2023 edition of the Global Innovation Index (GII) Luxembourg was ranked 7th in business sophistication, 11th in creative outputs and 21st, globally, amongst the 132 economies featured. The GI provides a particular window of analysis on the potential of innovation-driven growth in the Luxembourg economy.

European Innovation Scoreboard 2023

Luxembourg was the 8th best performing country in the EU in the 2023 edition of the European Innovation Scoreboard (EIS), which aims to measure and compare the relative innovation performance of the 27 EU member states.

Luxembourg, together with Ireland, Austria, Germany, Cyprus, and France fall into the category of strong innovators with a performance above the EU average.

Global Talent Competitiveness Index 2022

In the 2022 edition of the Global Talent Competitiveness index (GTCI), Luxembourg was ranked 1st in terms of overall attractiveness, and 11th out of 133 countries in the overall GTCI.

Global Resilience Index 2023

Economic resilience has now come to the forefront of focus across the EU. The Global Resilience Index ranks 130 countries and territories around the world according to the relative resilience of their business environment.

Luxembourg is ranked 1st as the world's most resilient economy in the economic category with a score of 100/100 due to its high productivity and low political risk. Overall, Luxembourg is the world's third most resilient economy overall, with a global score of 97.5.

Index of Economic Freedom 2023

The Index of Economic Freedom measures the impact of liberty and free markets around the globe.

Luxembourg was ranked 7th in the world amongst 175 countries in the 2023 Index of Economic Freedom.

2.2 Positioning in the digital economy

European Digital Economy and Society Index (DESI) 2023 dashboard for the Digital Decade

This is a new dashboard of indicators summarising Europe's and its member states performance across the four dimensions of the Digital Decade policy programme: digital skills, digital infrastructure, digitalisation of business and digitalisation of public services.

It replaces the more specific 2022 edition of the Digital Economy and Society Index (DESI) where Luxembourg was then ranked 8th of 27 EU Member States.

In this new "dashboard", Luxembourg emerges as a digital front-runner in key areas across the four dimensions of the dashboard. In Digital Skills, Luxembourg is ranked 2nd in the EU in terms of ICT specialists and 4th in terms of ICT graduates. In Digital Infrastructure, Luxembourg is ranked 4th in the EU in terms of mobile broadband take-up and 5th in terms of fixed very high-capacity networks. In Digitalisation of Business, Luxembourg is ranked 5th in terms of AI and 9th in terms of Big Data with respect to digital transformation of business. However, the low level of SME's selling online and using e-invoices between companies remains to be further addressed. Finally, in the digitalisation of public services dimension, Luxembourg is ranked 2nd in terms of digital public services for citizens and ranked 5th in terms of digital public services for businesses.

IMD World digital competitiveness ranking

Luxembourg is placed 11th in the EU and ranked 26th of 64 countries in the 2023 World digital competitiveness ranking.

Luxembourg is ranked 25th globally in the Technology block which notes the overall national context that enables the development of digital technologies, and 21st in Future Readiness.

2.3 Positioning in the green economy

The Global Sustainable Competitiveness Index 2023

Luxembourg is ranked 20th out of 180 countries in the 2023 Global Sustainability Rankings (GSCI) which measures national development and green growth since 2012, based on 131 quantitative indicators derived from recognized international organisations.

Environmental Performance Index (EPI)

Luxembourg was ranked 6th globally amongst 180 countries in the 2022 Environmental Performance Index (EPI) which provides a data-driven summary of the state of sustainability around the world. The EPI ranks countries on climate change performance, environmental health, and ecosystem vitality. These indicators provide a gauge at a national scale of how close countries are to established international environmental policy targets.

At a regional level, Luxembourg was ranked 1st in the Benelux countries with its neighbors at 11th place (Netherlands) and 21st place (Belgium) respectively.

2.4 Economic context

Luxembourg is one of the smallest EU Member State's with an area of 2,586 km². Its population, as of January 2023, was 651,766 inhabitants, equivalent to approximately 0.01% of the total world population. Cross-border workers from France, Belgium, and Germany account for 46% of domestic employment.

In 2023, Luxembourg's GDP per capita (based on purchasing power parity) was €131,538 (IMF). The share in the global GDP adjusted for purchasing power parity in Luxembourg is forecast to stay on the same level over the period 2023 to 2028 (Statista).

Luxembourg's economy is dominated by the services sector, which contributes to 83% of GDP. The services sector itself is dominated by the financial services industry, which accounted for 23% of country GDP and approximately 10.5% of employment.

SMEs play a critical role in Luxembourg's "non-financial business economy", accounting for 99.5% of all non-financial firms in Luxembourg. In 2018 (the latest year for which structural business statistics are available) SMEs employed approximately 66% of the labour force and generated 63% of the economy's total value added.



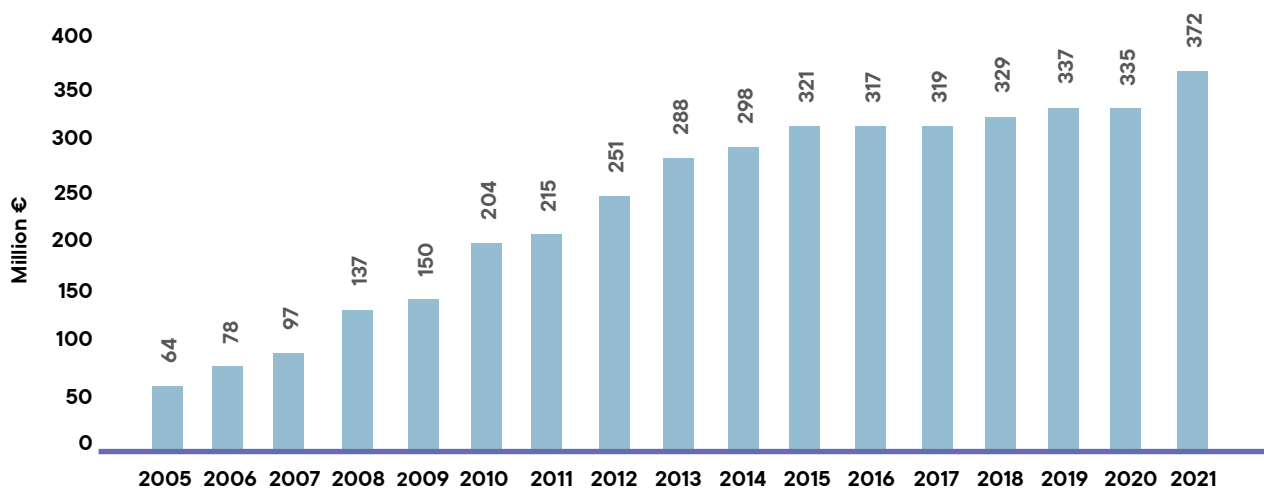
2.5 Research and Innovation Landscape

Whilst Luxembourg performs strongly in innovation, ranked 8th in the EU in the 2023 edition of the European Innovation Scoreboard, total R&D intensity dropped again to 1.02% in 2021 versus 1.13% in 2020, far below the EU average of 2.22%.

As noted in the 2023 European semester country report, Luxembourg has been unable to raise its R&D intensity, which has been on a declining trend over the past decade; 1.02% in 2021 as compared to 1.42% in 2011. This is notably in terms of business R&D intensity which has continued to decline, falling to 0.47% in 2021. This is compounded by the fact that public research system – business sector linkages remain weak and underexploited as evidenced by the low share of public expenditure on R&D financed by businesses (0.014% in 2019 compared to an EU average of 0.054%). Public support for business innovation remains marginal (0.037% of GDP, compared to an EU average of 0.196%).

However, this business R&D intensity data also reflects the differences in R&D intensity in industries and sectors and the historically low level of R&D intensity in the services sector across advanced economies.⁶

This picture is in contrast with the growth in intensity of Luxembourg public R&D (public sector and higher education), which has increased considerably, albeit stagnant in recent years with a significant progression in 2021. The increase in state spending (see Graph 1 below) on research and development increased from 64 million € in 2005 to 372 million € in 2021.



Graph 1: State expenditure in R&D in public sector

The publication of the second cycle of the Luxembourg RIS3 detailing specific national economic priority sectors facilitated the adoption of a more strategic and focused approach by the Luxembourg research and innovation ecosystem to foster innovation and economic growth.

This is best exemplified in the National Research and Innovation Strategy for Luxembourg⁷ adopted by the Government and published by the Ministry of Higher Education and Research⁸ end of 2019, where it is clearly stated that a trans- and interdisciplinary approach in public research as well as the transfer and use of research findings in priority areas should be encouraged in order to foster economic diversification in priority sectors

The four interdisciplinary research priority areas retained (see Figure 1), integrate well the national economic priority areas of the second RIS3 national strategy. Moreover, two of them, “Industrial and Service Transformation” and “Sustainable and Responsible Development” are already well placed to support the strategic economic pivot of Luxembourg from a Data-driven innovation economy to a Competitive and Sustainable economy, with its dual focus on leveraging both the digital transformation of industry and the green transition towards carbon neutrality.

6— OECD Taxonomy of Economic Activities Based on R&D Intensity, OECD Science, Technology and Industry Working paper 2016/04.

