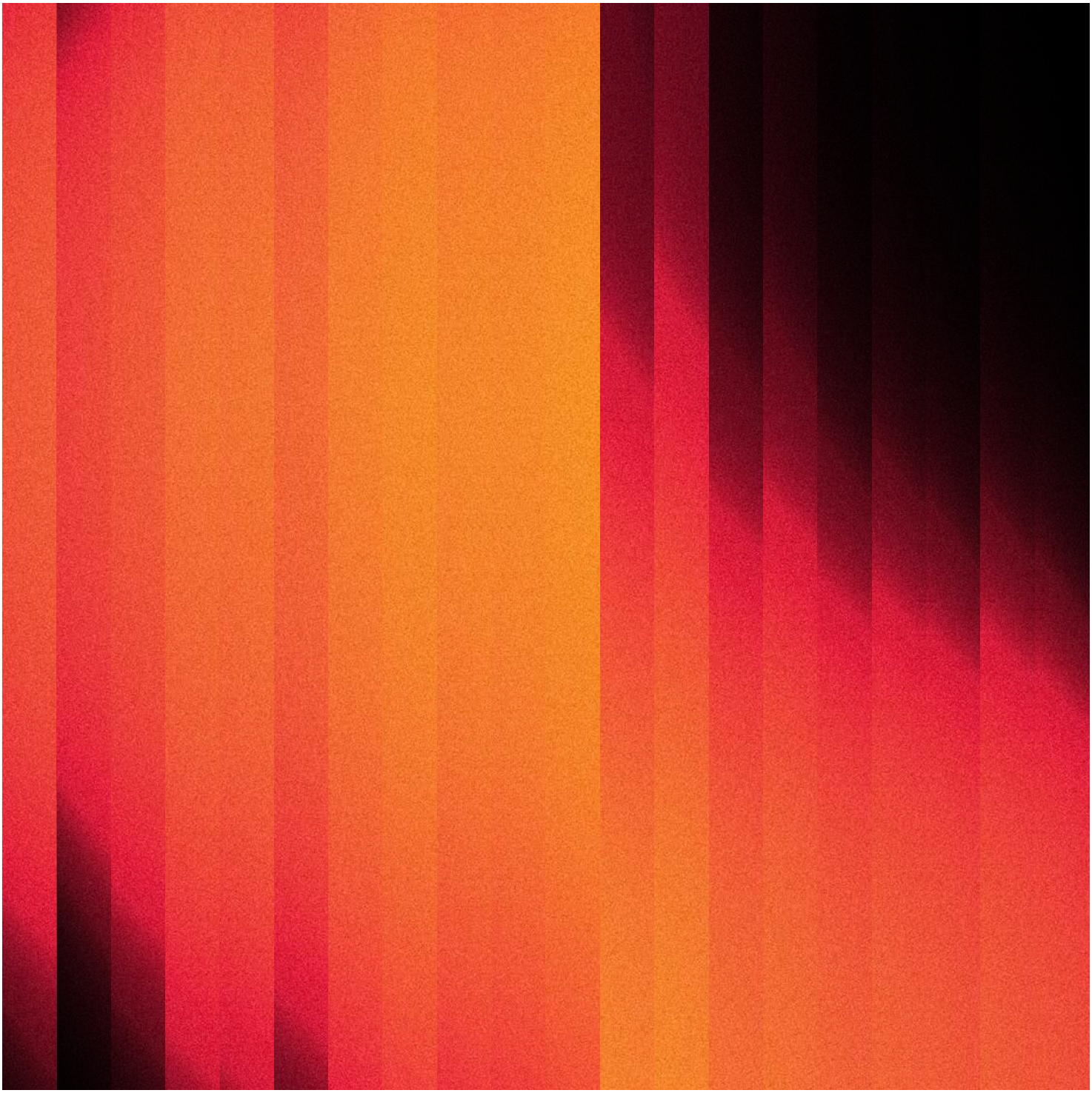

Accelerating digital sovereignty 2030

Luxembourg's AI Strategy

THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG

Accelerating digital sovereignty 2030

Luxembourg's AI Strategy

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Forewords

Luc Frieden

“Innovation is the driving force of human progress and, consequently, of economic and social development. Thanks to the ambitious and coherent vision defined in these strategies, as well as the flagship projects identified, the government will transform Luxembourg into an international centre of reference for the sovereign and secure valorisation of data. We aspire to create an agile centre, founded on trust and transparency, where private and public actors collaborate to put innovation at the service of humanity – European-style innovation, with a Luxembourgish touch!”

Stéphanie Obertin

“National strategies on data, AI, and quantum technologies are the result of excellent collaboration between ministries, public research stakeholders, the private sector, and civil society. The three strategies place humans at the centre of our digital transformation and inspire common ambitions and shared actions to create a dynamic, resilient, and inclusive ecosystem capable of responding to current and future challenges.

The valorisation of data is at the heart of our vision, enabling informed decision-making, the design of judicious policies, and the delivery of effective public services while establishing the foundation for AI and quantum technologies.”

Elisabeth Margue

“Prioritising adoption – this is the principle that guided us in drafting the ambitions and actions regarding AI, whether through the multiplier effect of digital public administration or within Luxembourg’s key sectors such as finance or health. Each company, each person will have a different journey in increasing their AI expertise. Everyone will be able to rely on the great strengths of our country: connectivity, computational resources, and digital skills. Additionally, by adding regulations that accelerate innovation, Luxembourg truly has a strong card to play within the European Union. Let’s be as ambitious as we can be!”

Lex Delles

“Digitalisation is no longer an option: it is an absolute necessity for any business that wishes to gain productivity and remain competitive in an increasingly rapidly evolving environment. This is why Luxembourg is investing in cutting-edge digital infrastructure while facilitating access through the provision of services adapted to the needs of businesses and research. With the future quantum computer MeluXina-Q and the future supercomputer MeluXina-AI placed at the heart of the national AI Factory, we offer businesses of all sizes a favourable framework for innovation to concretely accelerate their digitalisation.

By implementing a digital strategy built around three fundamental pillars - data, AI, and quantum technologies - we are giving ourselves the means to strengthen our digital sovereignty, guarantee our long-term competitiveness, and consolidate the resilience of our economy in an increasingly digitalised world.”

Accelerating digital sovereignty 2030

Luxembourg's ambition in data, artificial intelligence and quantum technologies

As part of the 2023-2028 coalition agreement, the government has committed to promoting innovation with the aim of keeping Luxembourg at the forefront of new technologies and digital advancement. In this context, **data, artificial intelligence (AI), and quantum technologies** constitute the **three areas** that Luxembourg aims to advance in order to continue stimulating its economy, improve the quality of life of its citizens, strengthen its digital and technological sovereignty, and contribute to the digital sovereignty of the European Union.

Since the publication of "**The Data-Driven Strategy for the Development of a Trusted and Sustainable Economy in Luxembourg**" and "**Artificial Intelligence: A Strategic Vision for Luxembourg**" in 2019, as well as the "**Ons Wirtschaft vu Muer**" strategy presented in 2021, technological evolution and its impact on our daily lives has substantially changed. With the rapid popularity of new AI tools in 2023 and the growing importance of data and its valorisation, a review of government strategies became necessary. In parallel, a technological evolution that is certainly less mature but no less fundamental, namely that of quantum technologies, has also rapidly gained momentum. It is therefore opportune, even urgent, to position the country for the next technological era, particularly through the adoption of innovative and high-impact solutions by 2030, thanks to the implementation of dedicated and additional budgets.

Luxembourg focuses on data, AI, and quantum technologies to strengthen its digital sovereignty and remain at the forefront of innovation.

Organisational approach

The government has invited **the Ministry of State (ME), the Ministry for Research and Higher Education (MESR), the Ministry of the Economy (MECO) and the Ministry for Digitalisation (MinDigital)** to identify complementarities and opportunities through national and international initiatives. To benefit from synergies and achieve ambitious objectives by 2030, a **holistic approach** has been adopted by these ministries, while ensuring the participation, from the initial preparations during workshops, thematic meetings and working groups, of representatives from civil society, private and public sectors, as well as experts from Luxembourg's public research. The **monitoring of the strategy implementation** according to its three axes relies on a transversal approach involving the entire government.

For the sake of general coherence, the three priority axes are addressed in **three dedicated documents**. Each document includes an **identical common section** that highlights the shared ambitions and synergy between the three axes, followed by a specific section for each: **data, AI, and quantum technologies.** It is this entire **strategic corpus** that constitutes the national ambition aimed at **accelerating the digital sovereignty of the Grand Duchy by 2030**.

Strategic vision

By 2030, Luxembourg aspires to become a country of digital and technological innovation centred on people, agility, sustainability and international collaboration. To achieve this, the Grand Duchy is determined to stimulate its digital ecosystem to make it increasingly innovative, dynamic, and agile. To ensure coherence, inclusivity, and collaboration within this ecosystem, both public and private sectors - including research and development - will be heavily involved. Built upon international openness, proven economic dynamism, and unparalleled and highly reliable digital infrastructure, the national ambitions regarding data valorisation, AI, and quantum technologies aim to consolidate Luxembourg's character as a European pioneer in digital transition, capable of serving as a model and benefiting from the advantages offered by digital technologies. The vision aims to support digital sovereignty, technological and economic progress, and to promote citizens' well-being.

This common vision for the **strategic corpus** is based on the conviction that digital and technological innovation is essential to ensure the country's competitiveness and future prosperity. Building on its unique advantages such as **cutting-edge sovereign infrastructure** and **the agility of a country of limited size**, Luxembourg will position itself as a leader in the field of high value-added applications in highly regulated sectors and thus offers true complementarity and added value on the European and global stage.

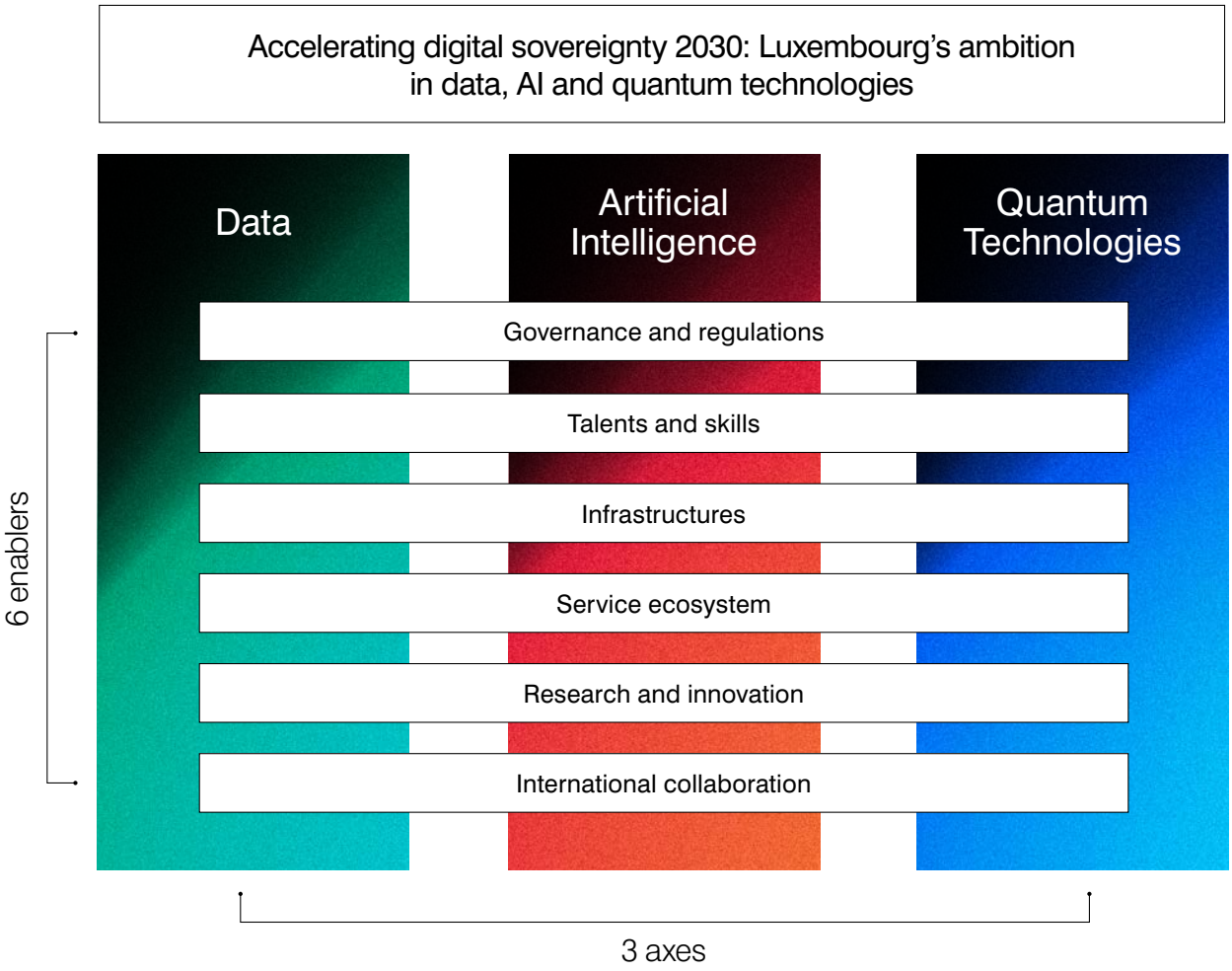
These strategies have been developed to position Luxembourg at the forefront of a future where technology is an essential driver of economic growth and citizens' well-being while ensuring the country's digital sovereignty.

A unified approach: leveraging interactions between data, AI and quantum technologies

Data represents the raw material of digital innovation, artificial intelligence allows value to be extracted from it, and quantum technologies promise to push the current limits of information processing, security, and analysis. To unleash their full potential, these three strategies should not be approached in isolation but rather as complementary components of an interactive technological ecosystem.

An integrated approach also allows for **greater sharing of infrastructure** (for example cloud, HPC (high-performance computing) and quantum computing) and **human and financial resources**. These interactions strengthen the country's ability to develop more powerful, safer technological solutions that are better adapted to tomorrow's challenges, particularly in key sectors such as the public sector, finance, cybersecurity, health, culture or space.

