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Monitoring industrial ecosystems

EU MEMBER STATES FACT SHEETS

Luxembourg

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Key Highlights

This country report has been developed as part of the '**European Monitor of Industrial Ecosystems**' project of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency. It provides data insights into the twin transition and the technological performance of industrial ecosystems. The key findings of the report are summarised below:

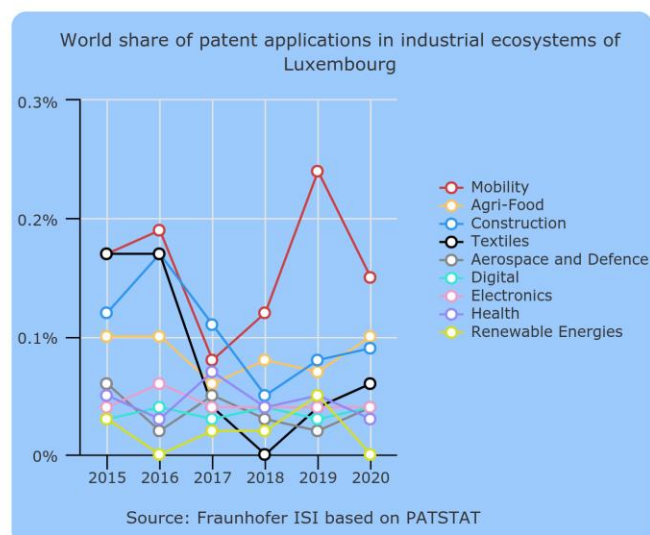


Technological performance in industrial ecosystems:

- Regarding technology development, Luxembourg had the highest share of patent applications within its country in **Agri-Food and Mobility** as suggested by patent data. In global comparison, it was particularly strong in **Mobility** taking into account also the size of the country.

Digital and green transition technologies:

- Among the digital technologies monitored in this project, Luxembourg had the highest share of its patent applications in **Advanced Manufacturing and Robotics and Micro- and Nanoelectronics** within the country. Trends over time indicate an increase in the world share in Internet of Things. Digital Mobility technologies present a decreasing trend in recent years.
- Among the green technologies monitored in this project, Luxembourg had the highest share of patent applications in **Advanced Materials and Nanotechnology**. Trends in the share of world patent applications of Luxembourg show an increase in the relative strengths of Advanced Materials and Nanotechnology, while the share of Geothermal, Hydropower and Biomass patent applications has declined.



Capacity to produce goods based on digital and green technologies:

- Luxembourg's production share in digital technologies globally indicates that it created the highest value by the deployment of **Digital Mobility and Big Data**. Trends over time show a dynamic increase in its global share in Big Data and a decrease or stagnation in other digital technology related goods.
- In the field of green transition technologies, the share of production in a certain technology over Luxembourg's total production indicates an increase in **Advanced Materials and Nanotechnology**, followed by Energy Saving Technologies.

1. Introduction

This country report has been prepared within the '**European Monitor of Industrial Ecosystems**' (**EMI**) project, initiated by the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and SMEs Executive Agency (EISMEA). The overall goal of the project is to **analyse the green and digital transformation of industrial ecosystems**.

The EU's updated industrial strategy from May 2021¹ has outlined 14 industrial ecosystems that are in the focus of the project. The 14 industrial ecosystems include *aerospace and defence, agri-food, construction, cultural and creative industries, digital, electronics, energy intensive industries, energy-renewables, health, mobility – transport – automotive, proximity, social economy and civil security, retail, textile and tourism*. The industrial strategy defined industrial ecosystems as encompassing all players operating in a value chain: from the smallest startups to the largest companies, from academia to research, service providers to suppliers².

The objective of this report is to **present key findings from data** collected within the framework of this project at country level notably on **patent applications, production data, trade** (available only for ten industrial ecosystems), **private equity and venture capital** investments. Nonetheless, this report does not aim to be comprehensive; the data presented here only complement other important statistics on technology development in each country.

The monitoring framework has a technological focus. Industrial transition is driven by technological, economic, and social changes, and in particular by digital technologies and the shift to a green and circular economy. The green and digital technologies that have been taken into account are presented in the table below.