7— <https://gouvernement.lu/dam-assets/documents/actualites/2020/02-fevrier/25-mesr-strategie-recherche-innovation/mesr-strategy-research-innovation.pdf>

8— After the elections of 2023, the name changed to Ministry of Research and Higher Education

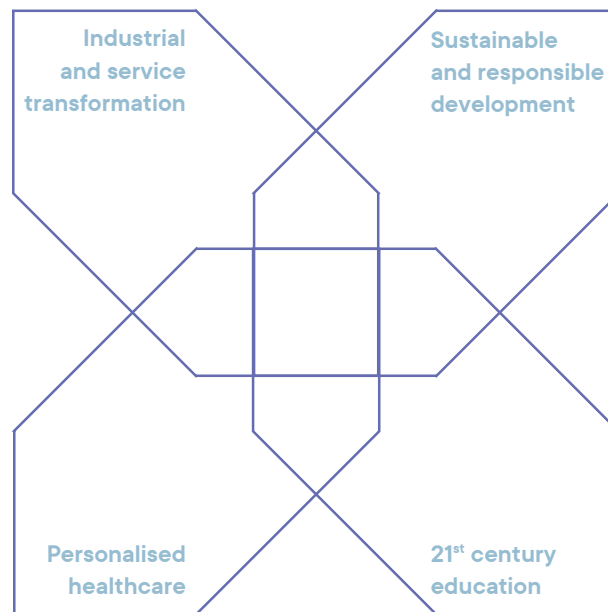


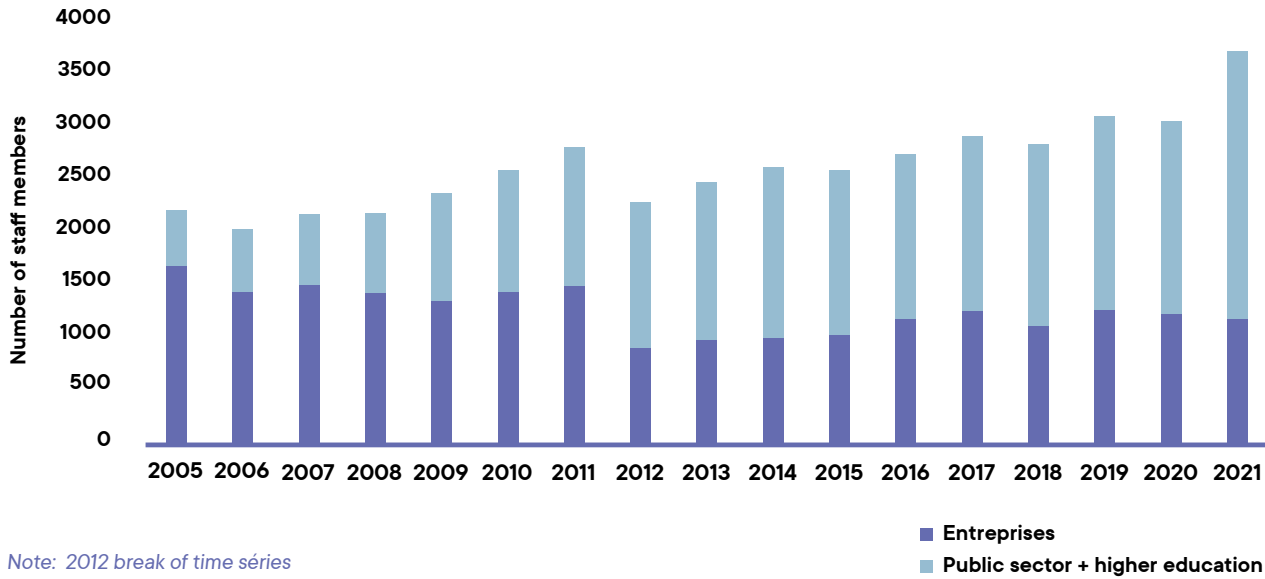
Figure 1: Interdisciplinary research priority areas in the National Research and Innovation Strategy for Luxembourg published by the Ministry of Higher Education and Research

State spending for public research activities in Luxembourg has been primarily channeled to-date through institutional funding by the Ministry of Higher Education and Research, with the competitive spending element managed by the Luxembourg National Research Fund (FNR). However, more recently, the Ministry of the Economy has directed significant resources into digital infrastructure to support the ongoing digital transformation of the Luxembourg economy. Major investments such as that into Meluxina, the national High-Performance Supercomputer, supports both public and private R&D initiatives. In addition, the Ministry of the Economy has actively shaped joint calls with the FNR for research and innovation proposals in areas of strategic economic importance such as health technologies, 5G communication technologies, industrial HPC applications and advanced materials.

This continued state research support has been reflected in the continuous increase in R&D staff levels in the Luxembourg public sector, from 531 full-time equivalents (FTE) in 2005 to 1562 FTEs in 2015 and 1832 in 2021 as detailed in Graph 2 next page).

During the second cycle of the RIS3, the Ministry of the Economy launched the Luxembourg Digital Innovation Hub (L-DIH) together with FEDIL, Luxinnovation, the Chamber of Commerce, the University of Luxembourg, the Luxembourg Institute of Science and Technology (LIST) and the FNR. This initiative was specially designed to address one key shortcoming identified during the 2nd RIS3 benchmarking analysis, namely the low rate of integration of digital technology by Luxembourg businesses. The mission of L-DIH is to actively contribute to digital transformation of SMEs in the manufacturing sector.

In addition, the Ministry of the Economy has stimulated the creation of a number of research and innovation support centres as detailed in Chapter 4.



**Graph 2: R&D staff (fulltime equivalents)
in the Luxembourg Public sector and Enterprises**

2.6 Summary

No individual ranking of a country, be it on global, European, digital, or green performance indicators, should be seen as the definitive ranking of a country with respect to research, innovation, and economic competitiveness, particularly within a place-based strengths context. However, such national scores both inform and allow for observation of trends.

From a global perspective, Luxembourg was ranked 20th in the world in the 2023 edition of the IMD World Competitiveness Ranking and ranked 21st globally amongst 132 economies in the Global Innovation Index 2023.

In terms of a specific European innovation ranking, Luxembourg was ranked the 8th best performing country amongst the EU 27 member states in the 2023 edition of the European Innovation Scoreboard (EIS) and ranked 11th amongst the broader 39 economies in Europe by the Global Innovation Index (GII).

With respect to digital competitiveness, Luxembourg was ranked 11th in the EU and 26th globally in the 2023 World digital competitiveness ranking. In the DESI 2023 dashboard for the Digital decade, Luxembourg emerges as a digital front-runner. The low level of SME's selling online and using e-invoices remains a subject of attention.

Finally, in terms of competitive sustainability and Environmental Performance, Luxembourg was ranked sixth (6th) globally in the 2022 Environmental Performance Index (EPI) amongst 180 countries and 20th globally in the 2023 Global Sustainability rankings.

A specific picture of the Luxembourgish economy and innovation ecosystem emerges from the above global, digital, and green economy benchmarking, that of an economy and innovation ecosystem that is globally competitive across a range of competitiveness indicators, a European front-runner and well positioned to drive forward a competitive and sustainable economy.

3. SMART SPECIALISATION VISION AND PRIORITIES

3.1 Third Research and innovation smart specialisation strategy: background strategic landscape

This third RIS3 leverages the very considerable planning and strategizing that has taken place across all parts of Government addressing research and innovation since the publication of the 2nd cycle RIS3 in 2017. In particular, the 2022 “National Space Strategy for 2023 to 2027”⁹, the 2021 Ministry of the Economy roadmap “Ons Wirtschaft vu Muer”¹⁰ (“Our economy of tomorrow”) addressing the challenge of building both a competitive and sustainable economy, the 2019 national data-driven innovation economy strategy¹¹, the 2019 strategy on Artificial Intelligence “Artificial Intelligence: a strategic vision for Luxembourg”, the National Research and Innovation Strategy along with elements of the National Energy and Climate Plan (PNEC). It thus integrates a comprehensive Luxembourg whole-of-economy response. The further elaboration of national strategies for data, AI and quantum technologies will further complement this response.

The reflection on the third RIS3 strategy has also benefited from the broad Nation-wide consultation process and strategic foresight activities launched by “Luxembourg Stratégie”¹². This bottom-up consultation involved over 1000 participants, including representatives from government ministries and administrations, intermediate bodies, trade unions, employers, the Chamber of Deputies, and various thematic observatories. All participated in a deep reflexion on three possible and desirable scenarios based on different levels of digitalisation and decarbonisation of the economy in order to stress test certain medium- and long-term strategic decisions to pave the way to a resilient, smart, sustainable and inclusive economy. The large public consultation allowed testing and fine-tuning of the different scenarios before finalization of the strategy in September 2023¹³. The workshops have confirmed Luxembourg ambitions in the transition towards climate neutrality by 2050 and European leadership of the digital transformation of the economy.

9— The national space strategy for 2023 to 2027, 13 December 2022, Ministry of the Economy

10— Ons Wirtschaft vu muer, Feuille de route pour une économie compétitive et durable 2025, Juin 2021 ministère de l'Économie.

11— The data-driven innovation strategy for the development of a trusted and sustainable economy in Luxembourg, May 2019, Ministry of the Economy, The Government of the Grand Duchy of Luxembourg

12— Direction de prospective stratégique du ministère de l'Économie. Established 2020.

13— <https://luxstrategie.gouvernement.lu/fr/publicationsbis/rapport-vision-eco2050.html>

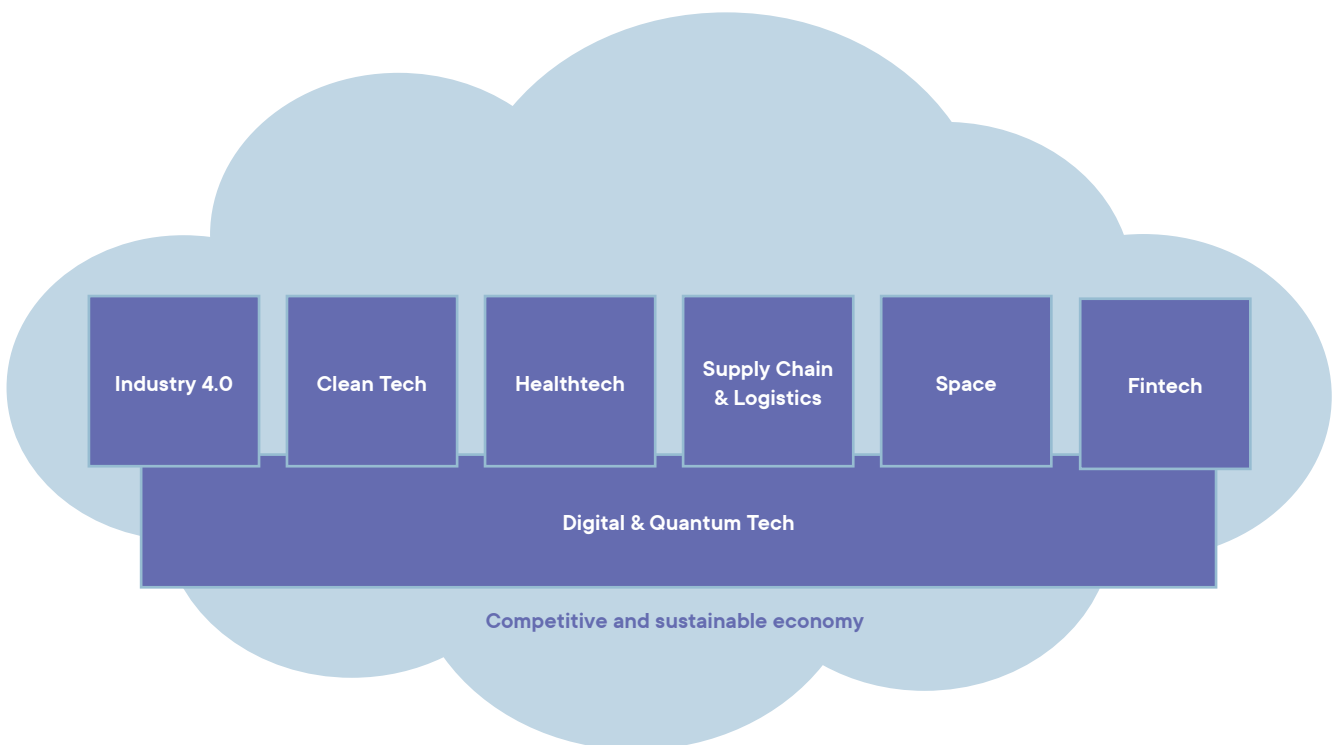
This third RIS3 is also in alignment with the European Commission policy initiatives published since 2017 on the Green Deal, Shaping Europe's Digital Future and the New Industry Strategy for Europe, including The European Green Deal communication¹⁴, A new Circular Economy Action Plan for a More Competitive Europe¹⁵, The Sustainable and Smart Mobility Strategy¹⁶, The Strategy on Shaping Europe's Digital Future¹⁷, A European strategy for data¹⁸, A New Industrial Strategy for Europe¹⁹, and An SME Strategy for a Sustainable and Digital Europe²⁰