The common thread through each of the different documents is provided by **six transversal enablers**. The advantage of this articulation is to avoid a siloed approach and to facilitate synergies. It allows both a thematic reading (by vertical axis) and a pragmatic one (by horizontal action) of Luxembourg's various ambitions in terms of digital technology.



Six action enablers common to the three strategic development axes

The enablers for building a coherent digital ecosystem are as follows:

- Establish and promote governance means and regulations to encourage the use and reuse of data, as well as accelerate the adoption of AI and quantum technologies while guaranteeing data security and protection, infrastructure sovereignty, and reliability of software creation;
- Develop and attract the necessary skills and talents to strengthen national competitiveness, innovate and work in the field of digital technologies, and enhance digital literacy at the societal level;
- Continue to deploy cutting-edge infrastructure adapted to evolving national needs, both public and private, in terms of connectivity and computing;
- Offer a complete range of specialised services to support the dissemination and adoption of data culture and new digital technologies within society and the economy, particularly by offering more efficient and personalised public services, thus reducing the administrative burden for citizens and businesses;
- Stimulate agile research and innovation, at both public and private levels, to solve complex societal challenges;
- Contribute to international initiatives in the field of data, AI, and quantum technologies to promote digital sovereignty and European values.

Implementation of strategies: integrated dynamics and flagship projects

The operationalisation of the strategy will rely on a **set of flagship projects** translating concrete sectoral ambitions into strategic domains such as finance, health, culture, space, education, skills, cybersecurity, energy, mobility, and the optimisation of legislative and administrative processes. This approach will stimulate the digital and innovation ecosystem in Luxembourg through the adoption of innovative and high-impact solutions. To this end, dedicated budgets will also be established to meet the needs expressed by the consulted stakeholders.

This dynamic is supported by integrated governance and dedicated structures such as the **Deep Tech Lab** (see below) and the **collaborative Data, AI, and Quantum Factory platforms** (see below), true catalysts for innovation and coordination.

Flagship projects in key sectors will boost innovation in Luxembourg, supported by dedicated budgets and integrated governance.

Luxembourg's strategic assets for succeeding in its digital transition

Over the past decades, the government has committed to developing cutting-edge infrastructures and has continuously engaged in international initiatives and collaborations. Luxembourg already has a few key elements to assert itself as a digital pioneer on an international scale:

- Luxembourg has the highest density of **"Tier IV" data centres** in Europe. These data centres guarantee the highest level of resilience in terms of electricity, water, and connectivity supply while ensuring a very high level of physical security. Thanks to this security level, these data centres can host highly critical data storage and processing infrastructures.

- Luxembourg is an active and recognised member of AISBL **Gaia-X**, a European initiative aimed at creating an **open, secure, and sovereign data infrastructure** to promote the interoperability of data or cloud services while respecting European standards. Luxembourg plays an important role with a Luxembourgish representative sitting on the board of directors and having leadership of the health ecosystem within this same association.

- Operational since 2023, the **Luxembourg National Data Service (LNDS)** facilitates value creation from secondary use of data for both public and private partners and supports the sharing and reuse of public sector data in a reliable manner. Its approach, unique in Europe, aims to offer a complete range of data-related services (management, access, cataloguing, Ethical, Legal, and Social Issues (ELSI) assessment, pseudonymisation and anonymisation, etc.) in an intersectoral and centralised way to accelerate data exploitation in Luxembourg.

- Luxembourg positions itself as a European leader in digital connectivity, with **high-speed Internet infrastructure** and **5G coverage** that far exceed the EU average.

- Luxembourg is one of the first EU Member States selected to host a supercomputer as part of the EuroHPC network. Operational since 2021, the **HPC MeluXina** was designed in particular to process AI computational tasks. In 2023, MeluXina processed 35% of all EuroHPC AI projects, highlighting its key role in advancing AI in Europe. At the national level, its computing hours are increasingly being used to develop AI applications for a growing number of companies, including startups.

- Luxembourg is among the first seven Member States to have signed in 2019 a declaration on the development and deployment of a European quantum communication infrastructure, the

EuroQCI. From this declaration was born the national initiative **LuxQCI** which aims to create an experimental laboratory for quantum communications, to develop and implement a quantum communications network at the national level in order to interconnect it with the quantum communications networks of other European Union Member States, thus creating the EuroQCI. The development of the national ecosystem in the field of quantum communications is another key objective of the LuxQCI initiative.

Far from being established achievements, these assets must be continuously developed so that Luxembourg can accelerate its digital sovereignty and remain at the forefront of digital technologies and meet national and international needs.

Fostering innovation and creation

Intellectual property has become an economic issue that must be considered to ensure the growth of innovative, creative, and economic actors. It must therefore be integrated in a transversal and strategic manner in the initiatives of the various ministerial departments and in the sectors of the economy and culture, particularly in the context of AI, quantum technologies, and data, so that creative and innovative efforts result in competitive advantages that will ultimately benefit society, the economy, and Luxembourgish culture.

Luxembourg has established a fully developed legal and regulatory framework in the field of intellectual property. This legislative framework helps ensure Luxembourg's position among the leaders in innovation. Luxembourg will continue to engage in discussions and developments in this area at the European and international levels.

It should be emphasised that in the context of the sustainability of the knowledge economy, access to content should not be considered solely in a dematerialised manner. In this regard, and to sustainably guarantee Luxembourg's sovereignty, it is essential to ensure that intellectual resources and access to knowledge are not solely dependent on external operators and their digital resources.

These various elements will help maintain Luxembourg's position at the forefront of knowledge-based and innovative economies, which are guarantees of competitiveness and growth.

Becoming and remaining a key player in the digital ecosystem

The key arguments highlighted below, drawn from the strategies, emphasise specific actions that will contribute to positioning Luxembourg as a key player in the European digital ecosystem:

- Luxembourg will establish centralised data governance to ensure data reuse and exchange in a trusted environment. To facilitate relations with citizens in their administrative procedures, the government is also planning a solid and coherent framework for data exchange by introducing the Once-only principle (a principle whereby a person provides data to administrations only once). To facilitate data access and reuse, while ensuring legal certainty and maintaining citizen trust, the government also aims to establish a precise framework for the reuse of data held by the public sector (G2B) by both public and private actors. It specifically provides for:
  - authorised purposes for which data access and reuse are permitted, e.g., for training, testing, and evaluating algorithms and AI solutions;
  - rigorous control of rules through the intervention of the Government Commissioner for Data Protection with the State (CGPD), acting as the Data Authority in charge of

Luxembourg establishes itself as a European digital hub with a strategy focused on data, AI, and quantum technologies.

authorising data access and reuse based on a specific request by the re-user;

- the fact that data access and reuse take place in a secure processing environment set up by the CGPD and managed by the State Information Technology Centre (CTIE);
- the fact that data is anonymised, pseudonymised, or aggregated (if necessary by a trusted third party) prior to being made available.

- The network of AI Factories will facilitate access to large volumes of data and pool expertise at a European scale. Additionally, Luxembourg will be able to rely on its new MeluXina-AI supercomputer to further accelerate the development of its already dynamic and agile digital ecosystem. The national AI Factory, with its centre in Belval, will constitute a one-stop shop increasing the visibility of available initiatives and offerings, and providing access to essential resources to accelerate AI development in Luxembourg, while promoting collaboration, knowledge exchange, and inter- and intra-sectoral synergies.
- The new MeluXina-AI supercomputer will be integrated with sovereign cloud solutions and Tier IV data centres in a computing continuum. This will offer flexibility, robustness, and security in terms of data protection and IP necessary for applications in highly regulated domains.
- To attract and advance the talents and skills necessary for developing a thriving AI ecosystem, Luxembourg will adopt an agile, sectoral, and inclusive approach, combining pedagogical innovation and close industry-academia collaborations, while capitalising on MeluXina-AI. Luxembourg will equip itself with an advanced AI-based tool to anticipate skills needs in order to align training with labour market developments. To position the country as a model in Europe for equitable access to AI skills, Luxembourg will seek to find a good balance between developing elite talent and the broad inclusion of citizens.
- In order to drive the rapid application of AI in the key economic sector of finance, a major project will be implemented to explore the potential of AI-based use cases. In the same spirit, the health sector is complementing its digital strategy with a major project that uses AI to improve patient medication care, thus driving the application of AI with the aim of making medicine more personalised.
- The Deep Tech Lab (DTL) aims to promote the economic valorisation of Deep Tech research activities in Luxembourg. Its goal is to facilitate interactions between the academic and economic worlds. To achieve this, it encourages the creation of public-private partnerships, the development of spin-offs, and the commercialisation of licenses. Furthermore, the DTL will allow Luxembourg to become a hub that attracts, retains, and develops talent in the field of Deep Tech technologies, to guarantee national sovereignty and realise national ambitions in the areas of data, AI, and quantum technologies. It will usefully complement the existing solutions in Luxembourg to stimulate research, innovation, and entrepreneurship, thereby supporting the activities of this ecosystem as a whole. Additionally, the DTL will constitute a dynamic scientific and technological environment where researchers and engineers can focus on providing innovative and concrete solutions, particularly in the fields of data, AI, and quantum technologies, in line with the ambitions defined in Luxembourg's strategies. Its ultimate goal will be to promote high-level research, both public and private, to address societal and industrial challenges with high added value. Both bottom-up and top-down approaches will be used to identify and address research questions and high-impact innovation areas.
- To prepare for cyber threats in the quantum era, Luxembourg aims to accelerate the transition to post-quantum cryptography and deploy quantum communication networks integrated with the European EuroQCI initiative. This includes support for test beds for secure terrestrial and satellite networks, as well as promoting concrete use cases. The space component, with the development of a QKD satellite, is one of the country's strategic priorities. These efforts will contribute to strengthening national cybersecurity and defence capabilities, in line with its long-term priorities in terms of digital sovereignty, cybersecurity, and space technologies.
- The integration of the MeluXina-Q quantum computer into the existing MeluXina HPC infrastructure and the future coupling with MeluXina-AI allows for intelligent distribution of computational tasks between different architectures, thus optimising the use of available resources. This configuration will create a centre of computing excellence, where the advanced capabilities of classical and AI-specialised supercomputers are enhanced by the unique assets of quantum computers.

All of these strengths and key arguments will allow Luxembourg to present itself as a centre of competence and a true European hub at the cutting edge of digital technology.

Part 1. Introduction

Luxembourg's AI strategy

1. Vision and values

Luxembourg aims to become a renowned innovation hub with a European and international impact on human-centred AI. Luxembourg seeks to demonstrate how AI can benefit its citizens and businesses, achieve its ecological ambitions, and share its experiences in the spirit of international cooperation. To achieve this, Luxembourg is committed to creating a trusted AI ecosystem that is coherent, inclusive, and collaborative, involving the public, private, and research sectors. This ambition is based on the values of openness, dynamism, and reliability that characterise Luxembourg.

A thriving and constructive AI ecosystem should incorporate the following:

1. **Human-centred AI**

   Place humans at the heart of innovation by ensuring that technological advancements concretely improve quality of life for citizens.

2. **Effective and proactive public administration**

   Optimise public administration by promoting intelligent and efficient processes, and personalised, inclusive public services.

3. **Strengthened competitiveness of businesses**

   Encourage the adoption of AI technologies across the entire economy by continuing to deploy cutting-edge infrastructure and foster a skills ecosystem.

4. **World-class research that draws and develops talent**

   Create a research ecosystem that (1) positions AI as transversal and interdisciplinary, (2) drives innovation, (3) attracts and develops national and international talent.

Luxembourg is considered to be a living AI laboratory that cultivates responsible AI applications, tailored to local needs and priorities. The Grand Duchy wants to solidify its position as a responsible AI leader, and harness the technology to build a more sustainable and inclusive future.

Luxembourg's AI strategy is guided by the OECD's recommendations to governments[1], as well as the previous 2019 initiative **"Luxembourg's Strategic Vision for AI"**, which served as a starting point in this process. A key action point in the 2019 vision was a **public consultation to understand the citizens attitudes towards AI**. Conducted in 2021, the consultation's results were considered in the strategic process.

Luxembourg wants to become a hub for human-centred AI innovation, based on trust, competitiveness, collaboration and societal impact.

[1] OECD, AI principles, 2019

2. Today's AI ecosystem

A snapshot of AI in Luxembourg

AI ecosystem mapping

Luxinnovation, Luxembourg's national innovation agency, completed an AI mapping project in 2024 that provided a snapshot of the country's AI ecosystem.

568
entities actively utilising AI, including early adopters and companies developing solutions

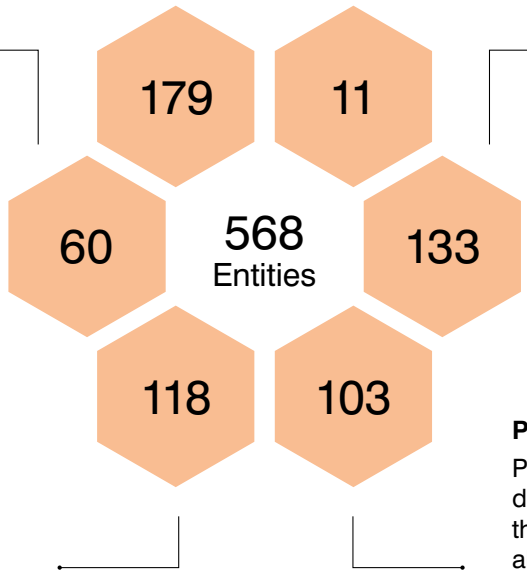
179
active private investors and incubators

568 entities make up the AI economic ecosystem in Luxembourg, positioned all along the AI value chain

Private investors, incubators
Organisations and funds that provide capital, resources, mentorship and support to AI startups, technology companies and AI projects.

AI Technology solution providers
Companies creating the foundational AI models, alogrithms and systems that drive intelligent functionalities in various applications and industries.

AI communities (consulting, academia & research)
Consultancy firms, academic institutions and research organisations that enable the use of AI technologies and support their adoption by end users.



AI Company, AI Developer, AI Startup / SME
Providers using existing AI technologies to develop, customise and deploy AI-driven applications, tools and services to businesses and industries.

AI users (Early adopters)
Public and private organisations using or planning to use AI technologies and solutions in their tasks, processes and decision-making.