Table 1: Technologies monitored in the project by patent, trade and prodcom data

Green technologies	Digital technologies
Advanced Materials and Nanotechnology	Advanced Manufacturing & Robotics
Biotechnology (for sustainability)	Advanced Manufacturing
Energy Saving Technologies	Robotics
Renewable Energy Technologies	Artificial Intelligence
Solar Power	Big Data
Wind Power	Digital Security & Networks/ Cybersecurity
other (geothermal, hydropower, biomass)	Digital Technology for Mobility
	Internet of Things
	Micro- and Nanoelectronics & Photonics
	Micro- and Nanoelectronics
	Photonics

Source: Technopolis Group, IDEA Consult and Fraunhofer ISI

The methodological report that sets the conceptual basis and explains the technical details of each indicator is available on the [EMI website](#). This report was prepared by Agnes Martinelle, PwC, for the European Commission. However, it does not necessarily reflect the views of the European Commission.

¹ European Commission (2021). Communication on Updating the 2020 New Industrial Strategy, COM(2021)350 final https://commission.europa.eu/system/files/2021-05/communication-industrial-strategy-update-2020_en.pdf

² European Commission (2020). A New Industrial Strategy for Europe, COM/2020/102 final [Commission Communication: A New Industrial Strategy for Europe | European Commission \(europa.eu\)](#)

2. Advanced technologies fostering the green and digital transition of industrial ecosystems

2.1. Data sources

This chapter outlines a set of indicators that capture the capacities of EU Member States to generate technologies that foster the green and digital transformation of industrial ecosystems. Industries that are underpinned by a strong technology basis and supported by vibrant entrepreneurial communities have better conditions for success. The production of technology-based products indicates that technologies are commercialised, while a positive trade balance in technologies is a sign of international competitiveness.

Patent analysis is a widely used method for tracking technological development activities. With a view to industrial ecosystems under study in this project, technology generation and hence patenting takes place in a relatively limited number of ecosystems, while others mainly profit from technologies generated elsewhere. Technology development drives industrial transformation in a general way. The patent analysis is based on transnational patents, notably those filed through the WIPO PCT procedure³ or at the European Patent Office⁴ directly. They have been localised based on the address of the applicant. The different advanced technologies have been identified based on International Patent Classification (IPC) codes and keyword searches.

Trade data, more specifically export data, is a further relevant indicator to document industrial development at higher technology readiness levels. It informs on countries' competitive advantage in specific technology-based product areas. While somewhat simplistic, export strengths in certain technological areas still mark a specific relevance of technology relevant goods for the economy and remain among the reliable indicators of performance. The analysis focuses on trade balances based on UN Comtrade⁵ statistics processed specifically for the purposes of this project. The trade balance can help reveal how nations are intricately involved in supply chains with substantial imports and relevant exports. By putting exports in relation to parallel imports, it is possible to assess whether a country displays strength in production.

Prodcom data⁶ allows the monitoring of technology diffusion. Prodcom provides statistics on the production of manufactured goods carried out by enterprises on the national territory of the reporting countries. It helps measuring the uptake of technology through the production of manufactured goods by focusing on the specific components and elements enabled by green and digital technologies. Production data allows to measure to what extent technology-related products are being produced in the country. The production indicators are calculated based on product-level data from the Eurostat's Prodcom database.

Crunchbase data⁷ were used to analyse entrepreneurial dynamics and private equity and venture capital investment. Crunchbase is a widely trusted source of information on venture capital – innovative companies. Technology startups represent key building blocks in the transition towards a more digital, green and resilient economic model. Entrepreneurial activity helps accelerate the diffusion of technologies in industrial ecosystems and startups that provide green and digital solutions are relevant indicators of how the industrial ecosystem is transforming itself to reach environmental sustainability objectives. More information about these data sources can be found in the methodological report of the project.

³ World Intellectual Property Organization, WIPO Patent Cooperation Treaty (PCT) <https://www.wipo.int/pct/en/>

⁴ European Patent Office, Supporting Innovation and Patents in Europe <https://www.epo.org/en>

⁵ United Nations Comtrade, UN Comtrade Plus-International Trade Data Platform <https://comtradeplus.un.org/>