3.2 National economic priority sectors

The second RIS3 strategy (2017) identified six priority sectors: Industry, Eco-technologies (including Circularity and Smart Mobility), Health technologies, Logistics, Information and Communication Technologies (ICT) and Space. This

was further updated in the 2021 Ministry of the economy roadmap "Ons Wirtschaft vu muer" ("Our economy of tomorrow") with the inclusion of the Financial Services sector (from the data economy perspective) and consolidated within the Luxembourg government 2023-2028 programme. This third RIS3 further updates this prioritization of strategic economic sectors to reflect the resulting dual focus on both the digital transformation of the economy and the green transition.

The updated priority sector list now includes an explicit Clean Technologies sector, the addition of Supply Chains to the sector previously entitled Logistics, a sharper focus on Digital and Quantum Technologies within the broader ICT context, and finally, reflecting the 2021 ministry of the economy roadmap "Ons Wirtschaft vu muer", considering these sectors within the lens of a Competitive and Sustainable economy.



Schematic 1 : Identified priority economic sectors 2023

An updated overview of each strategic priority sector is given in the following sections.

14— The European Green Deal COM (2019) 640

15— A new Circular Economy Action Plan for a Cleaner and More Competitive Europe COM (2020) 98

16— Sustainable and Smart Mobility Strategy COM/2020/789

17— The Strategy on Shaping Europe's Digital Future COM (2020) 67

18— A European Strategy for Data COM (2020) 66

19— A New Industrial Strategy for Europe COM (2020) 102

20— An SME Strategy for a Sustainable and Digital Europe COM (2020) 103

3.2.1 Clean technologies sector

Clean technologies are key to address the challenges of the green transition, climate change and biodiversity loss. Circularity, sustainability, and carbon neutrality are important crosscutting themes. Luxembourg is committed to being a forerunner in the twin ecological and digital transition strengthening a sustainable, resilient, and competitive economy.

With the focus of becoming a leading circular economy hub, Luxembourg continues to develop the circular economy, particularly through circular product design and the extension of product durability and lifespan, circular business models, as well as the use of circular data, notably through the PCDS. Luxembourg aims to develop resilient, low-carbon, circular value chains, with a special focus on the construction value chain and agrifood activities.

Other important subsectors are energy, water, air, soil, waste, and smart cities. Emphasis is placed on decarbonisation including energy efficiency, renewable energy electrification, energy storage, renewable hydrogen and CO₂ capture and valorization.

The notion of the twin transition further applies to the development of the automotive and smart mobility sector. Driven by its own specific mobility challenges, Luxembourg is committed to the decarbonization of transport and to the implementation of an integrated multimodal mobility system. The emergence of data-driven mobility services, including shared, cooperative, connected and automated mobility is actively encouraged, with Luxembourg positioning itself as Europe's living laboratory for intelligent mobility solutions.

Luxembourg's investments in a holistic digital eco-system, with proven capacities in high-speed connectivity, data management, storage and processing, coupled to competences in cybersecurity, reliability and trust, are strong enabling elements. In addition, sizeable investments in electric charging infrastructure and grid capacity, as well as in the implementation of hydrogen recharging stations are being undertaken. Coupled with initiatives to promote the testing, validation and adoption of electrified and alternative energy vehicles, Luxembourg is ensuring that the ambitious objectives regarding carbon-neutral mobility are being met.

3.2.2 Industry 4.0 sector

In Luxembourg, the manufacturing industry plays a major role in the economy, serving as one of the main drivers of innovation and social promotion. Some industrial players are pioneers in their business segments and have become global leaders. However, the ongoing transformation urges them to revise their traditional production processes and rethink their industrial strategies deeply.

While the Luxembourgish manufacturing industry has already begun its digital, ecological, and energy-related transformation, it remains crucial to provide continuous support to enhance its productivity while guiding its transition towards the Industry of the Future model. This necessitates a modern and ambitious industrial policy that will allow competitive exploitation of the potential offered by the deployment of digital technologies and achieve the climate goals of 2030 and carbon neutrality by 2050.

Creating an enabling framework in Luxembourg for factories of the future will require overcoming many challenges. The need for system interoperability, data sharing, cybersecurity, skills development, funding, climate, and environment considerations are some of the challenges that must be met if benefits to be gained from new manufacturing technologies and sustainable solutions. If these obstacles can be overcome, factories of the future will enable increased flexibility, productivity gains and increased competitiveness while reducing the impact on the environment and the climate.

The Ministry of the Economy is supporting the digitization of the Luxembourgish manufacturing industry at several levels:

- Investments in digital computing infrastructure (High Performance Computing capacity and capability)
- Development of a “trusted” world-class cloud and data infrastructure that will provide Luxembourg companies with wide computing and data analytics capacity
- Supporting digitisation pilots at national and European level (for example collaboration on “HPC and Big Data enabled Testbeds)
- Addressing new regulatory challenges arising from digitization of the industrial fabric (e.g., the issues relating to data generated by the multitude of new smart products, liability of autonomous systems).

In addition to these initiatives there is an ambition for Luxembourg to advance a modern and clear industrial policy addressing areas such as:

- Stimulate the sharing and exploitation of data among existing industrial actors by combining awareness of use cases, creating financial and non-financial incentives, and developing secure data platforms
- Stimulate and promote the implementation of innovative business models, especially those of the functionality economy known as “as-a-service”
- Develop and implement a concept of future industrial sites that meet the criteria for rational use of space, industrial symbiosis, and the factory of the future while facilitating the implementation of new essential activities
- Create testing and experimentation infrastructures around transversal digital technologies identified as having high potential for the future industrial sector, such as applied artificial intelligence, additive manufacturing, and digital twins
- Establish a dedicated scientific and technological park for collaborative research activities involving innovative companies, startups, and units and competence centers from the academic and public research world
- Encourage open innovation, especially between manufacturing companies and young innovative companies (manufacturing startups)
- Modernize financial and tax instruments to support manufacturing companies in their efforts toward digital transformation and ecological and energy-related transition
- Acquire new skills, particularly by promoting STEM learning from a young age, attracting foreign talents, or encouraging the implementation of upskilling or reskilling programs for the workforce
- Ensure the strengthening of skills and capacities in cybersecurity.

From a sustainability perspective, initiatives include:

- Support the decarbonization efforts of existing manufacturing companies by encouraging energy efficiency, the use of renewable energy (including green hydrogen), “Net-Zero” technologies, carbon dioxide capture and utilization solutions (where other decarbonization technologies are technical and economically not feasible i.e., the cement industry), and the integration of circular economy principles throughout the product lifecycle
- Ensure access to renewable energy by promoting the development of production, storage, and distribution infrastructure at a stable and competitive price
- Create a framework for the local production of hydrogen, the use of hydrogen and the cross-border supply of renewable/green hydrogen, develop a hydrogen infrastructure
- Create a framework that allows the introduction of dynamic electricity pricing for all industrial consumers and the remuneration of flexibility
- Simplify and modernize administrative and regulatory procedures to facilitate the implementation of activities considered priorities for the Industry of the Future ecosystem, particularly “Net-Zero” technologies facilitating the development of green industries

3.2.3 Healthtech sector

In 2008, through its “Health Sciences & Technologies Action Plan”, the Luxembourg government made the strategic decision to develop the strong growth potential of health technologies (HealthTech) to foster its innovation capabilities, sustainably diversify its economy and support the transition of its health system towards preventive and personalised medicine, i.e., a data-driven medicine model allowing to make informed decisions about individualised and optimised patient care.

Such as all industrialized countries facing the challenges associated with the aging of their populations, this transition towards a data-driven personalised medicine appears to be, also in Luxembourg, the best compromise to reconcile sustainably excellence in quality of life and quality of care for all, while controlling health system costs. It generates new market opportunities for companies in the HealthTech sector and therefore stimulates their investments in research and innovation, and their collaborations with public research.



In line with its RIS3 2017 strategy, Luxembourg has chosen to specialise within the HealthTech sector, in the technological fields of medical devices, *in vitro* diagnostics and, more particularly, in digital health. Altogether, these areas cover products/solutions used by healthcare professionals for the prevention, diagnosis, prognosis, or treatment of diseases and play a key role for the implementation of a data-driven personalised medicine. Access to the European market for these health products is regulated, subject to obtaining CE marking according to regulations (EU) 2017/745 or (EU) 2017/746.