Potential data providers
Providers offering raw or processed data that can be used to enhance the performance and accuracy of AI algorithms.

Luxembourg's AI mapping scope defined according to the "Call for the selection of Hosting Entities for acquiring or upgrading EuroHPC systems with AI capabilities and establishment of associated AI Factories" (source)

N.B.: Some entities are classified in more than one category where relevant.

Mapping of the Luxembourg AI ecosystem (as of September 2024)

3. Approach

AI that enhances societal wellbeing

Luxembourg's population already embraces AI in day-to-day tasks, driven by widespread connectivity, strong digital skills, digital inclusion initiatives, public engagement, citizen dialogue and a high level of trust in the government.[2] Local businesses are actively adopting and investing in AI solutions. Though enthusiastic about AI adoption, the public is increasingly aware of the associated risks, such as biases, misinformation and environmental impacts. AI has the potential to become a valuable ally, but only if aligned with ethical principles and regulatory frameworks that minimise risks and maximise benefits.

These principles define our approach:

People-first

The goal is that any AI solution developed in the country (1) complies with regulations, (2) avoids perpetuating existing inequalities, and (3) emphasises the values of trustworthy AI, such as fairness, accountability and privacy. To ensure the utmost safety, Luxembourg joined fellow EU Member States in setting up testing and experimentation facilities that allow AI developers to address risks before deployment. In September 2024, the Luxembourg Institute of Standardisation, Accreditation, Safety and Quality of Products and Services (ILNAS) launched a National Standardisation Commission for Artificial Intelligence (ILNAS/NSC 04[3]) that contributes to the global standardisation of AI. It addresses technical interoperability and compatibility requirements, while enhancing quality, safety, and trust in AI systems. Another example of Luxembourg's effort to ensure the responsible use of AI is its position on Autonomous Weapons Systems as the defence industry is currently less regulated than the civil domain. Thanks to these efforts and many others, a continuous assessment of AI applications is carried out based on the value they bring to society.

Sustainable energy use

Luxembourg is committed to aligning with both, the EU and the UN, to advocate for the responsible and sustainable use of AI by businesses and citizens, to harness its full potential to support the energy transition in Luxembourg and to make energy supply more reliable and affordable. Thus, AI will play a central role in implementing Luxembourg's integrated National Energy and Climate Plan (PNEC[4]). Additionally, AI is part of several initiatives at the intersection of energy and digitalisation, such as Luxembourg's Digital Decade and a national research centre of excellence. The significance of AI for the energy sector is further emphasised by a flagship project dedicated to this goal.

AI will play a crucial role in the implementation and success of all these initiatives. However, without a secure and thoughtful approach to AI deployment, the energy impact and its environmental consequences of inappropriate or excessive use poses a risk of environmental harm: long-term strategies are necessary to balance energy needs with sustainability while also improving the efficiency of AI models.

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[2] Statec, Trust in Institutions, Democracy, and Official Statistics, (n°10) 10/2023

[3] Portail-Qualité, Artificial Intelligence and Big Data, Normes et Normalisation, 12/2024

[4] Luxembourgish Government, Luxembourg's integrated national energy and climate plan for the period 2021-2030 (PNEC)

Democratic discourse

AI has become a powerful force in shaping democratic discourse. It offers the opportunity to enhance the democratic process by helping citizens gain a deeper understanding of politics and engage actively in political discussions. However, it also poses risks, such as the spread of misinformation and the manipulation of public opinion.

The media, a vital and indispensable protector of our democracy, faces particularly difficult challenges. While promising to revolutionise how journalists leverage data and generate content, AI systems risk undermining editorial independence and quality. For example, in the absence of balanced, fact-checked information, AI could further enable political echo chambers. Additionally, it has become difficult to distinguish journalist-created content from AI-generated content. This includes political deepfakes[5], which are among the most prevalent misuses of AI, raising fundamental ethical questions and threatening democratic discourse. Regulators must ensure adherence to ethical standards regardless of content origin. Human oversight and transparency in newsrooms, such as labelling AI-generated articles as outlined in the European regulation on artificial intelligence "AI Act"[6], will be crucial to public trust. Luxembourg's regulations will work to safeguard the integrity of information and uphold the public's confidence in its media and governmental institutions. Thus, the Convention between the State and the public service media 100,7 obliges the latter to ensure that algorithms reflect public service values where applicable and promote content discovery. Furthermore, the professional journalism aid scheme constitutes a strategic pillar of democratic debate. By supporting a pluralistic, independent, and professional media landscape, it helps strengthen the resilience of the public sphere against informational drifts related to AI, and ensures citizens have sustainable access to reliable, diverse, and quality information.

Agility

The ability to quickly adapt to changing market demands, shifting value chains and technological advancements is central to Luxembourg's approach. To maintain this agility, public procurement practices should be forward-thinking, prioritising flexibility over indefinite contracts for overly specific or short-term AI needs. Instead of locking into long-term commitments, Luxembourg's public administration should favour adaptable agreements that allow for quick responses to technological developments in AI. Agility also includes more streamlined processes and increased efficiency to foster an environment prosperous for AI innovation.

Open-source models

Open-source AI models can offer significant benefits, including transparency, faster progress, and decentralised control. The Open-Source Initiative (OSI) has defined open-source AI models as systems that can be freely used, studied, modified, and shared, including transparency in training data, source code, and crucially, the model weights.[7] True open-source models provide comprehensive access to all aspects necessary for understanding and reproducing the model. Luxembourg will continue to value both open- and closed-source models while focusing on addressing the risks and opportunities of these models from legal and governance perspectives. Public entities, including research organisations, are encouraged to prioritise the use of open-source AI models to whatever extent is possible.

Trustworthy

Trustworthy AI, particularly explainable AI, is fundamental for ensuring transparency, robustness, and accountability in AI systems. In adopting new technologies, it is crucial to consider intellectual property rights, data protection, cybersecurity and ethics. These aspects need to be built in—i.e. trustworthy by design—for long-term AI adoption to succeed throughout our economy. This includes adhering to the emerging consensus on trustworthy AI standards and regulations. The aim is to contribute to broader European efforts in developing trustworthy AI solutions.

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[5] Financial Times, Political deepfakes top list of malicious AI use, DeepMind finds, 06/2024

[6] Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828
Art. 50: Deployers of an AI system that generates or manipulates texts published for the purpose of informing the public about matters of public interest shall indicate that the text has been generated or manipulated by an AI. This obligation does not apply where the use is authorised by law for the purposes of the prevention, detection, investigation or prosecution of criminal offences, or where the AI-generated content has been subject to a human review or editorial control process and where a natural or legal person assumes editorial responsibility for the publication of the content.

[7] Open-Source Initiative, The Open-Source AI Definition – 1.0

Sovereign

Luxembourg aims to position itself as a European hub for the responsible development of sovereign AI. This approach reflects the growing geopolitical importance of developing independent AI capabilities within Europe, while simultaneously emphasising ethical considerations and safe deployment practices. Finally, our AI-focused flagship projects will concretely demonstrate Luxembourg's sovereign AI capabilities and contribute to broader European efforts aimed at developing sovereign AI solutions.

Luxembourg relies on a sovereign, transparent and ethical AI to support democracy and guarantee the reliability of information.

Part 2. Enablers

Addressing AI from all sides

The second part of this strategy outlines the critical enablers essential for driving AI's success in Luxembourg. Each enabler plays a pivotal role in strengthening the AI ecosystem, with distinct ambitions and actions aimed at promoting innovation and growth. They contribute to creating a dynamic environment in which AI can thrive, unlocking new opportunities and generating lasting value for both businesses and society as a whole.

1. Talents and skills

Cultivating the expertise critical to a bright future

Luxembourg's ambition is to strengthen the nation's AI readiness. To achieve this, the aim is to cultivate AI competencies across all levels of society. This involves implementing approaches tailored to targeted skill profiles.

Three key skill profiles have been identified:

1. **AI Excellence:** This group consists of AI creators with deep technical knowledge and creativity who design algorithms, train and fine-tune models, build AI pipelines, and integrate these models into products and services. They are our core AI innovators. It is crucial to give them access to the right infrastructure, specialised technical training and ongoing support to develop cutting-edge solutions and impactful AI tools. Additionally, they should be fully aware of the related ethical considerations.
2. **AI Practitioners:** These professionals understand AI technologies, implement and maintain AI models and systems within their fields, even if they do not build the solutions themselves. This category includes business analysts, business developers, project managers, IT support teams, IT integrators, legal and ethics experts, and more. It is important that they have access to domain-specific AI training tailored to their expertise, awareness training, and opportunities for peer exchange.
3. **AI Users:** This group involves non-technical professionals in diverse sectors who use pre-built AI applications and solutions (e.g., decision-making tools, chatbots, predictive analytics) to enhance productivity and outcomes. It is important for them to know how to use AI correctly to maximise its benefits and ensure responsible usage. This includes basic training on AI functionalities, best practices for using AI tools, and awareness of the legal, ethical and security implications of AI.

Ambition: Developing AI excellence

The development of AI innovation and responsible deployment requires highly specialised expertise that goes beyond general technical and digital skills. The contributions of AI creators—experts in machine learning, algorithm ethics, data governance and human-centred AI design—are critical to developing and refining models, building AI pipelines, and integrating AI into real-world applications.

By combining targeted talent attraction policies, strong research-industry cooperation and state-of-the-art AI infrastructure, Luxembourg reinforces its position as a key driver of AI development and innovation.

Recent legislative measures include streamlining the EU Blue Card process, facilitating post-graduation work

permits for non-European researchers, and granting family members of third-country nationals unrestricted access to the job market. These initiatives fuel a welcoming environment for top AI professionals and strengthen Luxembourg's AI ecosystem.

Ambition: Empowering AI practitioners

Luxembourg's strategy for **cultivating AI practitioners** is two-fold: strengthening the talent pipeline through academic programmes and addressing immediate skill gaps through upskilling and reskilling initiatives. The following initiatives are central to this strategy:

- **Structured AI apprenticeship programme** with the Luxembourg Institute of Science and Technology (LIST): Collaborative AI research projects that the LIST conducts with SMEs who cannot assign staff to long, formal training programmes. This results in the upskilling of mid-career professionals into AI experts, domain-focused AI practitioners and AI-savvy business leaders through a combination of training, on-the-job learning and mentoring, thus boosting AI-innovation among SMEs.
- **Hands-on HPC training sessions** with LuxProvide, Luxembourg's national supercomputing centre and the Digital Learning Hub: Practical training solutions to equip practitioners with the necessary technical and operational skills for AI deployment.
- **Data literacy courses** with LNDS and with the Luxembourg training institute for the public sector (INAP).
- **AI4All continuing professional education platform:** Blends Massive Open Online Courses (MOOCs) hosted at the University's Competence Centre with in-person trainings and workshops offered by partner training institutions, such as the Digital Learning Hub, the House of Training, the LIST, industry partners, etc., providing participants with both theoretical and practical AI skills.
- **An extended continued education offer for AI skills:** Development of modular courses to enable participants to gradually build expertise.

Such a continued education offer would reinforce Luxembourg's commitment to customised, high-quality AI education. Developed within the AI4All programme, these adaptable courses can also be applied to other technological fields.

While the focus here remains on AI practitioners with technical expertise, it is also important to recognise the equally important role of professionals with complementary skills (AI governance, cybersecurity or project management), who ensure responsible deployment and alignment with organisational goals.

Ambition: AI expertise and engagement in higher education

The University of Luxembourg's comprehensive talent strategy aims to attract, develop, and retain high calibre experts and professionals in AI. It features competitive salaries, state-of-the-art research facilities, opportunities for interdisciplinary collaboration and research support.

› **Action 1:** Expanding AI integration in higher education

To equip students at the University of Luxembourg with cutting-edge skills, faculty will continuously update **AI curriculum** to reflect the latest industry trends and technological advancements. This approach encompasses all education cycles, Bachelor, Master and Doctorate, in line with the University's **comprehensive talent strategy**.

- **Master in Information and Computer Science** provides a specialisation in AI that teaches students to use state-of-the-art approaches and tools for assessing large amounts of data; explore and extract knowledge from large and/or complex sets of information; implement and apply machine learning methods for solving common AI problems; use logic to formalise knowledge and present reasoning, in particular in multi-agent systems and deontic contexts.
- **Master in Data Science**; **Master in High Performance Computing;** and **Master in Cybersecurity and Cyber Defence** provide a variety of courses on Machine Learning, Deep Learning and Natural Language Processing.
- Furthermore, The University of Luxembourg and ILNAS offer the **Master in Technopreneurship (MTECH)** to equip professionals with skills in AI standardisation, smart technologies, and trustworthiness—combining hands-on industry projects with close collaboration between academia, research, and technical standardisation communities.

Luxembourg secondary schools offer numerous BTS (*Brevet de technicien supérieur*) programmes: two-year post-secondary courses worth 120 ECTS. That already includes a **BTS programme for Applied Artificial Intelligence** that educates students on the use, design and training of AI models through both theoretical and practical approaches.

In addition to its technical focus, the **University of Luxembourg Institute for Digital Ethics (ULIDE)** aims to encourage and support faculties in integrating key principles of risk ethics, fairness, transparency, and sustainability into AI-related courses, equipping

students to address the societal implications of AI, such as fake news, algorithmic bias, and inclusivity in AI applications.

› Action 2: Implementing the "AI Sphere" initiative

The University of Luxembourg is expanding its science collaboration efforts with the "AI Sphere" initiative, which builds a bridge between academia, industry and society. It enriches academic learning through practical applications, industry collaborations and interactive engagement. It connects AI talent with industry and society through maker spaces, hackathons and real-world AI projects. This enables companies to engage with skilled talent, develop AI solutions, and recruit future employees.

Students and researchers gain hands-on AI experience, industry exposure and opportunities for internships and research partnerships. The "AI Sphere" initiative promotes gender diversity in science, notably by building on the annual "Women & Girls in Science" campaign, which aims to encourage the participation of women and girls in STEM fields.

The "AI Sphere" initiative complements existing, formal AI skills programmes, such as the national AI Factory's AI4ALL. As the University of Luxembourg reinforces its role as a hub for AI education, innovation and industry collaboration, it provides policymakers with valuable insights to shape Luxembourg's digital economy.