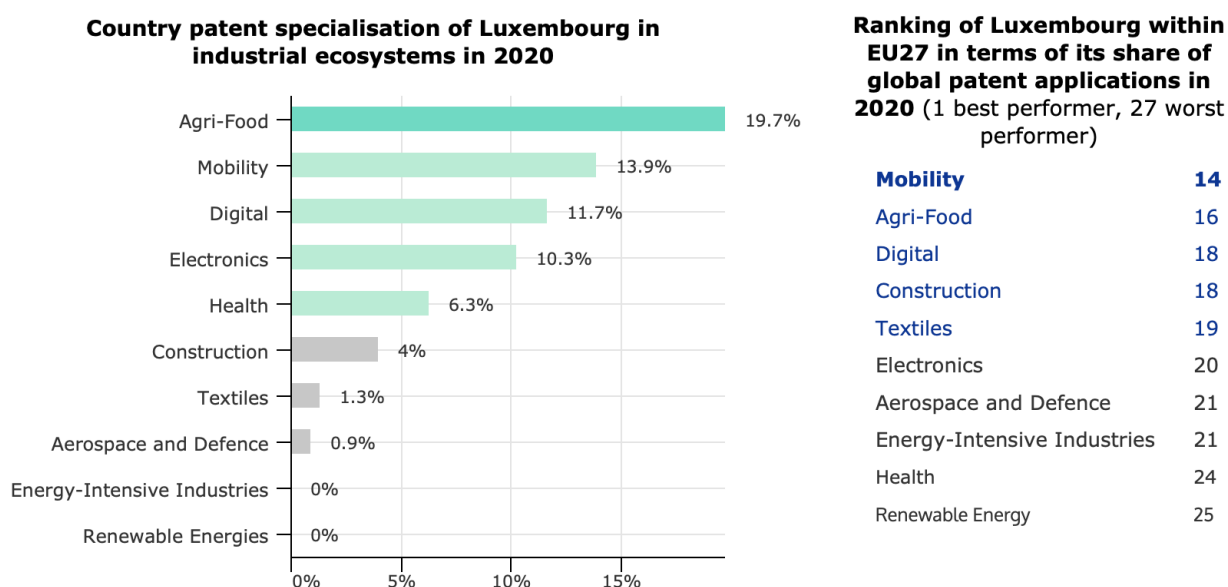
⁶ Eurostat, Eurostat PRODCOM-European Union Production and Trade Statistics <https://ec.europa.eu/eurostat/web/prodcom>

⁷ Crunchbase, Business Information and Networking Platform <https://www.crunchbase.com/>

2.2 Technology development in industrial ecosystems

Regarding technology development, Luxembourg had the highest share of patent applications within its country in Agri-Food, followed by the Mobility industrial ecosystems in 2020 as captured by patent data. In a global comparison, it ranked at the 14th place within the EU27 countries in Mobility, transport and automotive.

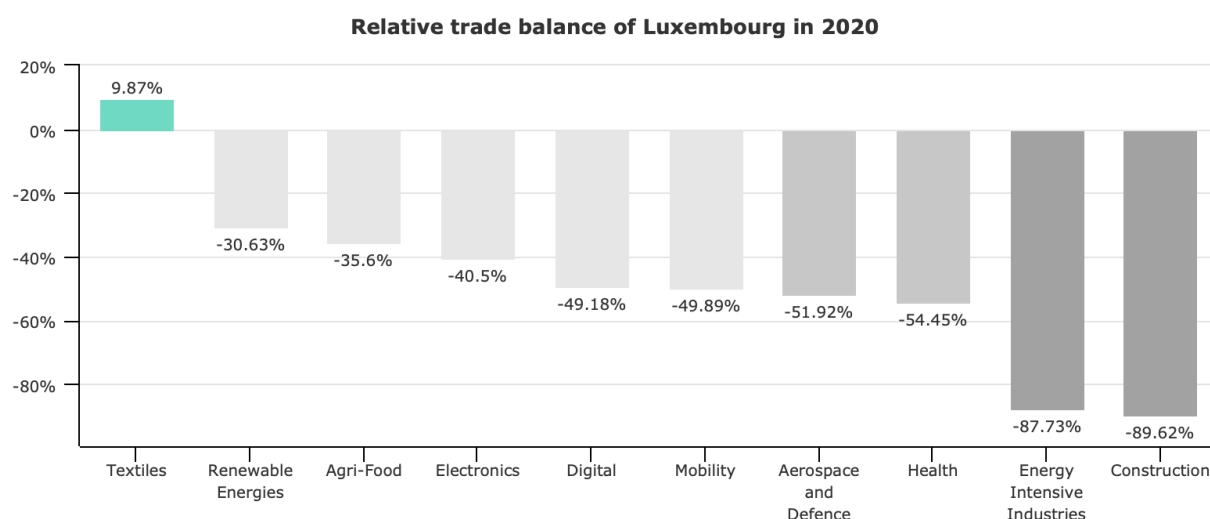
Figure 1: Country share and world share (expressed in terms of ranking) in patent applications in industrial ecosystems related technologies