The uptake of digital health technologies, which encompasses tools for remote monitoring and telemedicine, connected devices, digital health platforms and health apps, has been accelerated by the covid-19 pandemic. Europe's digital health market is rapidly expanding, boosting research and innovation, as well as job creation. More than ever, digital health is becoming a strategic pillar for the development of the HealthTech sector in Luxembourg, which is now made-up of about 150 companies, nearly 30% of which are developing digital health tools.

Luxembourg is therefore pursuing the ambition of becoming a leading European hub in HealthTech for the development, evaluation and entry into the European market of digital health technologies.

The innovation strategy for the development of the HealthTech sector through digital health is strongly anchored in the Luxembourg “Data-driven Innovation Strategy”. It aims to enable companies in the sector to innovate by extracting value from health data via access to the digital infrastructures and services of Meluxina, the Luxembourg National Data Service (LNDS), and a sovereign cloud; and in addition access to high-quality standardized data from cohorts of patients established as part of research projects such as NCER-PD & Clinnova initiated by the Luxembourg Center for Systems Biomedicine of the University of Luxembourg and the Luxembourg Institute of Health, in collaboration with Luxembourg hospitals and international partners.

Luxembourg also strives to put in place the necessary measures to offer HealthTech companies the conditions they need for the development of the entire innovation value chain in digital health technologies, including their “scale-up” and their adoption by players of the national healthcare system.

3.2.4 Supply chain and logistics sector

Over the past decade, Luxembourg has consistently enhanced its position as an intercontinental and multi-modal logistics hub in Europe for value-added logistics, such as contract logistics and supply chain management. To ensure sustainable growth in its logistics and supply chain sector, continued support is necessary to develop Luxembourg as an innovative, efficient, and eco-responsible European platform for contractual logistics, particularly for certain product types requiring specialized logistics services.

Dealing with various disruptions related to geopolitical tensions, pandemics, or extreme climate events, among others, has highlighted the critical importance of expertise in global procurement operations. Therefore, the ongoing efforts aim to develop and position Luxembourg as an excellent platform in digital procurement. Additionally, support for end-to-end supply chain monitoring will be provided to enhance resilience and agility.

To achieve these goals, companies will require assistance in their efforts toward the digital transformation and decarbonization of their logistics and transport activities. In this context, we intend to promote the implementation of new technologies as well as green solutions in the fields of logistics and supply chain management.

Concerning innovation and the digital transformation of companies, the increased use of data with artificial intelligence will enable the sector to improve processes, save costs, and become more sustainable. Big Data and predictive analytics represent significant potential for end-to-end visibility, demand forecasting, and inventory management. As logistics and supply chain involve numerous partners, open innovation and collaborative projects will be supported, particularly to stimulate data sharing. Furthermore, the internet of things, blockchain, robotics, and automation are reshaping logistics processes along the entire logistics value chain, from warehouse management to end-to-end traceability, last-mile delivery, and urban logistics.

Efforts toward decarbonization will also be supported, for instance through coordinated urban distribution solutions to address congestion in city centers or environmentally friendly delivery modes. This will create the demand for new, innovative, and sustainable e-fulfillment and last-mile delivery solutions, such as setting up urban consolidation hubs. Furthermore, with the expected emergence of circular business models, new business opportunities will arise within the logistics sector, in order to meet the needs of services to keep materials and products in circulation.

Finally, efforts will be intensified to attract innovative logistics startups offering digital solutions for supply chain management.



3.2.5 Space sector

Luxembourg has a growing space eco-system. For more than three decades, Luxembourg has been at the forefront of commercial and co-operative initiatives that have shaped a vibrant space economy. Today, the Grand Duchy is home to approximately 75 companies and research labs. The space sector's contribution to the nation's GDP is among the highest ratios in Europe. Luxembourg's first foray into space came in 1985, with the creation of the Société Européenne des Satellites (SES), a landmark for satellite telecommunications and a global leader in this sector today. Further space related services and businesses have developed alongside SES giving birth to an entire space industry in Luxembourg.

A second, important factor in positioning the country in the space sector was Luxembourg's accession in 2005 to the European Space Agency (ESA). From then on, the space industry in the Grand Duchy has continued to grow and diversify, with three identifiable segments:

– **The space segment:**

manufacturing of satellite and instrument structures, system integration of micro-satellites, electric propulsion for satellites, robotic payloads, in-space manufacturing, composites, RF payloads, FPGA.

– **The ground segment:**

ground stations development, mechanical and electrical ground support equipment, communication networks, operations.

– **The service segment:**

teleport services, satellite-based media and telecommunications services, risk management services, data analytics, environmental applications and services, aeronautical information services, analytics platform.



Over the past year, Luxembourg has redefined its national space strategy, to be sustainability focused, revolving around four sustainability pillars.

— **Resources for space.**

Launched in February 2016 and led by the Luxembourg Space Agency (LSA), the SpaceResources.lu initiative positions Luxembourg as a pioneer in the exploration and utilization of space resources. With this initiative, Luxembourg has defined a framework to promote and support the sustainable exploration and utilization of resources from ‘celestial bodies’ such as the Moon and asteroids. The Grand Duchy is the first European country, and the second worldwide, to offer a legal framework on the exploration and use of space resources. The European Space Resources Innovation Centre (ESRIC) was established in Luxembourg, in November 2020 powered by LSA, ESA, and LIST. ESRIC aims to become an internationally recognised centre of expertise for issues related to the use of space resources for human and robotic exploration, as well as for a future in-space economy.

— **Economic sustainability as well as human resources and innovation, space development requires serious financial input.**

Luxembourg’s unique cross-border expertise in international finance and the development of dedicated funding resources, have been crucial factors in the creation of a sustainable space industry. Together with a group of private and public investors, the Luxembourg Government has invested a stake in Orbital Ventures, an investment fund focused on early-stage companies engaged in space activities. At the European level, Luxembourg contributes to ESA programs, which support the development of technology and of products, services, and infrastructure in areas such as Telecommunications and Earth Observation. The national space program (LuxIMPULSE) implemented in partnership with ESA, also plays a key role in financing groundbreaking technological developments with market potential.

— **Sustainability in space.**

The new dynamics witnessed in the space sector over the past years, added to the intensive use of Earth orbits foreseen for the coming years, is leading to an increase in the risks of in-orbit operations and a proliferation of space debris. It is therefore urgent to promote a responsible and sustainable use of space. Luxembourg’s commitment is materialized at both national and international levels, and through the development of national competencies in space traffic management and in-orbit services.

— **Sustainability on earth.**

LSA targets segments which can contribute to some of the sustainable development objectives, with a particular focus on those relevant to Luxembourg’s commitments with regards to cooperation and humanitarian action. The Luxembourg Space Agency Data Center was created in 2019 to support businesses in Luxembourg with reliable, fast, and intuitive access to data streams from the European Copernicus Earth Observation programme.

3.2.6 Fintech sector

Luxembourg is one of the leading financial centers within the EU. Luxembourg offers a diverse range of financial services with cross-border, multi-jurisdictional expertise coupled with technology and innovation in the following areas:

– **Asset Management:**

As the 2nd largest investment fund center worldwide and number 1 in Europe, Luxembourg-domiciled investment funds are distributed in 80 countries, accounting for 56% of the global cross-border distribution of investment funds. Besides European UCITS funds, that target retail and institutional investors, the financial center is also home to private equity (PE) and venture capital funds with operations of 19 of the 20 largest PE houses located in Luxembourg.

– **Banking:**

Luxembourg is home to over 120 banks that run pan-European and global activities such as private and corporate banking, fund administration and custody, wealth management and treasury services.

– **Insurance:**

Over 77 insurance and 203 reinsurance companies serve the European market with life insurance, re-insurance, and non-life.

– **Capital Markets:**

The Luxembourg Stock Exchange is the global leader for international securities listings and runs the world's number one Green Exchange.

– **Payments:**

The financial center is home to leading international players that have chosen Luxembourg as their European Payments Hub.

In parallel to this, a Fintech sector has emerged over the course of the last decade. This growth was significantly propelled by the establishment of the LHoFT (Luxembourg House of Financial Technology) in 2016. This local fintech hub fosters connections between its members and the broader international fintech ecosystem. To date, the sector comprises more than 220 firms, engaged in domains such as regulatory technology (Regtech), insurance technology (Insurtech), blockchain, payment solutions, and digital investments. These companies cater to the global service providers located in the Luxembourg financial centre or offer regulated financial services across Europe to a diverse client base.

Numerous entities, including established financial institutions, are leading research and development initiatives in Luxembourg, with such efforts being strengthened by collaborative opportunities with public research institutions. In line with this, the University of Luxembourg has introduced the SnT Finnovation Hub, a dedicated initiative where 11 distinct research groups address Fintech-related subjects.

Alongside the development of Fintech, Luxembourg has implemented a comprehensive strategy for climate finance. This strategy aims both to make a significant contribution to the global battle against climate change and to solidify Luxembourg's position as a global hub for climate finance. The financial center serves as a premier international venue for sustainable finance, facilitating various initiatives including responsible investment funds, blended finance, green bond issuances, and ESG (Environmental, Social, and Governance) fund labelling.



3.2.7 Digital and Quantum technologies sector

Luxembourg has recently bolstered its outstanding IT infrastructures by implementing a hybrid HPC²⁰ (CPU and GPU). By ramping up the Luxembourg National Data Services²¹ (LNDS) as well as the Luxembourg GAIA-X²² hub, specialized data economy related services are available for the public and private sectors as well as for research entities.

The outstanding infrastructure and the available services paired with national call-based innovation funding scheme and the participation of the Luxembourg entities in Digital Europe Program calls, should speed-up innovation in Artificial Intelligence through Machine Learning, Federated Machine Learning and creation of sectorial Large Language Models.

To further facilitate and secure the provisioning of services from Luxembourg companies, including specifically SME and start-ups, towards their national and international customers, Luxembourg will launch in 2024 a national disconnected google cloud²³, which combines national sovereignty and cloud excellence. The creation of specialized cloud services and cloud applications for SME will be co-financed by national funding schemes and European DEP calls. These services and application should also grant SME access to the advantages of the cloud including resilience, data portability, and data interoperability.