Ambition: Future-ready students and teachers for an AI-driven future

AI literacy is becoming an essential skill for students and educators alike. AI-enabled tools are already part of everyday school life—personalising learning, improving assessment processes and enabling timely feedback. These tools can foster creativity, collaboration and critical thinking, while streamlining administrative tasks. However, realising these benefits require comprehensive strategies that empower students and teachers to use AI responsibly, critically, creatively and effectively.

› Action 3: Responsible, forward-looking and inclusive AI integration in education

Luxembourg's aim is to prepare students and educators for life and work in an AI-driven world where AI will be increasingly prevalent by promoting AI and data literacy at all levels of education. The concept of augmented intelligence lies at the heart of the current strategy of the Ministry of Education: human-AI collaboration that enhances teaching and learning, supports well-being and keeps human agency at the centre. Our focus centres on creating a reflective and critical AI culture that maximises opportunities while addressing risks.

- **Targeted trainings and professional development programmes** will equip teachers and school leaders with the skills they need to confidently integrate AI. A **national AI platform** will provide schools with tools compliant with the General Data Protection Regulation (GDPR) and pedagogically validated, accompanied by clear guidance, inspiring practices and training resources.
- An **AI-driven curriculum database** and a **sovereign national chatbot for professionals** will be developed to improve pedagogical planning, ensure data protection and promote innovative teaching and learning at all levels of the education system.
- In addition, a **central advisory body** will support schools on legal, technological and pedagogical issues, ensuring that the use of AI is consistent with ethical standards and privacy regulations.
- The strategy emphasises embedding **AI and data literacy in national curricula** to prepare students for the digital future, ensuring they become critical thinkers and responsible, creative users of technology.

Beyond pedagogical applications, the Ministry will explore **AI-driven automation, such as bots and virtual assistants,** and how they could support administrative workflows, streamline communication and efficiently manage routine tasks. These tools help reduce the workload of teachers and school leaders, allowing them to focus on student learning and leadership. Ensuring the responsible, safe and human-centred integration of such solutions is critical to maintaining high standards in education.

Ambition: Upskilling the labour force

AI's impact on jobs and skills already shows. Its transformative shift will affect a wide range of workers—from knowledge professionals and programmers to factory workers. According to the International Labour Organization (ILO), the impact of AI on jobs depends on the composition of tasks within an occupation. While automation technologies historically had the greatest impact on employees with lower levels of education, AI will likely have a higher impact on more educated employees. By 2030, 60% of jobs could have 30-40% of their tasks altered by AI, underscoring the urgency for upskilling and reskilling.

Globally, the ILO estimates that 13.4% of jobs could be enhanced by AI, while 5.1% may face displacement risks. Jobs that rely on manual skills or interpersonal relationships are likely to be complemented and enriched by AI technologies. This dual effect—risk and opportunity—underlines the nature of AI's potential.

› Action 4: Building AI skills for All

Luxembourg remains committed to embedding AI literacy and digital skills into professional development, ensuring that individuals can adapt, critically assess AI applications and work effectively with AI-enhanced systems.

- Institutions, such as the National Centre for Continuous Vocational Training (CNFPC), the National Employment Agency (ADEM), the Digital Learning Hub, the Luxembourg training institute for teachers (IFEN) and INAP, will expand AI-related competencies in their training programmes to enable continuous upskilling across industries and professions.
- By enhancing accessibility, flexibility and sector-specific AI training, Luxembourg's upskilling strategy will ensure that AI adoption is inclusive, ethically grounded and responsive to evolving labour market demands. Training courses will be developed with different learners in mind. Special attention will be paid to those groups who are particularly vulnerable to being left behind by technological advancements, such as those seeking employment, the elderly or those with disabilities.
- AI4ALL, a programme organised by the University of Luxembourg in cooperation with LIST and the Digital Learning Hub, offers flexible, modular learning pathways that adapt to fill skills gaps and sector-specific needs. Participants can progress from entry-level AI foundations to advanced, industry-specific applications. The programme uses both online MOOCs and in-person trainings. It fosters continuous upskilling opportunities across key sectors: finance, space, cybersecurity and the green economy, for example, bridging theoretical knowledge with real-world AI applications.

› Action 5: Business-driven upskilling

AI adoption varies across industries, each facing unique challenges and opportunities. Identifying sector-specific pain points enables the development of tailored training solutions that support companies in integrating AI effectively. Close collaboration with employers ensures that training programmes remain relevant, responsive, and aligned with evolving market needs. Public-private partnerships leverage AI expertise to enhance continuous vocational education and training (cVET), creating customised programmes that equip labour forces with targeted, high-impact AI skills to drive competitiveness, efficiency and innovation.

› Action 6: Structured AI traineeships

Structured AI traineeship initiatives between the University of Luxembourg, LIST and leading AI companies provide a dual advantage: students gain invaluable hands-on experience by contributing to AI-related projects, while companies actively shape the next generation of AI experts. This collaboration ensures a pipeline of talent equipped with cutting-edge knowledge and practical skills.

› Action 7: AI onboarding |helping companies harness their data and AI

Recognising that most companies using AI will not develop it in-house, we are making efforts to provide them with guidance on the initial steps of adoption. New strategic educational programmes tailored for executive management and delivered by institutions like CNFPC and the Digital Learning Hub, help companies navigate complexities and acquire the interdisciplinary skills required for successful AI implementation. This includes project management, cybersecurity, legal compliance and ethical considerations, such as bias.

Targeted support and training measures aim to demonstrate the tangible benefits of AI for SMEs, helping them identify and implement individual solutions tailored to their specific needs. Larger companies, on the other hand, may require advanced frameworks to scale AI adoption across their operations.

Ambition: Informed citizens and AI literacy

Rounding out the government's goal of making Luxembourg an AI-ready nation is the ambition to offer the resources necessary to level up our citizens' AI literacy level. This is crucial for the quality of our democratic discourse and keeping individual decision-making safe from AI risks.

› Action 8: Promoting the "Elements of AI" MOOC

The Luxembourg government actively supports the "Elements of AI" MOOC as part of its **commitment to fostering AI literacy among its population**. In collaboration with the University of Luxembourg Competence Centre (ULCC), the Finnish course has been tailored to meet Luxembourg's unique needs, incorporating features such as in-person study groups

and expert-led webinars to complement the online learning experience.

By engaging national partners like the Luxembourg training institute for teachers (IFEN), the Digital Learning Hub, and the Luxembourg training institute for the public sector (INAP), the initiative ensures accessibility and relevance across diverse audiences, including educators, professionals and the general public.

Participants who complete the course through the dedicated portal receive a certificate issued by the ULCC. Through initiatives like this one, the government **plans to equip at least 1% of the population with foundational AI knowledge**, in alignment with broader European digital literacy goals.

› Action 9: Promoting the University of Luxembourg Institute for Digital Ethics (ULIDE)

The Institute for Digital Ethics at the University of Luxembourg **offers AI ethics and awareness opportunities** for the public, students, educators, and professionals to promote understanding of responsible AI practices. It engages policymakers, researchers and industry leaders to best align AI development with ethical standards and sustainability goals. By fostering awareness across diverse groups, we create a well-informed society capable of critically engaging with AI technologies.

2. Infrastructures

Securing the foundations that enable AI technology

Luxembourg enjoys robust digital infrastructure. Its connectivity, energy grid infrastructure and processing power are both substantial and sovereign. All planned infrastructure and services development exploits these advantages.

Ambition: Continuous investment in sovereign digital capabilities

Luxembourg aims to continuously develop sovereign and cutting-edge digital infrastructures to enhance its technological capabilities while contributing to data security. This dual approach - sovereignty and technological excellence - serves as a strategic lever for AI innovation.

› Action 10: Operationalising MeluXina-AI

Luxembourg was recently awarded a state-of-the-art, AI-optimised supercomputing system, MeluXina-AI, through a European call for expressions of interest. The MeluXina-AI project will be owned by EuroHPC JU and operated by LuxProvide. Its implementation and operational launch are planned for mid-2026, following a procurement phase led by EuroHPC JU in 2025, based on the specifications outlined in Luxembourg's proposal. MeluXina-AI will be installed alongside existing MeluXina HPC infrastructure, eventually replacing it and seamlessly connecting to the future MeluXina-Q quantum computing platform.

MeluXina-AI is designed to deliver multi-exaflop performance, efficient data storage and low-latency interconnect fabric. It prioritises security and resilience through its ISO 27001 certification, multi-site redundancy and compliance. MeluXina-AI's adaptability supports evolving needs and integrates with national and European services. Sustainability remains a core focus, as seen through its energy-efficient design and low carbon footprint. The system's accessibility and user-friendliness take into consideration diverse communities, while its SaaS sandbox allows for safe experimentation.

› Action 11: Promoting sovereign cloud resources

While key government agencies like CTIE and the financial regulator CSSF have become launch clients of disconnected sovereign cloud solutions provided by Luxembourg-based vendors, the government looks to continue boosting overall sovereign cloud solution offers. Significant European cloud providers have recently started offering Luxembourg-based sovereign cloud solutions to the EU market. Additionally, several hyperscalers have announced cloud offers in Luxembourg for projects requiring national data localisation.

Both companies and institutional actors can benefit from this variety of cloud possibilities while maintaining an edge in the area of AI services. This significantly strengthens Luxembourg's positioning as a host country for international institutions.

Luxembourg has advanced broadband connectivity, enhanced by AI to optimise 5G networks, reduce energy consumption, and improve traffic management and cyber security.

Ambition: Connectivity infrastructure boosted by AI

Luxembourg enjoys extensive ultra-high bandwidth connectivity infrastructure, which will grow in efficiency as more and more components turn to AI-based technologies.

AI brings efficiency to 5G network slicing, allowing telecom operators to offer customised network segments for specific use cases, like IoT (Internet of Things) or high-bandwidth applications. AI can optimise the operation of Massive MIMO (Multiple Input Multiple Output) and beamforming technologies, which are crucial in 5G networks. AI facilitates efficient energy usage by allowing the power levels and directions of beams to be dynamically adjusted based on user demand and location. It also helps manage edge computing resources, ensuring low latency and high reliability for critical applications, such as those linked to autonomous vehicles and remote surgery.

AI-based traffic management can address the challenges faced by both fixed and mobile networks. In fixed networks, AI focuses on optimising stable, high-capacity connections. In mobile networks, it manages dynamic and variable conditions, for instance user mobility. In both cases, AI enhances network performance, reduces congestion and improves the overall user experience by intelligently managing traffic in real time. It can improve the forecasting of supply and demand, enhance energy efficiency measures, leverage the flexibility of batteries and demand response, enable more efficient energy trading, and optimise the planning and operation of networks and connectivity.

AI has the potential to transform threat detection by (1) monitoring network traffic for unusual patterns that may indicate security threats, such as DDoS (Distributed Denial-of-Service) attacks or unauthorised access, and (2) responding immediately. In the future, automated incident response could minimise the impact of security breaches and reduce response times. In essence, AI gives telecom operators new ways to enhance their operational efficiency, improve customer experience and unlock untapped revenue streams, all while maintaining a robust and secure network. This not only supports competitiveness, but also preserves flexibility in the face of rapidly evolving demands within the telecommunications industry.

AI tools can manage adapted sleep modes for network equipment, such as routers, switches and base stations, during low traffic periods. By adjusting sleep cycles based on predicted demand, operators significantly reduce energy consumption without affecting service quality. AI is poised to assist in the design and expansion of network infrastructure by analysing energy consumption patterns and recommending configurations that minimise energy use. For example, during off-peak hours, AI can reduce the power consumption of base stations or even selectively shut down underutilised network components.

Ambition: Energy considerations for AI and Luxembourg's digital infrastructure

The future of AI technologies and infrastructure will involve a rapid increase in energy requirements for data collection, storage and processing. Reliable, sustainable and affordable electricity will be essential to support the widespread adoption of digital solutions, attract businesses and enable large-scale infrastructure deployment. At the same time, the rapid growth of digital infrastructure, particularly through AI solutions, will present significant challenges and opportunities that will need to be managed carefully to ensure a balanced deployment in the following areas:

Renewable energy: renewable energy will be central to meeting the future energy needs of AI technologies. As AI continues to evolve, Luxembourg will require larger quantities of renewable energy to achieve its sustainability goals and reduce carbon emissions.

Energy efficiency: To ensure the most efficient use of resources and energy, Luxembourg plans to adopt frugal AI practices. These practices focus on optimising AI models to reduce their computational, memory, and energy consumption.

Development of networks: The increased demand for electricity due to AI and data centres will lead to improvements to Luxembourg's electrical grids, which in turn will ensure a stable, reliable, and scalable power supply.

Although energy is a critical consideration, Luxembourg provides a reliable, sustainable, and affordable supply

that will serve as a crucial foundation to become a sustainable AI development hub. By attracting investments, creating jobs and fostering innovation, it is possible to stimulate growth in both the energy and tech sectors. This vision positions Luxembourg as a pioneer in sustainable AI and a model for how digital infrastructure and energy systems can work together to support an energy-friendly future.

3. Service ecosystem

Accelerating AI innovation and implementation

To properly support the private sector, in particular startups and SMEs, Luxembourg offers services catered to diverse needs. As part of the effort to provide a simplified regulatory environment that boosts innovation, AI sandboxes give companies a safe space to innovate. The Luxembourg AI Factory, alongside MeluXina-AI and its next-generation computing resources, provides key services.

Ambition: Fostering an integrated AI innovation ecosystem

Luxembourg's ambition is to create an integrated AI innovation ecosystem, connecting all actors, resources and initiatives to accelerate AI adoption, development and deployment.