Source: Fraunhofer ISI based on Patstat

Trade is a common indicator of international competitiveness because it shows how attractive a country's products are outside of its domestic market. Total exports provide evidence about a country's role as a producer, and trade balance captures its sovereignty in certain areas of production. Figure 2 displays the trade balance in relation to overall trade volume by technology development in industrial ecosystems. Luxembourg registered a trade surplus in technology-based products related to Textiles.

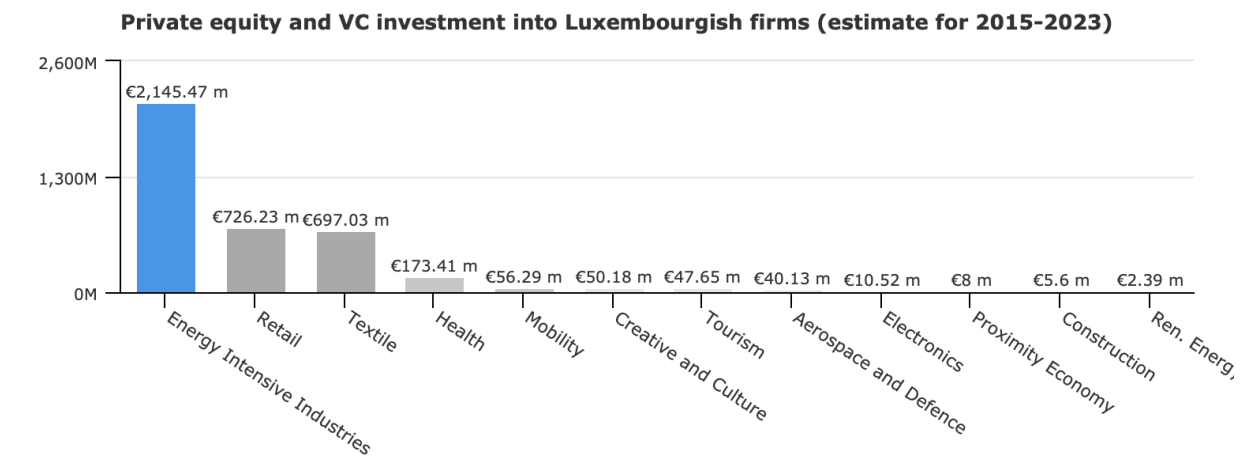
Figure 2: Trade balance in relation to overall trade volume $((exp - imp)/(exp + imp))$ (2020)



Source: Fraunhofer ISI based on UNCOMTRADE

Most private equity and venture capital investment in Luxembourg went into innovative companies operating in Energy Intensive Industries, followed by Retail and Textile from 2015 to 2023.

Figure 3: Private equity and venture capital investment into tech companies related to industrial ecosystems in Luxembourg