Luxembourg also participates through national companies and the Luxembourg House of Cybersecurity to the IPCEI CIS²⁴. This IPCEI aims at creating a European Cloud stack facilitating roaming of services between compatible cloud providers including cloud edge nodes for latency critical data processing respectively to provide high value-added services via a secure 5G network. Within the IPCEI-CIS, Luxembourg will co-finance with national state aid schemes the development of collaborative and open-source Security Operation Center (SOC) solutions, collaborative CSIRT cloud incident-response tools and the creation of a first open cybersecurity dataspace. Calls and multi-country joint-actions on the level of the ECCC²⁵

will co-finance the creation of innovative collaborative cybersecurity solutions to capitalize the resulting synergies in the context of the upcoming European legislation like NIS2²⁶ and DORA²⁷ and create unattended AI based cybersecurity tools for SME.

Due to the importance of cryptography for security protocols and trust, Luxembourg will further develop, next to the European flagship program, innovation in quantum key distribution technologies and associated services. In addition, Luxembourg also aims to acquire, in the context of a EURO-HPC call, a quantum computer capability which will be integrated with its national HPC.

As Luxembourg is aware of the complexity and the high degree of entanglement of the existing and upcoming EU regulations concerning cybersecurity, digital markets and the data economy, Luxembourg will continue to invest, parallel to European programs, with the intention to further democratize the access of SME to skills, expertise, and certification²⁸.



20—<https://www.luxprovide.lu/>

21— <https://www.lnds.lu/>

22— <https://www.gaia-x.lu/>

23— <https://www.luxconnect.lu/clarence-joint-venture-proximus-luxconnect-disconnected-sovereign-cloud/>

24— <http://www.ipcei-cis.eu/>

25— https://cybersecurity-centre.europa.eu/index_en

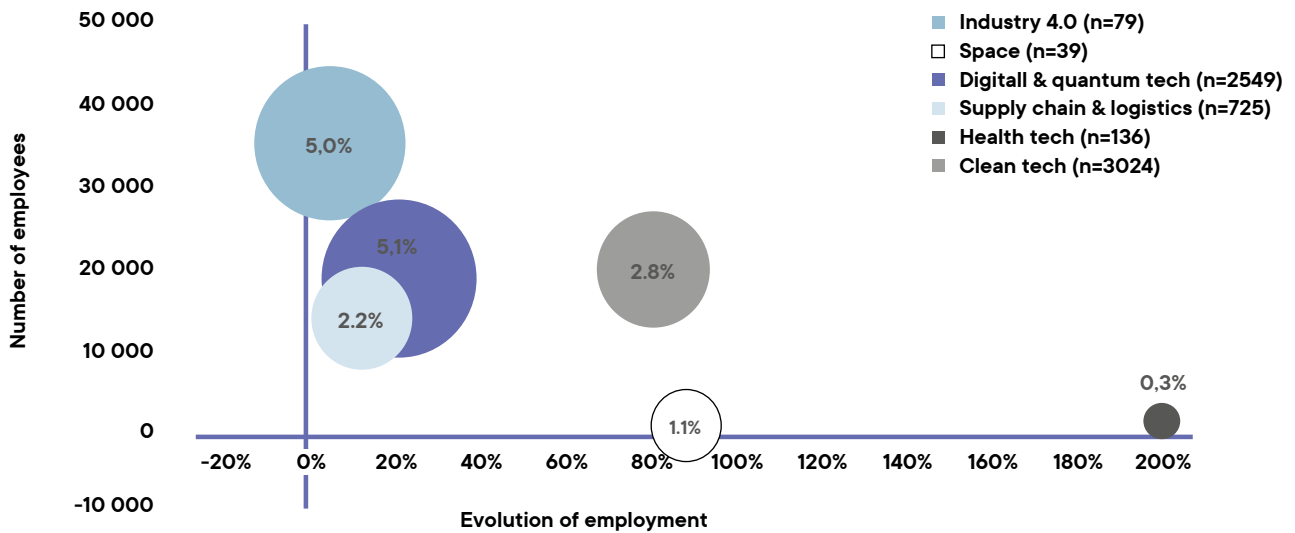
26— <https://digital-strategy.ec.europa.eu/en/policies/nis2-directive>

27— <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0595>

28— EU certification schemes

3.3 Smart Specialisation priority sectors

This new smart specialisation prioritisation process starts from the priority sectors of the 2nd RIS3 and includes an analysis of the importance of the different economic sectors on employment, gross added value, and number of enterprises. A summary of this analysis detailing the economic impact of the different national economic priority sectors is presented in Graph 3 below.



Graph 3: Impact analysis of the Ministry of the Economy priority sectors on employment and gross added value

Notes: n = number of companies

The evolution of employment is calculated between 2014 and 2019.

The size of the bubble and percentage figure within represents the part of the sector in the national economy in terms of added value 2019

Data supplied from Statec, governmental agencies, and European databases.

For the cleantech sector, the Statec data environmental goods and services accounts (EGSS): have been used (this covers not only core innovative clean tech companies).

The 2019 data are the most recent available for all the sectors concerned.

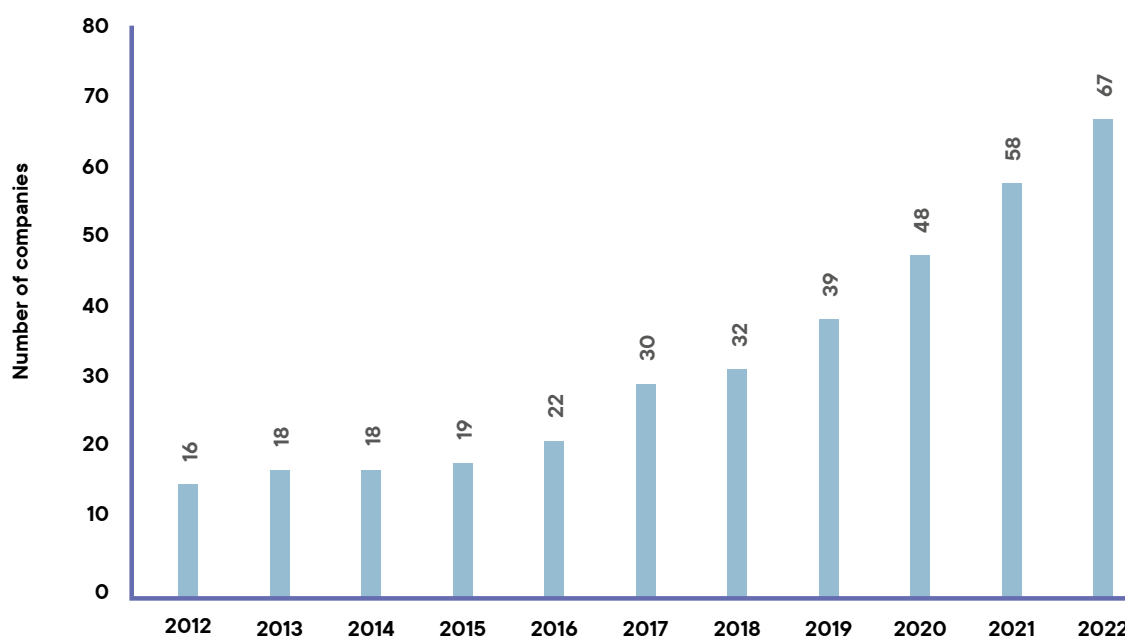
It is important to underline that between 2014 and 2019, all analysed sectors have grown in terms of number of employees.

The three fastest growing sectors are those of Healthtech (200 %), Space (89 %), and Cleantech (81 %).

In parallel, the logistic sector’s employment has increased by some 12 % from 2014 to 2019.

In terms of gross added value, Digital and Quantum Tech, Industry 4.0 and Cleantech are the largest sectors with respectively 5.1 %, 5.0 %, and 2.8 % of the national gross added value of 61.8 bn €.

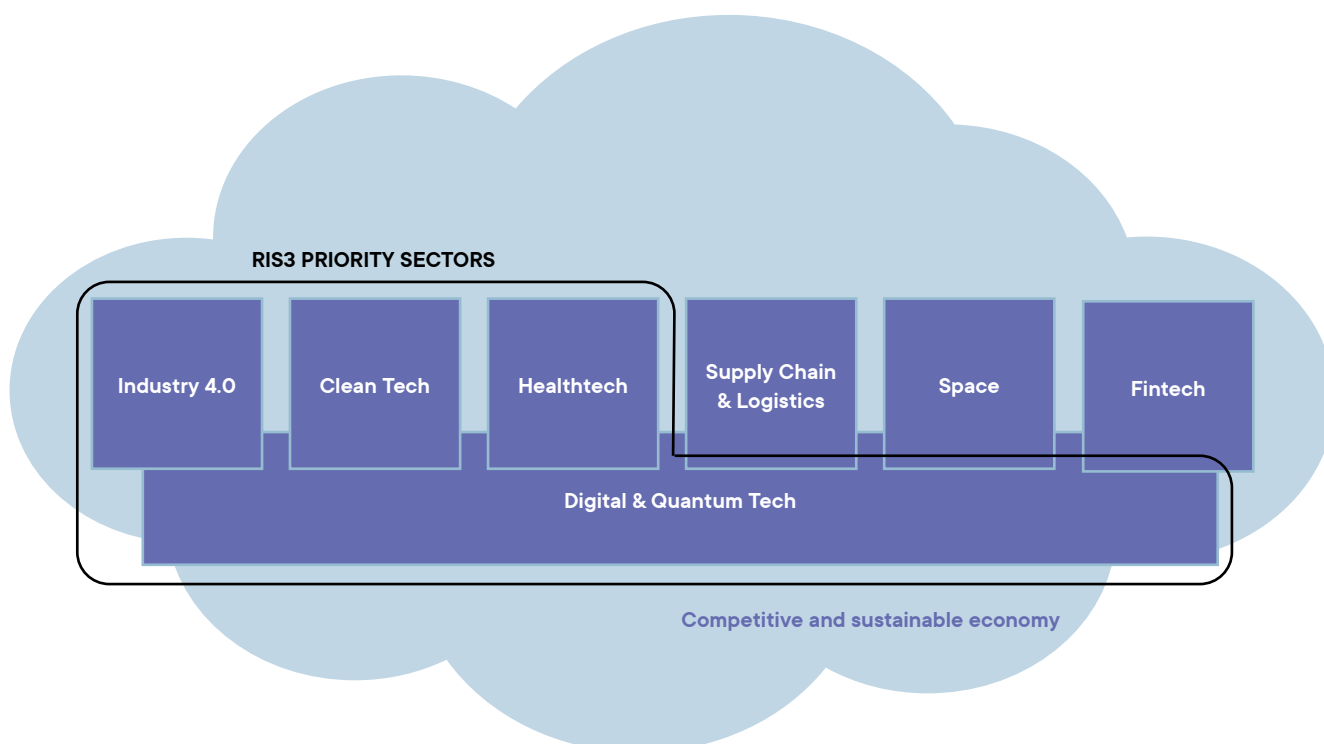
Of particular note, is the success of key industrial policies growing newly emerging sectors such as that of the Space sector with the number of active companies growing from 22 in 2016 to 67 in 2022 (see Graph 4).