› **Action 12:** Luxembourg AI Factory I a one-stop-shop for AI services

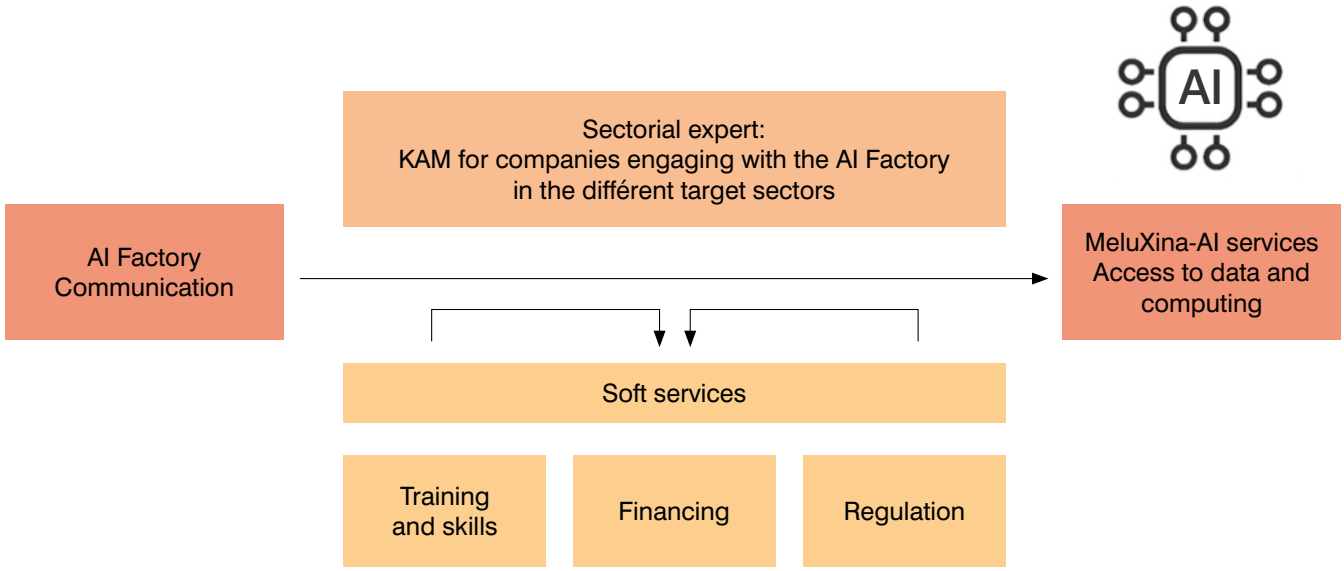
Designated to become a **premier one-stop shop** for AI services, the Luxembourg AI Factory will help companies explore, develop and deliver AI-driven projects. To provide a comprehensive suite of services, it will leverage the expertise and experience of five consortium members:

- **LuxProvide**, Luxembourg's national supercomputing centre, will implement and operate MeluXina-AI, provide HPC-AI engineering solutions, applications and support services to the ecosystem.
- **Luxinnovation,** the national innovation agency, will engage with private-sector companies to identify AI innovation opportunities, making companies more competitive and expanding the use of AI. Moreover, the agency will coordinate AI incubation activities and establish partnerships with other AI Factories.
- **LNDS,** which specialises in cross-sectorial data management and data value creation from secondary use, will facilitate access to the large volumes of high-quality data essential for AI development. It will help build up capabilities within the AI ecosystem, including ethical, legal and social-impact support tailored to recent data and AI regulations, while also collaborating with the EU AI Office.
- **LIST and the University of Luxembourg**, both public research organisations, will focus their research on concrete AI applications, in close partnership with the private sector. Furthermore, they will support skills development, provide access to specialised laboratories and facilities, and maintain an AI technology watch.

On top of these five consortium members, the Luxembourg AI Factory will be further supported by several associated ecosystem partners. The Luxembourg AI Factory's central office, established at Luxinnovation in Belval, will serve as the first point of contact for companies, researchers and other relevant stakeholders interested in AI adoption. This office will offer initial consulting services and assessments of each company's needs, potentially steering them to one of the five AI hubs for additional services and resources:

- Finance AI hub (LHoFT, Luxembourg House of Financial Technology)
- Space AI hub (LSA, Luxembourg Space Agency)
- Cybersecurity AI hub (LHC, Luxembourg House of Cybersecurity)
- Green Economy AI hub (LIST)
- Sector-agnostic AI hub for all other fields (Technoport)

This strategic approach is designed to maximise interaction between AI experts (solution providers) and sectoral players (solution adopters), including private companies, incubators, researchers, students, investors and Luxembourg AI Factory support teams. These hubs put private companies in close proximity



Visual of the AI Factory

to AI experts specialising in their field, which will facilitate collaboration and the development of common projects.

A comprehensive set of services for the AI ecosystem:

The Luxembourg AI Factory aims to support and stimulate a vibrant AI ecosystem in Luxembourg by fostering collaboration, knowledge exchange and mutual growth. This initiative will not only guide businesses in sharing insights, but also provide a platform for joint problem-solving to accelerate AI adoption, development and deployment.

The Luxembourg AI Factory is committed to supporting each relevant stakeholder, regardless of their level of AI maturity, expertise or size of organisation. This includes demystifying AI and providing digital literacy via specific training and project-based consulting services, as well as compliance support and networking activities. Its specific activities encompass the following:

- Guide businesses from ideation to execution in order to support every phase of AI adoption by offering these services:
  - Advanced AI solution building
  - AI maturity assessments
  - Regulatory sandboxes
  - Data-sharing frameworks
  - Data access and valorisation
- Foster AI expertise development through training and upskilling programmes, enabling companies to build and expand in-house AI capabilities.
- Connect businesses with AI accredited experts and funding sources, including Horizon Europe, R&D and Innovation grants, and financial incentives.
- Support companies in defining AI use cases and conducting feasibility studies, ensuring a structured and strategic approach to AI integration.

› Action 13: Collaborating strategically by uniting national initiatives

To foster innovation and harness synergies across different sectors, the Luxembourg AI Factory will work closely with existing national initiatives:

- The **Luxembourg Digital Innovation Hub (L-DIH)** supports Luxembourg-based companies, especially SMEs, in their digital transformation journey, with a focus on the manufacturing sector. It provides technology testing, skills development and access to funding opportunities to help companies assess their digital maturity, identify gaps and implement solutions that improve competitiveness. The Luxembourg AI Factory will enhance the L-DIH's services by integrating advanced AI capabilities into its offerings.
- The National Competence Centre for Super Computing (NCC Luxembourg) provides businesses and researchers with access to HPC resources and expertise. The project focuses on enhancing HPC knowledge and skills, making HPC more accessible to Luxembourg's industry and research communities. The NCC plays a pivotal role in enabling the development of cutting-edge

The Luxembourg AI Factory supports all stakeholders in accelerating the adoption and responsible use of AI through collaboration, training and personalised support.

technologies that require vast computational power, including AI, simulations and big data processing.

- The **Intellectual Property Institute Luxembourg (IPIL)** creates awareness around the importance of intellectual property and builds the capacity for **applying IP-rules to AI-projects** through trainings and guidance. IPIL links stakeholders involved in AI-projects to a network of 300+ IP professionals available in Luxembourg to ensure high level IP-related legal advice.

Ambition: Targeted funding for AI development and adoption

Luxembourg has created a robust funding ecosystem: A diverse range of funding opportunities spans the entire value chain, encouraging the commercialisation of academic research.

The Luxembourg AI Factory will play a crucial role in these initiatives, either by complementing existing activities or expanding their capabilities.

› Action 14: New thematic AI funding opportunity

The **National Research and Innovation Strategy** will be revised to reflect new strategic areas, including AI. The defined research priorities directly apply to the majority of the National Research Fund's (FNR) funding programmes, particularly CORE. Updating the National Research and Innovation Strategy to reflect developments in digital technologies encourages high-quality research projects in relevant fields. Additionally, the possible introduction of a new funding instrument for mission-driven research will be explored.

The Ministry of the Economy, the Ministry for Research and Higher Education, and the FNR encourage collaborations between public research institutions and private companies through **thematic joint calls for Private Public Partnership (PPP) projects** to foster technology and knowledge transfer between academia and industry in strategic areas, such as AI.

Private companies already benefit from a range of research, development and innovation instruments offered by the Ministry of the Economy. They support AI innovation under the umbrellas of innovation, new technologies and high-performance computing. These funding schemes utilise a project-based, bottom-up approach, nevertheless, AI innovation could benefit from a top-down framework. Therefore, the introduction of thematic calls with adjusted financial aid rates will be considered to incentivise specific types of innovation among private companies.

Beyond national support, Luxembourg actively encourages local companies to pursue **European funding opportunities and engage with collaborative AI initiatives**.

› Action 15: Supporting the creation and growth of AI startups

Startups and scale-ups are particularly vital to AI innovation. Luxembourg offers dedicated support that follows its "From Seed to Scale" roadmap and its resulting action plan for the startup ecosystem's development. It aims to offer a comprehensive set of services and programmes that cover the entire technology transfer process, from **spin-off development** to **startup creation** and **growth**.

To increase the number and quality of spin-offs with value propositions based on Luxembourg research, a **technology transfer strategy working group** has recently been set up, composed of key national stakeholders. It sets out to identify current obstacles to the creation and successful development of spin-offs and to propose an action plan for overcoming them.

Building on the success of Fit4Start—Luxembourg's flagship national seed funding initiative for early-stage startups—a **Fit4Scale programme** to help startups scale and expand into new markets will be launched. Both programmes focus on strategic areas and offer components tailored to the unique needs of AI ventures at different growth stages.

An essential pillar of a supportive startup ecosystem is access to investments**.** A range of funds to finance startups at the seed stage, such as the *Digital Tech Fund*, *Orbital Ventures* and the *Luxembourg Future Fund* are already in place.

To further encourage private investment in startups, **tax credits** will be introduced for investments in young, innovative enterprises by individual taxpayers.

› Action 16: AI integration support for SMEs

The Ministry of the Economy will offer various support modules to companies, particularly SMEs, to spur the adoption of digital technologies.

AI specific measures complement the available support for businesses, accelerating AI adoption among SMEs and boosting competitiveness:

- **AI-focused SME Package I** Supports SMEs in their first steps toward AI adoption and provides simple, easy-to-implement solutions.
- **Fit 4 Digital – AI I** Offers businesses the opportunity to collaborate with an experienced consultant to define challenges, objectives and priorities; includes a feasibility analysis of pre-selected use cases and the development of a roadmap (detailed action plan, cost estimates, the selection of an AI solution—whether generic or custom-made—and an estimated return on investment).

Ambition: Facilitating responsible AI experimentation

Sandboxes are structured frameworks for innovators to develop and test new ideas, products, business models and services in a controlled environment. Regulatory sandboxes are organised under the supervision of a competent authority and provide a structured process for companies that want to responsibly enter the AI market without legal uncertainty.

› Action 17: AI regulatory sandboxes

In May 2024, Luxembourg's National Data Protection Commission (CNPD) launched a regulatory sandbox focused on data protection in relation to AI. This isolated digital environment allows innovators to test AI systems for personal data protection and GDPR compliance before they enter the market. These tests are conducted in collaboration with local stakeholders. AI developers can collaborate with the CNPD to address data protection issues and potential privacy risks. Such pre-emptive efforts contribute to safer and more trustworthy systems.

The CNPD will set up a national AI regulatory sandbox under the AI Act once the relevant national law comes into force.[8]

The CGPD will also propose a regulatory sandbox for AI in accordance with the AI Act. The AI Act implementation bill will allow the sandbox to be integrated into the secure processing environment established by the CGPD, in compliance with EU data reuse regulations. This supports administrative simplification, procedural alignment and legal certainty.

› Action 18: LIST - LLM Observatory and technical sandbox[9]

In February 2024, LIST introduced an AI Sandbox for companies, AI developers and regulators to perform independent assessments of AI algorithms in light of the new AI Act requirements, which differ by sector and use case. LIST also released to the public the LLM Observatory, which assesses the social biases of the most popular large language models (LLMs). Biases include those based on sexual orientation, age, gender, politics, race, religion and ethnicity. The LLM social bias leaderboard makes citizens aware of the implicit bias embedded in LLMs. Companies can use the leaderboard to select the pre-trained model best suited for their specific needs and test their solutions based on pre-trained LLMs.

[8] Committee of Media and Communication, Law Project n°8476, Chambre des Députés.pdf

[9] The LIST AI Sandbox, Link: ai-sandbox.list.lu

4. Research, development and innovation

Transforming ideas into solutions

Small countries with limited resources cannot compete with larger nations capable of making massive investments in AI foundation models. Instead, Luxembourg must strategically focus its investments to maximise impact and competitiveness.

Ambition: Driving excellence in trusted, sustainable and secure AI development

As a country with a small research and innovation ecosystem, Luxembourg will define strategic priorities in the field of AI that leverage our ecosystem's overall strengths and ambitions.

› Action 19: Trusted, responsible and sovereign AI

Luxembourg, with its internationally known financial sector, has always emphasised providing trusted infrastructure for citizens and companies. It takes a similar approach to AI systems, for which trust is central to adoption. Research and innovation projects financed by Luxembourg will always consider ELSI – Ethical, Legal and Social Issues.

By focusing on trusted AI, Luxembourg fosters public confidence in AI technologies, encouraging their uptake in critical sectors such as healthcare, finance and governance. The pursuit of trusted AI includes financing research to develop frameworks for AI auditing, certification and ethical guidelines that preserve fair, responsible AI systems. Luxembourg is already active in this domain:

- LIST's HANDS (Human Centered AI, Data, and Software) Unit is comprised of 100+ researchers and engineers working on ethical AI assessment, AI trustworthiness, explainable AI, AI user acceptance and AI compliance, among other topics. LIST also operates a node of the Citcom.ai TEF (Testing and Experimentation Facilities) for testing AI in Smart Cities and Communities as well as a node of the EnerTEF project, addressing the need for reliable, rigorously tested AI tools in real-world energy environments.
- In February 2024, LIST released a technical AI sandbox designed to help AI developers ensure the trustworthiness of their solutions in preparation for the AI Act. The sandbox features a public assessment of the social biases of LLMs.
- LIST is also exploring how traditional AI metrics and benchmarks can expand to include aspects of trustworthiness, resilience and accountability as part of the EDF STORE project.
- The SnT (Interdisciplinary Centre for Security, Reliability and Trust) hosts the TruX Research Group committed to building explainable machine learning algorithms addressing the challenges related to the trade-off between accuracy and interpretability.
- The Chair in Cyber Policy, established by the Luxembourg Directorate of Defence and the University of Luxembourg, undertakes in-depth studies, engages in research activities and offers strategic advice and recommendations on policy, ethical and legal challenges related to AI.