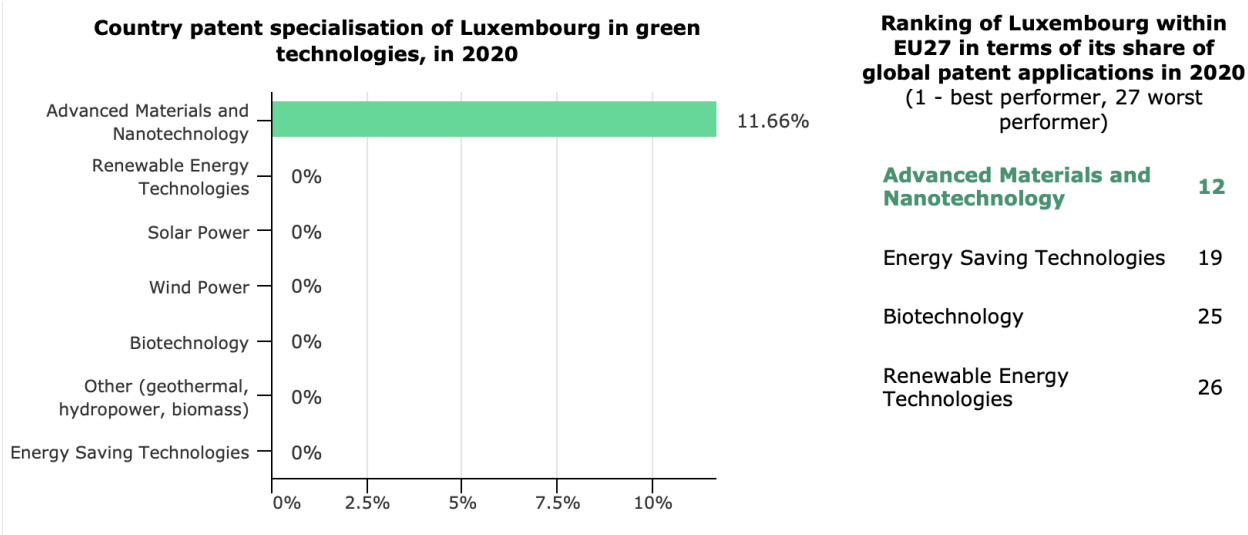


Source: Technopolis Group based on Crunchbase

2.3 Green transformation

Luxembourg had the highest share of patent applications in Advanced Materials and Nanotechnology among the green technologies monitored in this project in 2020. In comparison with the EU27 countries, it ranked 12th in terms of its share of global patent applications in this technology.

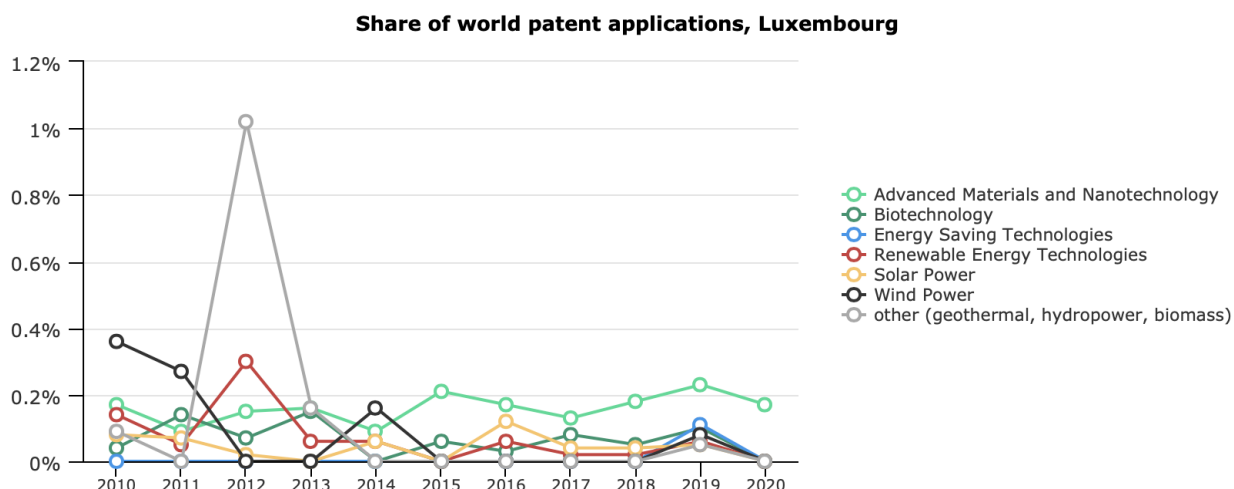
Figure 4: Country specialisation and world share (expressed in terms of ranking) in patent applications of Luxembourg



Source: Fraunhofer ISI based on Patstat

Trends in the share of world patent applications of Luxembourg until 2020 show an increase in the relative strengths of Advanced Materials and Nanotechnology, while the share of Geothermal, Hydropower and Biomass patent applications has declined the most.