Graph 4: Number of companies in the Space sector

To maximize the impact of the ERDF funds the final selection of Smart Specialisation priority sectors comprises Industry 4.0, Cleantech, Healthtech and the Digital and Quantum Tech sector (Schematic 2). As in the past, the choice of industry 4.0 reflects the competitive need to accelerate the digitalisation of SME's and industry highlighted in the

2023 European Commission Digital Economy and Society Index (DESI) benchmarking and the current IMD world digital competitiveness report. The choice of these sectors is in line with the priority sectors of the 2nd RIS3 and are designed to strengthen the impact of the ERDF funds.



Schematic 2: Smart specialisation priority sectors

4. SMART SPECIALISATION POLICY INSTRUMENTS

4.1 Luxembourg innovation delivery instruments supporting knowledge generation, diffusion and exploitation

The Luxembourg innovation delivery instruments are designed to accompany the ongoing strengthening of existing high-tech industry STI (Science, Technology and Innovation) capability and support the knowledge absorption and generation necessary for the diversification of the Luxembourg industrial tissue.

These instruments include:

R&D incentives

The innovation fund, created in 2009, provides direct R&D incentives²⁹ to support research and innovation:

- Research and Development projects and programmes
- Feasibility studies
- Innovation aid for SME's
- Aid for young innovative enterprises
- Aid for process and organisational innovation
- Aid and support for research infrastructure and Innovation clusters

The aid can be grants or repayable advances for all instruments and for certain interest bonus, loans, guaranties or equity investments.

Support for STI talent

(mobility, global talent attraction, and industry PhD schemes)

- Of particular note, the FNR operates the prestigious ATTRACT, PEARL and CORE programmes to attract outstanding researchers to Luxembourg.
- The KITS programme aims to attract and integrate highly skilled professionals in the area of knowledge transfer.
- The INTER MOBILITY programme promotes the exchange of key knowledge and technological know-how between research groups of the Luxembourg public research institutions and those abroad.

29— Incentive schemes of the modified law of 17 May 2017 to promote research, development and innovation.

Special support for start-ups

- Fit 4 Start programme
- Scale-up support pilot programme
- Support programmes for innovation, digitisation and sustainability
- Fit 4 Innovation
- Fit 4 Innovation - Health Tech Market
- Fit 4 Digital
- Fit 4 Sustainability
- Klimapakt fir Betriber
- SME packages

Public private research and innovation partnerships

- Specific FNR support schemes (BRIDGES, Industrial fellowships, IPBG, JUMP, and KITS) have been established for Luxembourg public research performers to promote public private partnerships with Luxembourg industry.
- Joint Calls with FNR (BRIDGES-programme) in the specific priority economic sectors (Healthtech, HPC, Defence (Space and Lightweight materials)) reinforce PPP.
- Furthermore, the innovation fund provides specific incentives for private sector companies entering public private research and innovation partnerships.
- Luxembourg's research community, the Luxembourg Government, and NVIDIA have created a joint AI laboratory in Luxembourg.

Competence centres

- Sustainable Composite Materials and Manufacturing Innovation Center (SCMM)
- Centre de Ressources des Technologies pour l'Innovation dans le Bâtiment G.I.E. (CRTI-B)
- Neobuild (innovation hub in the sustainable construction area)
- Sustainability Innovation Hub (SIH)
- National Competence Centre in High-Performance Computing (SCNCC)
- National Cybersecurity Competence Centre Luxembourg (nc3)
- Computer Incident Response Center Luxembourg (CIRCL)
- Luxembourg Digital Innovation Hub (manufacturing sector) (member of E-DIH network)

In addition to these technology Competence Centres, there are also two training competence centers:

- University of Luxembourg Competence Centre (training)
- Digital Learning Hub (DLH)³⁰.

Industry clusters

In 2023, the following clusters have been coordinated by Luxinnovation, the national innovation agency :

- Automobility cluster
- Healthtech cluster
- Creative industries cluster
- Cleantech cluster
- Materials & manufacturing cluster
- Wood cluster

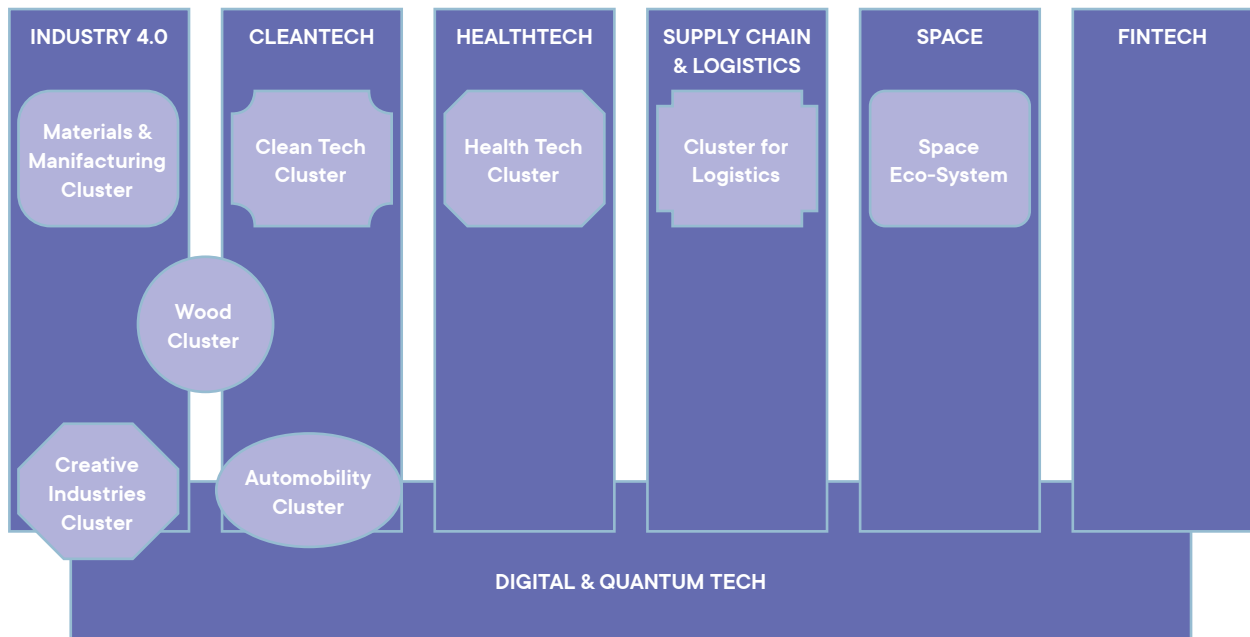
Two additional clusters are coordinated by relevant sectorial organisations:

- Luxembourg Maritime Cluster
- Cluster for Logistics

These clusters are supported by the Luxembourg Innovation Fund.



30— <https://dlh.lu/>



Schematic 3: Mapping of industry clusters to priority economic sectors

The following schematic positions the industry clusters relative to the national economic priority sectors:

Incubators

(including start-up support services, coaching, ...)

Luxembourg public and private sources support several incubators:

- Technoport
- Nyuko
- House of Biohealth (biotech, cleantech and ICT)
- Neobuild
- Luxembourg House of Fintech (LHoFT)
- 1535°C (creative hub)
- Innovation Hub Dudelange (cleantech)
- House of Start-ups
- Luxembourg City Incubator
- Paul Wurth InCub
- Tomorrow Street
- Automobility Campus Bissen

Seed and venture capital funds

- Société Nationale de Crédit et d'Investissement (SNCI)
- Eurefi
- Digital Tech Fund
- Luxembourg Future Fund (LFF)
- Luxembourg Future Fund 2 (LFF 2)
- Orbital Ventures Fund (space)
- private funds: Mangrove Capital Partners, Expon Capital, ...

Techno-economic intelligence service

- This service is provided by the national innovation agency Luxinnovation, supported by the Ministry of the Economy.

Support for participation in international competitive STI programmes

- ESA
- Horizon Europe
- Digital Europe
- EIT
- Interreg
- FEDER (ERDF)

Tax credits for investments³¹

- in digital transformation projects
- in ecological and energy transition projects

31– <https://guichet.public.lu/en/entreprises/fiscalite/bonification-impot-investissement.html>

4.2 Ongoing policy experimentation and optimization

Since the second RIS3 in 2017, Luxembourg has delivered a large range of innovative and efficient policy instruments supportive to different priority sectors. These include among others :

—Luxembourg Future Fund 2:

On March 2023, the Ministry of Finance, the Ministry of the Economy, the National Credit and Investment Company (SNCI) and the European Investment Fund (EIF) launched the Luxembourg Future Fund 2 (LFF 2) with a total capital of 200 mio €. The LFF 2 fund will support investments that further stimulate the diversification and sustainable development of the Luxembourg economy. The scope of LFF 2 covers venture capital and will be extended to hybrid debt-equity investments.

—Fit 4 Sustainability:

This is a support and co-financing programme that offers businesses the possibility of having an environmental impact assessment carried out on their activities, followed by various recommendations for reducing the environmental impact. Topics include lower energy consumption, reduced carbon footprint and reduction of waste. The Fit 4 Sustainability programme was launched in 2022 and is open to all Luxembourg companies, regardless of their size or sector of activity.

—Fit 4 Innovation HealthTech market:

This programme was launched in March 2023 and designed to provide HealthTech companies with the best possible support in bringing their products into line with the requirements of the (EU) 2017/745 (MDR) and (EU) 2017/746 (IVDR) regulations, at an early stage in the development of their product or service.

—Data Innovation Strategy:

In May 2019, the Ministry of the Economy published the “Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy”. The aim was to lay out the vision of digitalisation for priority economic development sectors to boost productivity and sustainable development across the whole Luxembourg economy. It addressed the assets and policies the Ministry of Economy would leverage in order to support the further emergence of a trusted data-driven economy in Luxembourg and accelerate the digital transformation of its strategic sectors.