› Action 20: Frugal AI and model efficiency

AI model efficiency and compression is an active area of research because of its importance to optimal resource utilisation. **Luxembourg will develop expertise in creating lightweight, efficient AI models that require less computational power and energy** and can run on edge nodes. This not only reduces operational costs but makes AI more accessible to a broader range of applications and users. By focusing on model pruning, quantisation and knowledge distillation, for example, it becomes possible to develop AI solutions that are both powerful and resource-efficient, thus accessible to users that cannot invest heavily in specialised hardware.

The ability to run lean and resource-efficient models on personal devices will become possible, resulting in increased privacy. Data distillation presents another promising approach. It consists of creating small datasets with which it is still possible to train models and achieve high accuracy. Luxembourg will leverage synthetic data to overcome the limited availability of national real-world data.

› Action 21: AI for security and security of AI

In the wrong hands, AI technologies heighten the threat of social engineering, deepfakes, phishing and malware attacks. Protecting people and assets from cyberattacks, fake news and other threats against society now takes on a new level of urgency.

Fortunately, AI can also be a strong ally for creating affordable cybersecurity tools and services. Continuously updated AI-enabled-countermeasures could be the perfect antidote to AI-crafted attacks. Research, as well as the AI Factory, will fuel new AI-enhanced cybersecurity tools and services for SMEs and larger entities.

AI-based systems are inherently unpredictable due to their statistical nature, sometimes producing incorrect or irrational outputs (so-called *hallucinations*). This stems from the intrinsic fragility of AI models and the complex, often unpredictable interactions between AI components and traditional software or hardware. Securing these systems presents a major challenge. The LHC and Luxembourg's active research community will, for their part, develop assessment tools that detect vulnerabilities, mitigate risks and strengthen AI models before and during deployment. Robust security measures are essential to ensuring AI reliability; preventing exploitation, pollution and exfiltration; and maintaining trust in AI-driven decisions.

Ambition: AI as a catalyst for research innovation

AI acts as a transformative force that accelerates and amplifies innovation in research. By leveraging the possibilities offered by this technology, Luxembourg aims to develop a vibrant and creative research environment conducive to significant scientific advances.

› **Action 22:** Software engineering for AI and AI for software engineering

AI is on the verge of transforming software engineering, and it is critical to adapt our skills accordingly. Developing, fine-tuning, testing and using AI-powered software relies on rigorous software engineering principles, such as modular design, testing, maintenance and reproducibility. AI can implement software engineering best practices on its own. In the very near future, a single software engineer will be able to deploy AI agents that automate routine tasks, enhance debugging and even generate codes. Luxembourg does not foresee this leading to a decrease in demand for software engineers. On the contrary, as they become more productive thanks to AI, demand for AI-savvy software engineers will increase.

To fully realise this vision, the **University of Luxembourg will tailor new degree programmes that blend core software engineering with advanced AI studies**. These programmes would combine courses in traditional software development, algorithms and data structures with subjects like machine learning, data science, AI ethics and human–computer interaction. The University of Luxembourg's Master in High Performance Computing, Master in Data Science and Master in Computational Biomedicine, will offer courses that equip students with the skills aligned with software engineering best practices. Such degrees would prepare graduates to design, build and manage AI systems that are reliable and maintainable, while also equipping them with the skills to develop AI agents that streamline software development processes.

› **Action 23:** AI for scientific discovery

Luxembourg will invest in AI for scientific discovery in order to accelerate breakthrough discoveries across various disciplines. These investments will support the development of specialised AI systems capable of generating novel hypotheses, analysing complex experimental data, automating laboratory processes, and modeling phenomena too intricate for traditional computational methods. By establishing cross-disciplinary collaborations between AI specialists and domain scientists, and creating shared infrastructure for data and computational resources, Luxembourg will be positioned at the forefront of AI-driven scientific advancement.

Citizen onboarding

Since these projects all rely on citizen support, Luxembourg will launch a series of **Citizen Onboarding for AI Projects** campaigns. The initiative aims to engage society in understanding and participating in AI research and development. By conducting structured interviews, discussions and educational campaigns, it will gather insight into public views and concerns regarding AI, focusing on ethics, data sharing and the societal impact. Through advertising and outreach efforts, including newspaper articles and social media campaigns, the initiative will promote the benefits of AI research and encourage broader participation. Additionally, citizen science projects will allow individuals to actively contribute to AI data collection and research, fostering a sense of ownership and involvement.

Luxembourg is developing a trusted, efficient and secure AI system, tailored to its resources.

5. Governance and regulations

AI adoption hinges on trust

Ambition: Clear regulatory guardrails

The EU has succeeded in establishing a unique framework within the internal market: the challenge now is to ensure an effective, pragmatic, and harmonised implementation in practice. Luxembourg welcomes the entry into force of the regulation on AI, which it considers an important step towards a safer and more ethical framework for this technology. While supporting its general objectives, Luxembourg remains attentive to its concrete implementation, which will constitute a decisive phase to fully evaluate its effects and adjust, if necessary, certain provisions according to operational realities.

› **Action 24:** Fast and practical implementation of the AI Act[10]

The European Artificial Intelligence Act entered into force on August 2, 2024, and the first provisions became applicable in February 2025. This regulation supports the development of human-centric and trustworthy AI that takes advantage of opportunities and protects against risks. It takes a horizontal and risk-based approach, prohibiting harmful AI practices contrary to EU values.

The AI Act also establishes a risk assessment methodology to identify “high-risk” AI systems, which may significantly affect health, safety or fundamental rights. These systems will have to meet a set of horizontal mandatory requirements and undergo a conformity assessment before being marketed in the EU.

Compliance will be overseen by a national governance system based on existing structures, as well as a European cooperation mechanism.

Luxembourg supports a pragmatic implementation that minimises the regulatory burden for businesses. Regulatory dialogue on highly complex AI use cases must be encouraged, structured, and oriented toward tangible solutions. At the same time, Luxembourg will support the new AI Office of the European Commission in its critical role at the centre of EU technology regulation.

For effective application and enforcement of the AI Act at the national level, bill no. 8476 was tabled on December 23, 2024. Since the regulation is directly applicable, the bill focuses primarily on designating the competent national authorities, defining powers and setting penalties. Luxembourg’s proposed approach relies on a decentralised approach, leveraging the expertise of already existing authorities who are experts in their respective fields (such as the CSSF for financial sector actors), in order to simplify interactions for businesses as much as possible. In the absence of a specific sectoral authority, the CNPD will be the default market surveillance authority and coordinate the lead authorities charged with monitoring their respective sectors in order to ensure harmonised application of the AI Act in Luxembourg.

› **Action 25:** Implementing the Framework Convention on AI, Human Rights, Democracy and the Rule of Law of the Council of Europe[11]

Luxembourg actively participates in the work of the Committee on Artificial Intelligence (CAI) of the Council of Europe. The CAI works on HUDERIA (Human Rights, Democracy and Rule of Law Impact Assessment), a methodology for identifying contexts in which AI systems could threaten human rights, democracy and the rules of law, and ways to assess and mitigate these risks.

The Framework Convention on Artificial Intelligence and Human Rights, Democracy and the Rule of Law aims to establish a legal framework that ensures AI systems respect human rights, democracy and the rule of law. It promotes responsible AI governance by defining binding international standards for transparency, accountability and risk management. The convention collaboratively addresses AI-related challenges while encouraging innovation and ethical AI development. By harmonising regulations, it provides a common foundation for AI policies across member and non-member countries. The Convention is the first internationally binding agreement on AI and aligns fully with the EU AI Act. In September 2024, the EU Commission signed the Convention on behalf of the EU at the informal conference of the Council of Europe Ministers of Justice in Vilnius.

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[10] Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending Regulations (EC) No 300/2008, (EU) No 167/2013, (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1139 and (EU) 2019/2144 and Directives 2014/90/EU, (EU) 2016/797 and (EU) 2020/1828

[11] COE, The Framework Convention on Artificial Intelligence, Council of Europe 2024

› **Action 26:** Recognising cybersecurity aspects of AI regulation

European legislators have established security requirements proportional to the inherent risks associated with using AI systems. The AI Act mandates an overall risk-based approach. To properly implement cybersecurity measures, providers of high-risk AI systems should refer to harmonised standards (yet to be adopted) and, if needed, provide proof of compliance through cybersecurity certifications. This links to the **Cybersecurity Act**, which harmonises certification across Europe. Since AI systems are often integrated into business processes, regulated entities must include these systems within their compliance efforts. This ties the AI Act to **NIS2**, **DORA** and other **sector-specific regulations**, such as those in healthcare. The AI Act also requires that specific high-risk AI systems meet the essential cybersecurity requirements outlined in the **Cyber Resilience Act** (CRA).

Ambition: Reducing red tape through AI

AI can play a pivotal role in ensuring compliance with regulations and standards across various industries. Luxembourg will use AI to automate compliance processes where possible, reducing the burden on businesses and making regulatory adherence more efficient. This does not mean lowering standards but making it easier to achieve them. A concrete flagship project, **4LM**, (presented in the flagship section at the end of this document) will further present uses of LLM's to find opportunities for simplifying reporting. This focus area aligns with the global trend towards stricter regulatory environments, positioning Luxembourg as a forward-thinking leader in compliance technology and leveraging the power of AI to manage increasingly complex regulatory frameworks at EU level. In parallel, Luxembourg will **use AI to reduce red tape** for companies through the development of dedicated AI-driven tools, helping them manage their compliance requirements.

Luxembourg supports a pragmatic implementation, the reduction of administrative burdens, and the strengthening of cybersecurity.

6. International collaboration

Luxembourg's role as a trusted gateway and natural hub for strategic partnerships

Luxembourg has long championed open markets, regulatory reliability, cross-border tech investments, trade openness and international partnerships. As a country with a limited domestic market, the country distinguishes itself as a trusted, longstanding gateway and natural hub to the entire European digital market and beyond.

Ambition: Further development of the Luxembourg-EU digital pole

With its advanced digital infrastructure and a proven role in trusted technology and data governance, Luxembourg is ideally positioned to play a central role in boosting the EU's technological capacity and anchoring Europe's leadership in ethical and high-performance AI.

Already home to multiple EU institutions[12], Luxembourg also partially hosts the EU AI Office through the presence of DG CONNECT (Directorate General for Communications Networks, Content and Technology). Luxembourg intends to support the EU Commission's work in delivering new digital services to EU citizens

[12] The European Court of Justice, the European Court of Auditors, the European Investment Bank, the European Investment Fund, the European Stability Mechanism, the European Publications Office, parts of the European Parliament's administration, several units of DG DIGIT, DG CNECT and DG Health of the European Commission

and increasing the AI Office's capabilities and capacities through expertise, common projects and conferences.

› Action 27: Connect with prime AI ecosystem regions

For the strongest possible ecosystem, Luxembourg needs to connect to regional AI ecosystems that complement the needs of our own. By building this network, we can more easily exchange value and open new opportunities.

- Luxembourg's regional proximity to internationally renowned AI excellence research centres—such as CISPA and DFKI in Saarland, INRIA in Nancy, and the Tübingen AI Centre in Baden-Württemberg—presents a prime opportunity to position Luxembourg as a multilingual hub and European bridge-builder.
- The Luxembourg AI Factory will further strengthen the country's ties to Europe's AI ecosystem by collaborating with an entire network of AI Factories, EU AI Office, the ESA (European Space Agency), EDIHs (European Digital Innovation Hubs Network) and TEFs.

› Action 28: Actively participating in European Digital Infrastructure Consortia

Luxembourg actively participates in a number of EDICs (European Digital Infrastructure Consortia), new European legal vehicles that facilitate multi-country projects. Each one covers a strategic topic of common interest for Member States. This allows for shared advancements on a European scale. Examples of EDICs in which Luxembourg participates include:

- **Alliance for Language Technologies EDIC**, particularly relevant for countries where data availability is relatively scarce when it comes to its language, as it is the case with Luxembourg.
- **Genome EDIC**, which builds data-access infrastructures for genomic data, enabling next-level research results. Luxembourg intends to become the host country.
- **CitiVerse EDIC,** benefits Luxembourg by driving resource management, urban innovation and sustainability through AI-powered solutions that address potential threats.

› Action 29: Contributing to international standardisation

Luxembourg plays an active role in the technical standardisation of AI via various European and international committees. These activities are coordinated by the National Standardisation Commission ILNAS/NSC 04 Artificial Intelligence, a key platform for Luxembourg market players to follow and contribute to standardisation activities. By sharing their expertise, they help shape global AI standards. Any interested national entity can register delegates to take part in the standardisation efforts.

The Commission actively participates in the work of the following technical standardisation committees:

- The **ISO/IEC JTC 1/SC 42 Artificial Intelligence subcommittee:** Develops AI standards and addresses technological aspects: terminology; machine learning framework; governance and AI management systems; data; trustworthiness; use cases and applications; system characteristics and algorithms for AI implementation.
- The **CEN-CENELEC Joint Technical Committee 21 (JTC 21):** Plays a key role in developing AI standards that support the implementation of the EU AI Act, aligning AI systems with European values and rights. It focuses on creating standards that meet the needs of the market and society. By developing harmonised standards, such as the Trust Framework and AI Risk Management, JTC 21 helps companies comply with the AI Act. JTC 21's Working Group 2 is chaired by a representative from Luxembourg and covers AI risk, quality management and AI conformity assessment.
- The **Industry Specification Group Securing Artificial Intelligence (TC SAI)** of ETSI (*European Telecommunications Standards Institute*): Develops technical specifications that help mitigate threats to AI systems, both from other AI systems and conventional sources.
- **ITU-T:** Considers the use and impact of AI in different areas and provides dedicated recommendations, mainly through focus groups.

› Action 30: Participation in international AI-related forums

Luxembourg actively engages with the OECD's digital policy working groups and the **AIGO (Artificial Intelligence Governance)** expert meetings. The OECD established and helped implement the OECD AI Principles, the first international standards for responsible AI.

Luxembourg is also a member of the Global Partnership on Artificial Intelligence (GPAI) to promote human-centric, safe and trustworthy AI in line with the OECD AI Principles. Given AI's cross-sectoral and global impact, GPAI fosters international cooperation and OECD synergies to address governance challenges and align AI initiatives.