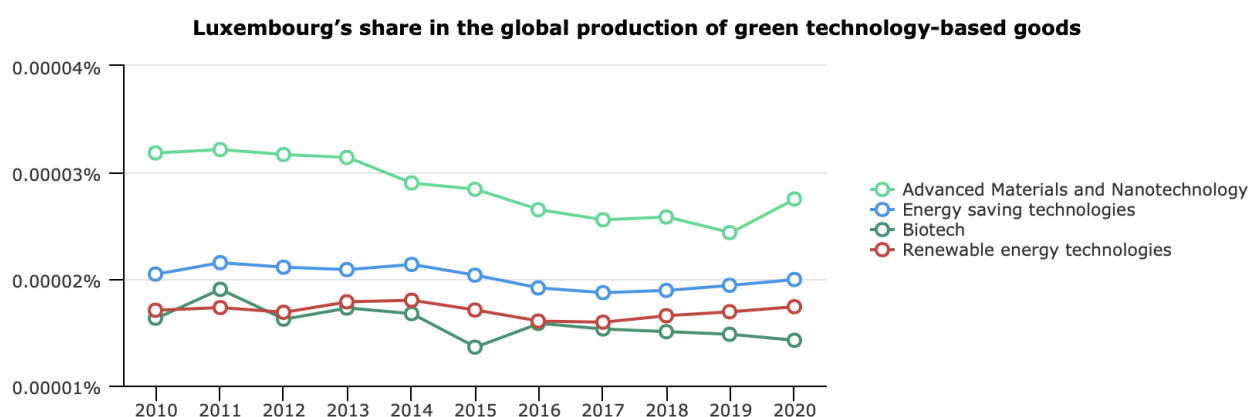
Figure 5: Trends over time in Luxembourg's share in world patent applications



Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of advanced technology-related production in Luxembourg for a given year. The trend over recent years indicates that Luxembourg has a relatively higher share in Advanced Materials and Nanotechnology.

Figure 6: Production of advanced technology-based products in Luxembourg

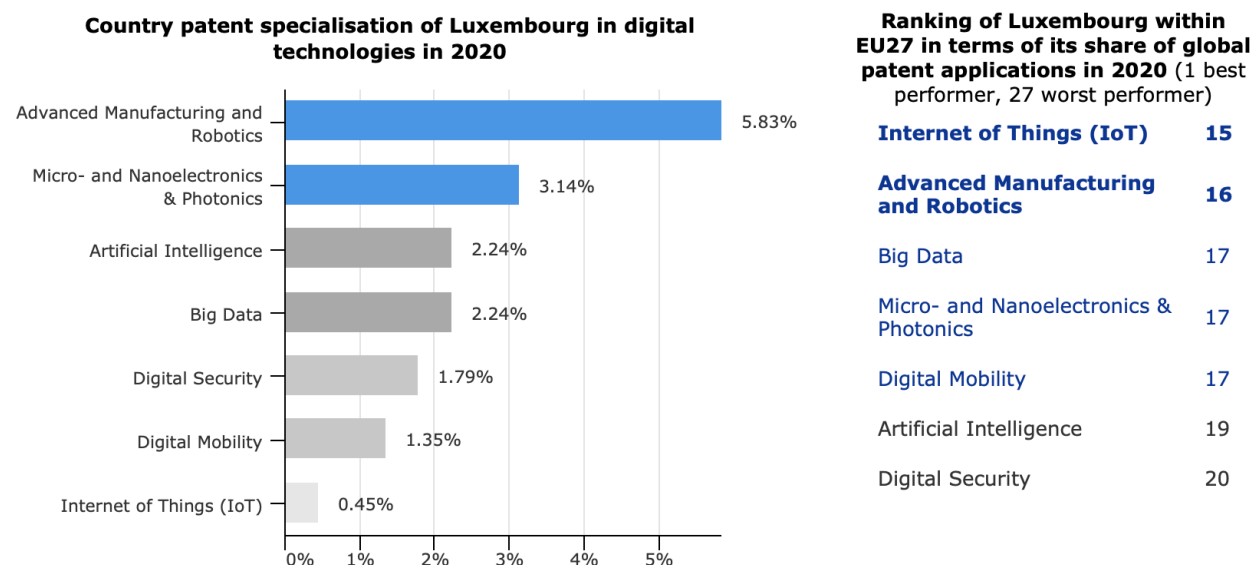


Source: IDEA Consult based on Prodcom data

2.4 Digital transformation

Among the digital technologies monitored in this project, Luxembourg had the highest share of its patent applications in Advanced Manufacturing and Robotics and Micro- and Nanoelectronics within the country. It ranked at the 15th place in the Internet of Things among the EU27 Member States in 2020.