—Start-ups:

In June 2023, a new roadmap “From Seed to Scale” was launched aimed at consolidating elements of the Luxembourg start-up ecosystem and to put in place specific measures for scale-ups to build a strong ecosystem for innovative entrepreneurship.

—Sustainable Composite Materials and Manufacturing (SCMM) Innovation Centre:

This centre was launched in December 2022 and hosted by LIST with the support of the Ministry of the Economy, the Ministry of Higher Education and Research and several industry players, who co-financed the initiative with a budget of over 16 mio €. Its aim is to develop sustainable, ultra-light composite materials suitable for a range of mobility applications in the rail, space, aeronautics, and future urban air mobility sectors, in order to combat the effects of climate change and achieve net-zero emissions targets by 2050.

—Data Exchange platform:

Luxembourg National Data Service (LNDS), launched in December 2023, is an economic interest group created by the Luxembourg Government, to implement Luxembourg’s strategies in research, innovation, and digitalisation. LNDS enables value creation from secondary use of data, for public and private partners and supports the sharing and re-use of public sector data, in a trustable manner. <https://www.lnds.lu/>

—Competence Centre for High-Performance Computing:

Since 2019, Luxinnovation, the University of Luxembourg and LuxProvide jointly manage the Luxembourg National Competence Centre for High-Performance Computing (CCHPC)³² which was set up as part of the EuroCC project, co-financed by the EU and by the Ministry of the Economy. The centre is a one-stop shop for Luxembourg companies, offering personalised professional support and technical expertise for setting up HPC projects.

32—<https://supercomputing.lu/>

—**Ons Wirtschaft vu muer:**

In June 2021, the Ministry for the Economy set up a vision and a roadmap for a competitive and sustainable economy, for the Grand Duchy of Luxembourg in the coming years “Ons Wirtschaft vu muer”. It addresses the industrial innovation policies, regulation, financial instruments and actions necessary to support the rapid emergence of a competitive, resilient and sustainable economy in Luxembourg. It sets out a number of Pilot Actions over the short and medium term that both address the need to implement immediate recovery measures for the economy whilst at the same time accelerating the economy in a strategic direction for the future.

LSA :

The Luxembourg Space Agency (LSA)³³ officially launched operations in September 2018 with the goal of promoting the further economic development of the Grand Duchy’s space industry by attracting businesses, developing human resources, providing innovative financial solutions and supporting educational and research infrastructure. LSA will not directly conduct research or launch missions, but foster collaboration between key players in the space industry, with the core mission of accelerating the emergence of innovation-driven businesses.

ESRIC:

The European Space Resources Innovation Centre (ESRIC)³⁴, at the Luxembourg Institute of Science and Technology (LIST), launched in 2020, is the world’s first innovation centre entirely dedicated to space resources. The centre which already set a record of developing the first-ever space resources start-up support programme, has been tasked by

the European Space Agency (ESA) with conceptualising a Space Resources Accelerator devoted to the lunar economy, in collaboration with a network of partners.

Orbital Ventures fund:

This in Luxembourg anchored fund is created in 2020 and targets early-stage investment opportunities in areas such as space-based telecommunications network and services, geospatial location-based services. The European Investment Fund, international corporate, institutional and private investors, as well as public bodies such as the Luxembourg Ministry of the Economy and the state investment bank SNCI.

Joint calls:

Since 2021, the Ministry of the Economy has launched joint calls together with FNR in specific priority economic sectors (e.g. HealthTech, High Performance Computing, Defense (Space and Lightweight materials)) in order to promote private public partnerships (PPP) and stimulate knowledge transfer.

33— <https://space-agency.public.lu/en.html>

34— <https://www.esric.lu/>

4.3 Smart specialisation investment programme

The Luxembourg RIS3 uses, in particular, R&D incentives to support public research projects in the RIS3 priority sectors.

In parallel, support is provided to the Ministry of Economy by Luxinnovation, the national agency for research and innovation in charge of the promotion and stimulation of related innovation activities in the private sector.

The competence centres and clusters are also valuable supports for the projects in the RIS3 priority sectors.

The ERDF programme “Investing in a smarter and greener Europe” for 2021-2027 was approved by the European Commission on the 20th of December 2022. The programme has a global budget of 49.22 million € of which 21.08 million € from the European commission.

PRIORITY AXIS		TOTAL BUDGET IN MIO €	ERDF CO-FINANCING IN MIO €
AXIS 1	A MORE COMPETITIVE AND SMARTER EUROPE BY FOSTERING INNOVATIVE AND SMART ECONOMIC TRANSFORMATION AND REGIONAL ICT CONNECTIVITY	22.59	9.03
AXIS 2	A GREENER, RESILIENT, AND LOW-CARBON EUROPE MOVING TOWARDS A NET-ZERO CARBON ECONOMY	10.59	4.24
JTF	JUST TRANSITION FUND	13.36	6.68
AT	TECHNICAL ASSISTANCE	2.68	1.13
TOTAL		49.22	21.08

Source: Ministry of the Economy

ERDF programme 2021-2027

Axis 1 Smarter Europe:

A more competitive and smarter Europe by fostering innovative and smart economic transformation and regional ICT connectivity

1. by developing and improving research and innovation capabilities and the use of cutting-edge technologies,
2. by harnessing the advantages of digitization for the benefit of citizens, businesses, research organizations and public authorities,
3. by enhancing sustainable growth and competitiveness of SMEs and job creation in SMEs, including through productive investments.

Axis 2 Greener Europe:

A greener, resilient, and low-carbon Europe moving towards a net-zero carbon economy, by promoting a clean and fair energy transition, green and blue investments, the circular economy, climate change mitigation and adaptation, risk prevention and management, and sustainable urban mobility

1. by promoting energy efficiency measures and reduce greenhouse gas emissions,

2. by promoting renewable energy in accordance with Directive (EU) 2018/2001, including the sustainability criteria set out therein.

Just Transition Fund - JTF

The JTF shall contribute to the single specific objective of enabling regions and people to address the social, employment, economic and environmental impacts of the transition towards the Union's 2030 targets for energy and climate and a climate-neutral economy of the Union by 2050, based on the Paris Agreement.

In Luxembourg, the JTF is supporting several activities:

1. investments in the deployment of technology as well as in systems and infrastructures for affordable clean energy, including energy storage technologies, and in greenhouse gas emission reduction;
2. investments in renewable energy in accordance with Directive (EU) 2018/2001 of the European Parliament and of the Council, including the sustainability criteria set out therein, and in energy efficiency, including for the purposes of reducing energy poverty;
3. investments in smart and sustainable local mobility, including decarbonisation of the local transport sector and its infrastructure.

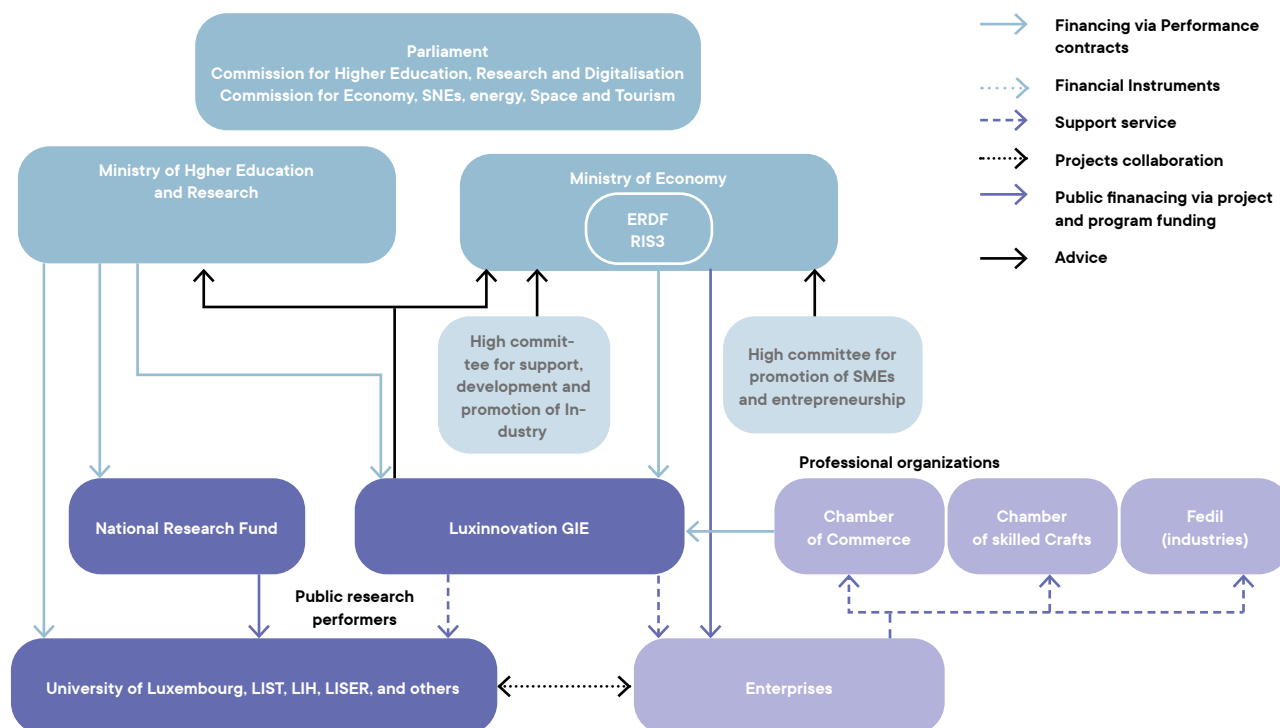
5. SMART SPECIALISATION GOVERNANCE

In the framework of the Luxembourg S3, the formal authority resides within the Ministry of the Economy. However, the RIS3 governance is characterised by the interaction of several different instances of coordination and consultation that include the four principal actors of the Luxembourg innovation economy: government, industry, public research and education actors, and civil society. This chapter details the Luxembourg innovation governance landscape, the resulting RIS3 governance structure along with the monitoring and evaluation process in place.