Part 3. High-impact sectors

Transforming the status quo through AI technology

After analysing the key enablers critical to accelerating Luxembourg's AI adoption, we now set our sights on the high-impact sectors in which AI will bring significant change. As AI continues to evolve, its transformative potential becomes increasingly evident. This chapter delves into four key sectors: public administration, finance, health and culture.

Public administration: boosting trustworthy AI adoption

Setting the standard for AI adoption

A nation's competitiveness hinges on the efficiency of its public administration and the availability of quality, accessible services for citizens and businesses. Across Luxembourg's government, gradual AI deployment has begun, impacting daily internal management and public services.

Key principles of AI development in the public sector

1. Human-centred

Public sector AI models must serve citizens, respecting public interest and fundamental rights. Its success relies on effective control methods and risk mitigation.

2. Performance and sustainability

AI should sustain continuous performance improvements across the public administration. It enables better internal organisation/management (G2G) and enhances responsiveness and reliability when serving businesses and citizens (G2B and G2C).

3. Transparency and explainability

AI improves political decision-making by leveraging data, analyses and extensive, objective information. However, to maintain trust, we must be able to demonstrate the reasoning behind those decisions—especially those supported by deep learning systems.

4. Inclusion

AI applications support a digital-by-design approach and enable public services to be tailored to the diverse needs of the population. It is essential to proactively avoid any discrimination in our public services. Any public agent, therefore, who develops or selects AI systems must be trained in non-discriminatory AI practices.

5. Governance, ethics and regulation

A risk management system should be set up to support state agents in designing and integrating non-discriminatory AI systems in line with the AI Act. A multidisciplinary, multi-ministerial governance approach involving legal, technical and ethical expertise will support professionals in AI development, application and analysis.

Objectives for adoption of AI in public administration

Specific strategic objectives must be pursued to ensure the effective and responsible integration of AI models in Luxembourg's public administration. These objectives aim to create a proactive, data-driven and performance-oriented administration while respecting ethical and legal principles.

1. Improving the citizen experience

AI's natural language processing capabilities enable new public services that improve how citizens interact with government agents, making communication smoother, more inclusive and more personalised.

2. Enhancing efficiency of internal state processes

Combining LLM algorithms with machine learning, AI promises massive potential for analysing large datasets, identifying information and recognising patterns. This makes AI highly effective in task automation and process optimisation.

3. Improving decision-making through data analysis

Apply AI's analytical and pattern recognition capabilities to large datasets, unlocking in-depth insight by detecting correlations and patterns not noticed by humans.

4. Support innovative AI projects

Continue financial and expert support for AI projects via initiatives like Tech-in-Gov and explore new AI-derived technologies.

5. Promote skills enhancement and knowledge sharing

Share best practices, provide quality training and strengthen capacities and competencies in data and AI. This includes supporting projects and initiatives of the Data Science Working Group, such as the "Best Practices Guide for Public Sector Data Scientists."

6. Support initiatives for developing models for the Luxembourgish language

Ensure AI solutions are effective, inclusive, culturally relevant and meet the unique needs of Luxembourg's citizens.

7. Establish a public administration AI algorithm registry

Essential for ethical and responsible AI use, enhancing transparency, accountability, and citizen trust in AI systems.

Laying the foundation for AI at the CTIE

The Government IT Centre (CTIE, *Centre des technologies de l'information de l'État*) is a trusted partner for ministries and administrations in developing *eGovernment* solutions. As AI has emerged and matured, the CTIE has supported the implementation of projects that incorporate AI elements.

The CTIE, will continue taking the necessary actions to provide an **IT environment conducive to AI projects** by integrating essential AI building blocks into its IT infrastructure and establishing a robust framework for developing and deploying AI models. It will ensure that all government teams have the **tools and support** needed to effectively integrate AI into their processes and services, offering various types of AI models (e.g. search models and generative models) that can be combined and fine-tuned to meet specific needs.

The CTIE will maintain its **standardisation philosophy** through shared infrastructure, platforms and project management methods. Clients will have the option to carry out their projects independently or in collaboration with the CTIE. Through this standardised approach, the CTIE ensures that projects comply with national and European regulations and meet IT security and interoperability requirements.

Offer intelligent AI assistants to boost productivity

The rise of advanced language models has popularised online, user-friendly intelligent assistants, publicly showcasing AI's potential. In the public sector, these assistants can simplify knowledge acquisition, summarise and analyse complex texts, generate content, suggest social media text, and enable seamless multilingual communication.

The CTIE offers intelligent assistants as part of its service catalogue for two primary reasons:

- Freely available intelligent assistants on the web pose significant risks to the security of sensitive data. By contrast, intelligent assistants offered under the CTIE's service catalogue operate within a contractual framework between the provider and the CTIE, ensuring greater data security and confidentiality.
- These assistants are user-friendly, featuring natural language interfaces that help employees, even those less experienced with digital tools, gradually adapt to AI technologies. This approach eases concerns, facilitates a smooth transition to modern practices and highlights AI's potential.

AI competence centre for the public sector

The CTIE recently established an AI competence centre for the public sector. Beyond defining and implementing the necessary architecture and tools for AI adoption, it emphasises technology monitoring, interdisciplinary collaboration, training and mentoring to facilitate AI adoption within the CTIE teams. These teams can benefit directly from the technology or collaborate on AI projects for clients. The competence centre will enable the widespread and rapid adoption of AI in the public sector.

Use case:

Leveraging generative AI to future-proof Luxembourg's economic diplomacy

This initiative aims to securely and ethically leverage trustworthy generative AI (RAG (Retrieval Augmented Generation) and sovereign AI) to **enhance Luxembourg's economic diplomacy and shape its future statecraft** through an integrated "Team Luxembourg" approach.

By providing **measurable results**, tracking progress, and improving resource allocation to ensure a greater impact on priority markets, this is the ambition of the Directorate for the Promotion of Foreign Trade and Investments (MFEA D8), which plays a **crucial role in defining and conducting Luxembourg's economic diplomacy**. The preparation of files is done in close collaboration with other ministries and key stakeholders: the tool put in place will be an undeniable support in these preparations.

Finance: applying AI across the ecosystem

AI at the heart of financial innovation

The Grand Duchy's financial ecosystem, already known for its regulatory expertise, fast implementation and cross-border experience, stands to significantly enhance its competitive advantage through strategic AI adoption in areas like regulatory compliance, risk management, and client services. Both the regulator, as well as the Ministry of Finance are moving towards implementing AI to be able to lead by example.

Applied AI across public financial authorities

In December 2024, the financial regulator **CSSF (Commission de Surveillance du Secteur Financier)** has become a launch client of a disconnected sovereign cloud. This helps boost its own efficiency, and act as an innovation agent for the ecosystem. With a flagship initiative and a concrete new action in this strategy developed by LHoFT, Luxembourg's finance ecosystem has the opportunity to profit from this sectoral strategy.

Several departments under the Ministry of Finance are already exploring or implementing AI projects. The potential benefits of AI are particularly significant for these departments due to their large size and extensive data handling:

- **Land Registry and Topography Administration**

  Responsible for providing geodata that is essential for territorial development and real estate market function, the Land Registry and Topography Administration is currently implementing two AI projects:

  - EXTOPIA successfully demonstrated the feasibility of using deep learning to extract topographic objects, particularly buildings, from aerial images. This technology is now used for recurring updates of building databases.
  - UrbIA aims to automate the transcription of old handwritten cadastral books. This project will enable easier access to property titles dating before 1972 and improve research efficiency.

- **Luxembourg Inland Revenue Authority**

  Strategically integrates AI into its digital transformation initiatives. A specialised team is actively developing AI models, drawing inspiration from international tax authority practices. Current projects are categorised into tax population intelligence (for forecasting and simulation), non-compliance and fraud detection, and operational models utilising generative AI. While initial applications are primarily internal, the authority plans to extend AI capabilities to public-facing services, such as a chatbot.

- **Customs and Excise Agency**

  The agency is currently implementing the LUCCS project, a comprehensive IT solution aimed at facilitating international trade and enhancing Luxembourg's position as a European logistics hub. LUCCS has integrated various functions for risk management, on-site inspections, and post-clearance monitoring. The next phase involves adding an exploratory layer to optimise risk management processes and improve the accuracy of targeting high-risk shipments.

- **Registration Duties, Estates and VAT Authority**

  Develops three AI projects to optimise administrative processes, reduce human error, accelerate decision-making, and lay the groundwork for future document analysis automation:

  - Deploying a chatbot to facilitate information retrieval from tax and non-tax related sources. The chatbot will provide employees with concise summaries and relevant links, saving time and enhancing efficiency.
  - SmartRetrieve, is an innovative information retrieval tool designed to assist subscription tax agents in processing collective investment fund documents. It streamlines the analysis process by providing contextual responses and document extracts, enabling agents to focus on higher-value tasks and improve verification accuracy.

- **Inspectorate of Finance (IGF)**

  The IGF conducted a study to explore the potential benefits, challenges, and risks associated with using AI in its operations and identified several benefits. Specific use cases include automating budget preparation and monitoring, implementing virtual assistants, analysing data related to the preparation of the budget, and using predictive analytics. The IGF's next steps will involve creating an AI implementation roadmap, preparing its technological infrastructure, and developing a data catalogue.

- **State Treasury**

  Like the IGF, the State Treasury aims to include AI in its digitalisation projects, with a particular focus on automatisation of case handling within the Caisse de consignation, as well as risk management, fraud detection for payment transactions, and overall monitoring of operations and reporting.

AI legislation and regulation

AI integration in financial services enhances decision-making, operational efficiency, risk management and customer experience. Managing challenges like compliance, KYC, data privacy, and algorithmic bias is crucial. The financial sector's role in funding AI innovations highlights its importance in driving economic and technological progress.

However, as AI evolves, so too must regulation. The Ministry of Finance is closely monitoring European AI legislation to ensure compliance. While Luxembourg has opted not to introduce specific national AI regulations for the financial sector, aligning with European standards is crucial for maintaining a competitive and compliant environment

Action: "AI for FinTech" event

As of 2026, a yearly AI in Fintech-themed flagship conference will represent a pivotal development in the country's broader AI strategy, specifically designed to accelerate adoption within its financial services sector. As a key initiative, the event will bring together Luxembourg's established financial institutions, emerging fintech innovators, and international AI experts to foster collaboration and knowledge exchange. The shape of the event series will be designed by LHoFT, under the strategic guidance of the Ministry of Finance.

By connecting Luxembourg's traditional banking strengths with cutting-edge AI capabilities, the country aims to position itself at the forefront of responsible AI adoption in financial services. This represents a natural evolution for Luxembourg's financial marketplace, which has consistently demonstrated adaptability through various market transformations while maintaining its reputation for stability and security in the highly regulated financial services domain.

Health: AI readiness for making personal-medicine a reality

Personalising care, transforming lives

The healthcare ecosystem covers all activities that improve and maintain health. It includes healthcare professionals (HCPs), hospitals, pharmaceutical firms, medical device companies, as well as policymakers and patients, making the healthcare ecosystem much broader. Moreover, this ecosystem also encompasses, for example, academic research, industrial research and innovation, information technology and law. The changing landscape and major advances in these fields have significant impacts on the healthcare ecosystem. Advances in AI are perhaps the most notable.

Luxembourg's AI healthcare strategy

The goal of the healthcare AI strategy is to improve human health through both prevention and care. **AI-driven precision medicine**, also known as **personalised medicine**, brings a significant shift in potential prevention and treatment. It seeks to tailor disease prevention and treatment to consider differences in people's genes, environments and lifestyles.[13]

Research institutions use AI to analyse large-scale biomedical data, which can offer insights into complex diseases, identify biomarkers, predict disease progression and tailor treatments to individual patient profiles. This is enabled in part by Luxembourg's high performance computing infrastructure, which allows researchers and healthcare institutions to process vast amounts of medical data securely and efficiently, facilitating the development of AI models for genomics, epidemiology and drug discovery.

Precision medicine requires vast amounts of data, and as a small country, Luxembourg stands to gain significantly by integrating into pan-European initiatives. Participation in the European Health Data Space and international efforts such as the 1+Million Genomes initiative and Genome EDIC, will be essential for accessing high-quality data and pooling resources to optimise costs.

Startups and established companies in Luxembourg are increasingly focusing on AI-driven health solutions, ranging from wearable devices to platforms that use natural language processing for medical records management.

Mission

The AI Healthcare Strategy includes a **readiness framework for the incorporation of AI into the Luxembourg healthcare ecosystem**. It offers a roadmap for coordinated and proactive contributions by stakeholders and will help develop the technical and analytical capabilities needed to achieve continuous improvement. Key factors for AI readiness in Luxembourg include digital readiness, market access, research and education, innovation, law, stakeholder engagement, and international engagement.

Vision

Luxembourg will be a European frontrunner in digital health, seamlessly integrating AI into all components of its healthcare systems, leading in disease prevention and precision treatment, and establishing itself as an **economic centre for digital health in Europe**.

Objectives

(1) Identify key factors—whether sectors, disciplines or actors—that play a critical role in bringing Luxembourg to a state of AI readiness.

(2) Create AI readiness framework for implementation of AI in healthcare.

(3) Identify gaps and issues preventing AI from being incorporated into the healthcare ecosystem.

(4) Develop a test case that defines and addresses the necessary elements for full AI adoption across the health system.

Guiding principles

(1) Luxembourg aims to build long-term guidelines and frameworks that are AI-ready by design.

(2) The framework will be applicable regardless of sector or level of maturity.

(3) AI will be built and implemented based on the principles of trustworthy AI, ensuring that it is transparent, explainable, robust and respectful of data privacy.

The elements contributing to Luxembourg's AI readiness framework are also focal points of other government policies and strategies. The work being done in these areas will support and complement the gaps identified above.

[13] Jørgensen JT. Twenty Years with Personalized Medicine: Past, Present, and Future of Individualized Pharmacotherapy. Oncologist. 2019 Jul;24(7):e432-e440. doi: 10.1634/theoncologist.2019-0054. Epub 2019 Apr 2. PMID: 30940745; PMCID: PMC6656435.

1) Digital health strategy: The European Health Data Space (EHDS) regulation[14] will be at the heart of the new digital health strategy developed by Luxembourg's Ministry of Health and Social Security. The digital health strategy aims to put the patient in control of their health data and at the heart of the healthcare system to ensure qualitative, integrated and multidisciplinary care. The strategy will develop frameworks to facilitate the adoption of innovative digital health technologies that respond to the needs of patients and healthcare professional.