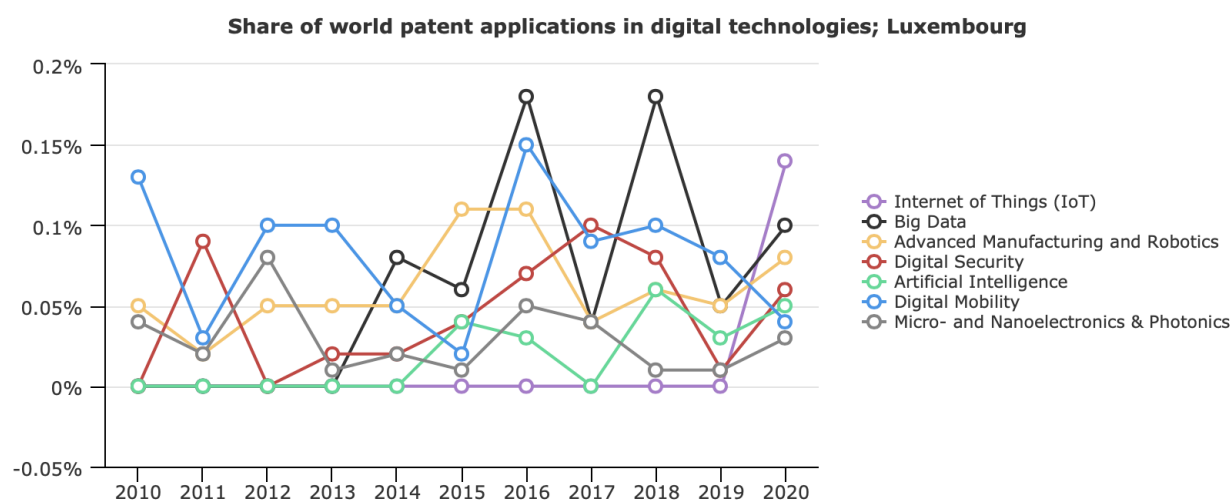
Figure 7: Country specialisation and world share (expressed in terms of ranking) in digital technology related patent applications of Luxembourg



Source: Fraunhofer ISI based on Patstat

Patenting trends show that the global share in Internet of Things has been increasing over time, while Luxembourg's global share in Big Data has been following an oscillating pattern. Digital Mobility has been experiencing a decreasing trend in recent years.

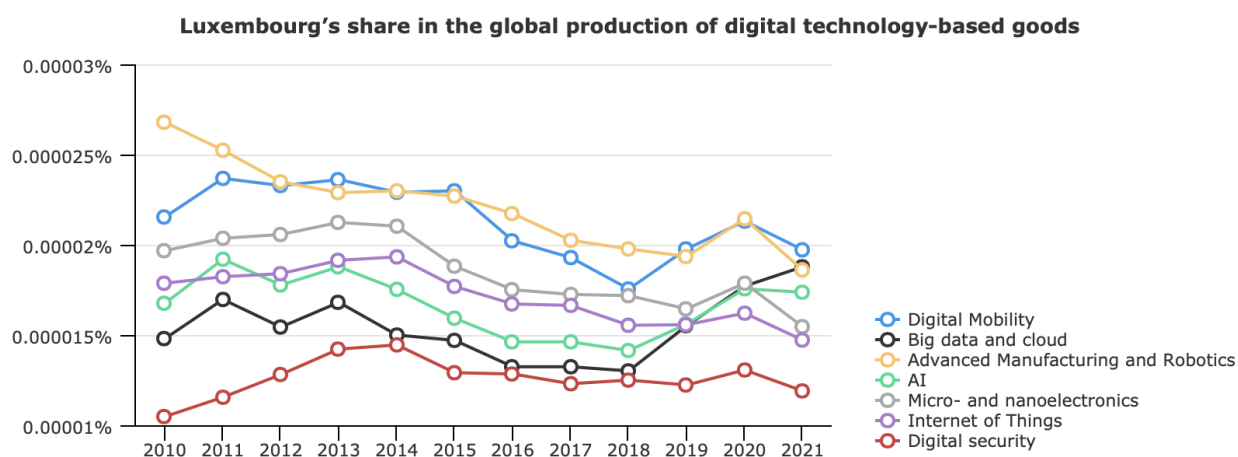
Figure 8: Trends over time in Luxembourg's share of world patent applications



Source: Fraunhofer ISI based on Patstat

The Prodcom-based indicator measures the share of Luxembourg in advanced technology-related production for a given year. The share of production in a certain technology over Luxembourg's total production indicates that Luxembourg had the largest share in Digital Mobility in 2021. The trends show a general decline from 2010 to 2021, with an increase between 2018 and 2020, followed by another decrease.

Figure 9: Production of advanced technology-based products in Luxembourg



Source: IDEA Consult based on Prodcorn data