5.1 National innovation governance landscape

Luxembourg has put in place a governance system that facilitates the management of the national research and innovation in a dynamic, multidisciplinary and holistic manner. The Ministries of the Economy and of Higher Education and Research are the primary actors concerned with the management of the research, development and innovation strategy of the country. The interactions between these ministries and other instances of decision are shown in the schematic below:



Schematic 4 : The national research and innovation governance landscape

The Luxembourg parliamentary commissions for Higher Education, Research and Digitalisation and for Economy, SMEs, Energy, Space and Tourism follow the work of the government at the level of economic diversification and research and innovation. In its coordination and elaboration of priorities, the government uses different inter-ministerial platforms, which include representatives of the business world along with professional federations and business chambers. The two principal platforms in this regard are the High Committee for the Support, Development and Promotion of Industry and the High Committee for the Promotion of SMEs.

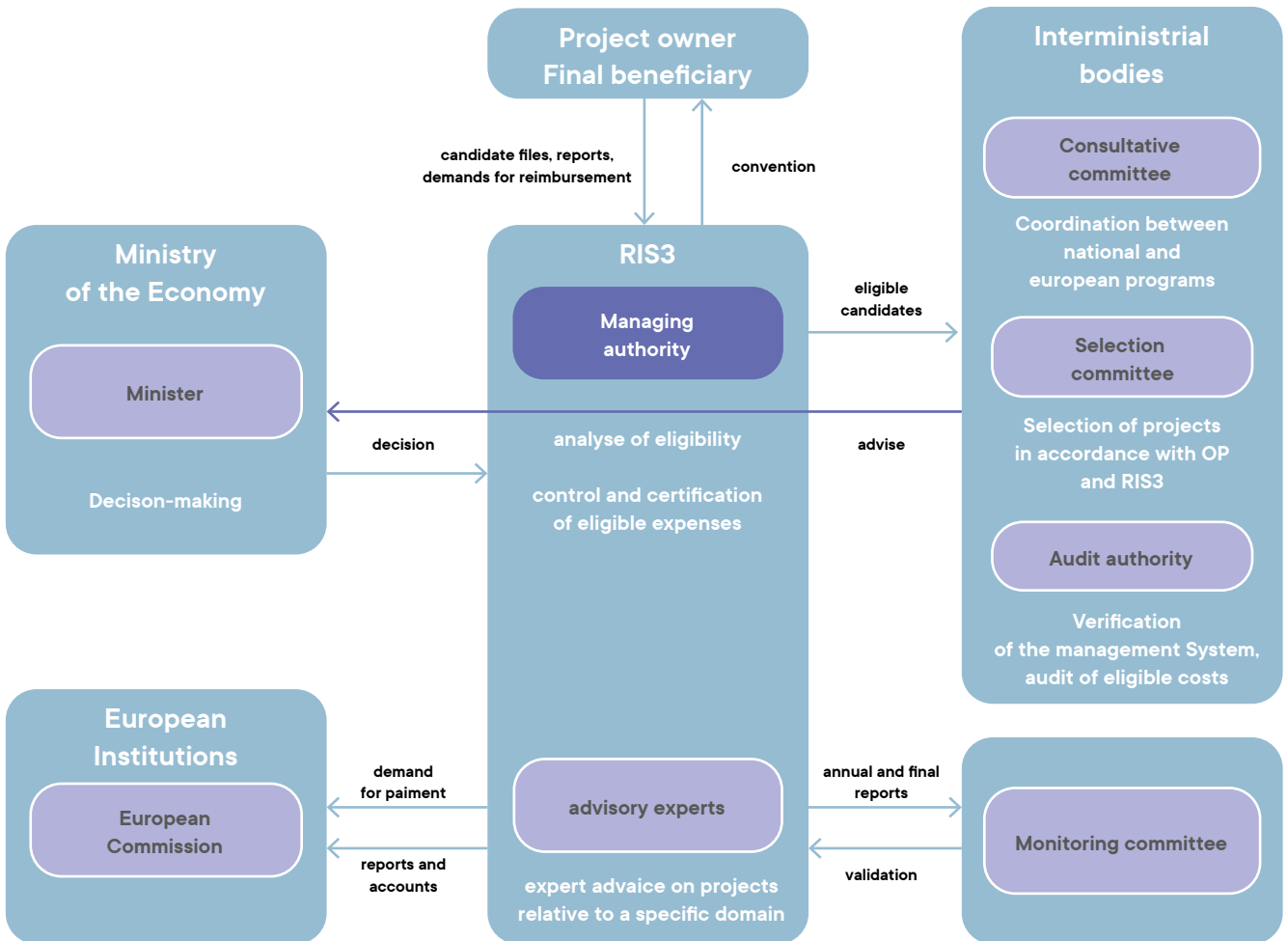
The High Committee for the support, development and promotion of industry has as mission to stimulate the industry sector. It is composed of members of government and experts from the world of industry. The committee can perform SWOT analyses of the Luxembourgish industry, formulate recommendations and action plans, propose new opportunities for industry and review national industrial policy in light of new industrial challenges that Luxembourg has to face.

The objective of the High Committee for the Promotion of SMEs is to discuss and propose measures to stimulate entrepreneurship, company creation and stimulate the development of the SME sector. It is composed of representatives of the Chamber of Commerce, the Chamber of Skilled Crafts, the Federation of Artisans and the Confederation of Commerce. It is presided by the Minister of the Economy.

Regular performance evaluations of the public research actors and relevant government research and innovation agencies (FNR, Luxinnovation), linked to performance contracts, allow the relevant Luxembourg authorities to follow the execution of their research and innovation strategy, and to take any corrective action deemed necessary. The performance contracts facilitate the focusing of resources on key operational targets.

5.2 Smart specialisation governance structure

The Ministry of the Economy has primary responsibility for the development and execution of the European Regional Development Fund (ERDF) Luxembourg operational programme in conformity with relevant European regulations. The managing authority for the implementation of the Luxembourg RIS3 lies within this ministry. The governance structure and decisional flow is shown in the schematic below.



Schematic 5: The smart specialisation governance structure

The consultative committee provides a forum to coordinate the development of EU strategies and priorities amongst the managing authorities of the European Regional Development Fund (ERDF), the INTERREG programmes, the European Social Funds (ESF), the European Agricultural Fund for Rural Development (EAFRD), the Internal Security Fund (ISF), the Instrument for Financial Support for Border Management and Visa Policy (BMVI), the Asylum, Migration and Integration Fund (AMIF), and the Recovery and Resilience Facility (RRF) in Luxembourg.

The coordinator of the committee is the ERDF managing authority in the Ministry of the Economy. The presence of the Ministry of Housing and Spatial Planning, who is the Managing Authority of the INTERREG programmes, assures the appropriate coordination of the broader Luxembourg strategy.

The selection committee has as mission, the selection of projects based on operational programme and S3 strategy criteria. It comprises representatives from government ministries and public research structures. The advisory experts have as mission, to provide advice on projects in a particular domain.

The audit authority assures operational financial control according to international audit standards and the ministry audit strategy. The audit authority issues an opinion on the annual accounts. Its reports are sent to the European Commission by the managing authority.

The monitoring committee has, as mission, to guarantee the efficiency and quality of the execution of the operational programme. It comprises representatives from Government ministries (in particular, the S3 Managing authority and all ministries directly concerned by the ERDF operational programme), Districts, Economic and social partners and, the European Commission.

The RIS3 governance actors at the level of the ERDF funds regroup with those who elaborate the research and innovation priorities at the national level. By this means, a permanent exchange between the two levels is thus guaranteed.

In conclusion, the governance structure in place allows the different actors to interact in such a manner as to guarantee a collaborative management of the RIS3 by the public authorities, enterprises, public research institutions and civil society.



5.3 Smart Specialisation Monitoring and Evaluation

The operation and implementation of the RIS3 is monitored at both political and stakeholder levels as can be seen from the RIS3 governance structure. The Ministry of the Economy is the designated ministry to monitor the implementation of the RIS3 and its impact.

In parallel with the above operational monitoring, a number of indicators are used to gauge the overall specific economic impact of the RIS3. These include:

- The number of new Luxembourg companies in supported strategic sectors.
- The percentage increase in employment in the supported strategic sectors.
- Share of public expenditure on R&D financed by businesses.
- Business R&D intensity.

These data are furnished by, and available from STATEC, the National Institute for Statistics and Economic Studies, an administration placed under the authority of the Ministry of the Economy. However, it is recognised that there can be a very significant response lag between the time of implementation and when benefit would flow to measurably affect the economy.

Finally, a broad range of external context innovation economy indicators are monitored at a European or global level. These include specific economic indicators as well as performance indicators of Luxembourg's position in both the global digital race for economic growth and the new global transition towards climate neutrality and net zero, detailed in Chapter 2.

6. OUTLOOK

The basis of smart specialisation is to identify and develop competitive advantages within a context specific and place-based approach. Or, alternatively, as the IMD World Competitive Ranking states “countries at the top have a unique approach to becoming competitive”.

This third RIS3 reinforces the recognition in both the second RIS3 and subsequent Luxembourg government industrial strategies that its digital data and infrastructure should be considered as strategic assets for competitiveness.

In addition, as Luxembourg approaches the mid-term of this third decade of the 21st century, it is clear that the need to strengthen its economic resilience and autonomy has never been as urgent.

In the coming years, Luxembourg will therefore once again make unprecedented investments in its digital infrastructure and competitiveness through additional investments in supercomputing and quantum computing capability, infrastructure and data services. This will both underpin and impact all strategic sectors of the economy.

Luxembourg will also leverage this investment by supporting and participating in joined-up actions at the European Union level in strategic initiatives including the EU Important Project of Common European Interest in cloud and edge computing technologies, the EU HPC hyperconnectivity initiative, the EU CHIPS JU initiative, and the EU Quantum Computers initiative.

Recognising that the Luxembourg economy is primarily SME based, the Luxembourg Ministry of the Economy will broaden the set of national Competence centres in high performance computing, digital transformation (EDIH) and sustainable materials to include a national competence centre in Semiconductor Technologies, to ensure access for SMEs to emerging EU level platforms in this key technology. Luxembourg is already an active member of the European Semiconductor Board.

In parallel, Luxembourg will actively work with the European Commission and related taskforces to reduce the risks to the resilience of strategic supply chains, and the physical and cyber-security of critical infrastructure.

Finally, the above Luxembourg ambition must be carried out within the context of the globally accelerating green transition to climate neutrality.