2) National data strategy: The use of public sector data includes developing systems that support the health of each individual and developing an economic environment that is attractive to innovators.

3) Health Data Access Body Luxembourg (HDAB-LU): As part of the EHDS regulation governing cross-border secondary use of data, each EU Member State will be required to be connected to the European Infrastructure HealthData@EU and set up national bodies that offer data management services and secure processing environments to data users and data holders.

4) The 1+Million Genomes Initiative: Supported by EU projects since 2018, the 1+MG initiative will seek to create a formal data space for collecting, curating, and sharing genomic and phenotypic data to enable new research and personalised, genome-based healthcare, fully integrated with the EHDS.

Culture: enablers of integration, creativity, and inclusion

Where AI meets imagination

Arts and culture have taught society how to face shared challenges through inclusive and critical thinking. Like libraries, cultural spaces give rise to debate, human interaction and civic engagement. The cultural sector offers a human-powered, value-based approach that can bring balance to AI and automation, ensuring that technology remains in service to humanity.

A value-based approach

The **AI cultural strategy** seeks to define a framework for AI applications and developments, and then make that framework available to both public and private entities. The cultural sector won't be positioned simply as a consumer of AI technologies, but as an actor involved in the development of solutions that reflect its needs and values.

The **Ministry of Culture's mission** is to develop policy frameworks that support sustainability and trust, while harmonising the fast pace of technological change with the often-slower rate of adoption. The aim is to foster creativity, inclusion, skills, digital literacy and critical thinking, while raising public awareness of possible challenges.

Protecting creators and users

AI must not only be tech and market-friendly but also creator and user-friendly. To support the creative sector's digital transition, it is essential to take into consideration existing copyright and related rights legislation to enhance the value of creative skills.

A **human-centred approach** should be paired with a **creator-centred** one, focusing on copyright and related rights, the principle of fair remuneration and the value of raw creative materials. A creator-centric approach considers both the impact of culture on AI and of AI on creators and cultural institutions.

The mission of cultural heritage institutions has always been to maintain the integrity of data through a trusted chain of custody, thus ensuring provenance and authenticity. In the context of a data-driven economy, the skills, infrastructure and processes developed within the cultural heritage sector are significant assets.

Cultural heritage institutions can contribute to national efforts, for example (1) through their experience with trustworthy workflows and data management, and (2) with their vast amounts of data that can be used as training models. This sector should be viewed as both a user of AI technology, as well as valuable actors involved in the development of solutions.

[14] Regulation (EU) 2025/327 of the European Parliament and of the Council of 11 February 2025 on the European Health Data Space and amending Directive 2011/24/EU and Regulation (EU) 2024/2847

Action points:

- Address complexity of AI through a transversal, creator-friendly and user-friendly approach.
- View cultural heritage institutions as key assets and partners in the development of an AI ecosystem, offering experimental ground to explore ethics, governance and transparency.
- Maintaining a balanced intellectual property framework and continue awareness activities through IPIL's services regarding AI and intellectual property.
- Develop rights policies as a first step in regulating and creating transparency around the re-use of cultural heritage data for training AI models.

AI as a tool for creators

Generative AI is now a part of everyday life, it should be seen as a **facilitator rather than a threat to artistic creation**: AI enhances rather than replaces human capabilities. They unlock new methods of idea generation and sharing, as well as greater precision. Mastering these technologies is essential. At the EU level, dedicated initiatives should address the current media literacy gap, prioritising a multi-stakeholder approach for a more inclusive impact.

Action points:

- Integrate the Luxembourgish language into generative AI platforms, which require a minimum of two million words. Cultural institutions could contribute to this effort but must first be given the opportunity to increase their digital maturity.
    - Note that the Ministry of Culture and the Zenter fir d'Lëtzebuerger Sprooch participate in and support the ALT-EDIC project, which involves the creation of large language models (LLM) for Luxembourg.
- Reconcile the discrepancy between fast technological changes and the slower rates of adoption.
- Prioritise training catalogues and upskilling programmes that understand and meet the needs of the sector.

Inclusion and education

AI can promote inclusion, particularly for people who are neurodivergent or living with a disability. Companies in Luxembourg have launched projects that demonstrate how AI is capable of empowering these communities. For example, cultural heritage institutions could employ immersive VR and AI technologies to make collections more accessible and inclusive. In collaboration with museums, collaborations would help establish dedicated VR spaces that ensure equitable access to collections and art installations for individuals with disabilities. This could eventually inform a wider public strategy.

Culture as a driver of innovation

Creators have always pioneered the adoption of emerging technologies. The government plays a key role in supporting the evolution of the creative sector and the development of new skills. It is in a unique position to absorb certain costs and provide space for experimentation, research and development. The development of in-house playpens and a culture of trial and error shifts the role of the government from pure administrative body to enabler of transversal co-creation.

AI as a tool for linguistic development and multilingualism

Zenter fir d'Lëtzebuerger Sprooch (Centre for the Luxembourgish Language)

As a highly multilingual environment, Luxembourg is an ideal setting to advance AI technologies that reflect a multilingual world, while actively supporting the growth and sustainability of the Luxembourgish language.

The Zenter fir d'Lëtzebuerger Sprooch (ZLS) is well positioned to guide these efforts, due to its expertise in Luxembourgish and linguistic technological development. Through this work, Luxembourg can demonstrate how smaller languages thrive through the ethical development of datasets, models, and technologies. In this way, AI supports both global languages as well as those central to cultural identity and heritage.

Key points:

- AI systems should be developed to operate seamlessly across languages from the ground up, reflecting Luxembourg's everyday linguistic reality and setting a standard for inclusive, adaptable technology.
- Sustainable AI development relies on shared, high-quality public datasets and tools that ensure equitable access and long-term benefits for the entire linguistic community.
- AI should contribute not only to communication needs but also to preserving, evolving and enriching cultural identity through language.
- By working together with other regions, institutions and communities facing similar challenges, Luxembourg can play a role in developing shared solutions for small and/or low-resourced languages.

Part 4.
Flagship projects

Public administration: Luxembourg's legal Large Language Model (4LM)

The 4LM project aims to develop a Large Language Model (LLM) specialised in Luxembourgish legal texts. A domain-specific LLM will enhance efficiency in the legal and regulatory domain, benefiting governmental institutions, legal professionals, the judiciary and companies. The public will also gain access to AI tools like chatbots and automatic translation, improving access to legal information. Companies will be provided with AI-driven tools that will help them in their efforts to be compliant with an ever-growing body of legal and regulatory constraints, thus increasing their productivity through an AI-driven automatisation of compliance processes.

This project aligns with Luxembourg's digital transformation goals, reinforcing its position in AI-driven governance and legal innovation.

The context of the 4LM project centres around the development and deployment of a Large Language Model (LLM) specifically tailored for legislative legal and regulatory processes in Luxembourg. This project is situated at the intersection of AI innovation, digital transformation, and public administration modernisation. It aligns with national and European strategies to improve digital governance while addressing critical societal, economic, and security challenges.

Below is a detailed breakdown of the context:

For the general public:

- Improve understanding, accessibility and inclusiveness of legislation.
- Make legislative texts currently in force available in as many languages as possible to meet the needs of a multicultural and multilingual audience.
- Produce "understandable" summaries for citizens (Einfach Sprooch).

For government administration and legal professionals:

- Identify legislative needs and LLM use cases, especially for drafting and compliance with European laws.
- Train a Luxembourgish LLM for precise legislative text interpretation.
- Ensure interoperability with government digital platforms to enhance cooperation.

For companies:

Companies are increasingly seeking ways to navigate the growing regulatory requirements at both the national and European levels. Ensuring compliance can be complex, particularly for SMEs, and may impact productivity. The 4LM project aims to provide a solution by developing specialised AI-driven tools designed to streamline and automate compliance processes, helping businesses meet their obligations more efficiently and effectively.

Finance: The AI Experience Centre at the LHoFT

Luxembourg is a leading European financial centre, with strategic priorities focused on digital transformation, innovation, and sustainability. However, the adoption of advanced technologies such as AI remains nascent across many institutions. The AI Experience Centre addresses this by lowering barriers to experimentation and adoption, helping financial institutions to understand and integrate AI in secure and sovereign conditions.

The LHoFT's plays a key role in Luxembourg's financial services ecosystem. Its catalysing effect happens by boosting early adoption of cutting-edge technology. The LHoFT has chosen to play this role through the design of the AI Experience Centre, a physical experience inside LHoFT's growing office footprint at the heart of Luxembourg City. It will activate and engage the finance sector in AI, ensuring the financial centre's future competitiveness and helping to cement Luxembourg as a leading hub for digital finance innovation, showcasing state-of-the-art technologies that meet global financial challenges.

LuxProvide contributes its state-of-the-art MeluXina supercomputer and expertise in high-performance computing, essential for handling extensive datasets and executing sophisticated AI models. The LHoFT Foundation brings its extensive network within the FinTech ecosystem and its understanding of financial regulations and market dynamics. This unique combination ensures that the AI Experience Centre will be both technologically advanced and finely attuned to the specific challenges, needs and opportunities of the financial sector.

Its concept is shaped through the following goals:

- **Demonstrate AI's potential in finance.** Display how AI can be leveraged to improve financial services by enhancing decision-making processes, increasing operational efficiency, and providing superior risk management solutions.
- **Facilitate technological innovation and adoption.** Accelerate the adoption of AI technologies within Luxembourg's financial sector by providing hands-on experiences, demonstrations, and success stories.
- **Enhance collaboration between technology and finance.** Encourage and strengthen the collaboration between tech providers, financial institutions, and regulatory bodies by creating an environment that fosters dialogue and partnership.
- **Educate and train industry professionals.** Develop and deliver educational programmes and workshops that train financial sector professionals on the latest AI technologies and their applications.

It is designed to evolve in close alignment with the government's AI Factory programme, acting as both an intake mechanism and a market engagement interface for AI solutions emerging from the national innovation pipeline. By exposing financial institutions to real-world AI applications and facilitating experimentation, the Centre will help identify viable, scalable use cases that may be further industrialised within the AI Factory framework. Conversely, it will showcase outputs from the AI Factory, creating a public-facing demonstrator of Luxembourg's AI innovation capabilities.

Precision medicine: AI readiness for precision medicine

Luxembourg will advance its digital health strategy by integrating AI and data-driven approaches to support precision medicine with the aim of moving healthcare from a reactive model focused on treating diseases to a proactive system that leverages genomic and clinical data. The transformation will rely on a continuous feedback loop of research, deployment, and fine-tuning, emphasising key areas such as clinical data integration, robust infrastructure, skilled personnel, legal compliance, and active citizen engagement. Drawing on insights from the past 15 years of significant investments in biomedical research, clinical trials, and large-scale health data initiatives, Luxembourg will prioritise these areas to enhance interoperability and support evidence-based decision-making.

The project will serve as a catalyst for this evolution by developing the necessary infrastructure, along with AI-driven tools to match treatments to individual patients. This effort will build on several key initiatives such as the 1+Million Genomes project/Genome EDIC, the European Health Data Space (EHDS) and initiatives that aim at reducing all preventable deaths from cancer and neurodegenerative diseases. Additionally, it will leverage current national expertise in AI-driven multimodal analysis, which personalises treatments for conditions such as multiple sclerosis, rheumatoid arthritis, cancer and neurodegenerative diseases embodying the "right drug for the right patient" philosophy. Scaling these efforts beyond research will require addressing significant challenges in data governance, interoperability, market access pathways and public engagement. The flagship will expand this focus on complex cancer cases and neurodegenerative diseases with an ambitious aim of minimising unnecessary deaths through prevention, early detection, and tailored therapies. Precision medicine will demand vast amounts of data, and as a small country, Luxembourg will benefit greatly from integrating into pan-European efforts.

The 1+Million Genomes Initiative, supported by EU projects, will seek to create a formal data space for collecting, curating, and sharing data in Europe to enable new research and personalised, genome-based healthcare. In 2025, a new legal entity, the Genome EDIC will take over the core operations of the 1+MG initiative, and Luxembourg will be well-positioned to serve as its host.

The AI in Health flagship will be built on a comprehensive health data strategy and AI readiness framework that spans the entire patient journey, with AI continuously improving through clinical feedback. Luxembourg's advanced digital infrastructure, including the MeluXina supercomputer and the forthcoming MeluXina-Q quantum computer, will support AI research in fields like genomics, cancer, neurodegenerative diseases and drug discovery. Additionally, the AI Factory will accelerate development, enhancing the pace of innovation.

This approach will deliver a clear benefit:

- **It will improve patient outcomes and support healthcare providers by streamlining decision-making and workflows, aided by tools such as AI scribes for standardised data entry.**

Nevertheless, challenges in data governance, interoperability, market access pathways and public engagement will need to be resolved to scale these efforts effectively. The EHDS regulation will foster structured health data exchange across Europe, aligning with Luxembourg's pan-European objectives. Through these strategic investments, Luxembourg will aim to position itself as a leader in AI-driven healthcare innovation.

Labour market: AI-powered skills insights

Luxembourg faces specific challenges in leveraging skills data due to its diverse, multilingual, and highly dynamic labour market. The OECD Skills Strategy[15] highlighted critical gaps in the quality of existing skills data in Luxembourg, including incomplete data (e.g., limited to Luxembourg residents), incorrect data (e.g., errors in occupations reported to social security), outdated data (e.g., surveys conducted only every few years), insufficient detail (e.g., data on occupation categories and not detailed skills), and lack of interoperability (different classifications used between administrations).

These challenges mean that it is currently impossible to say how many people work in which occupation in Luxembourg, let alone what skills are missing or predicting future trends. However, these challenges present significant opportunities for innovation by leveraging AI technologies.

ADEM, the national employment agency, seeks to use AI to improve our understanding of Luxembourg's skills needs and shortages.

Those insights can be used to:

- Guide citizens (including youth) to occupations with high prospects.
- Guide citizens (including youth) to courses in order to acquire skills that will be needed on the labour market.
- Show opportunities for upskilling and reskilling between different occupations.
- Help employers in their recruitment efforts.
- Assess relevance of education/training offer in Luxembourg and identify missing offers.
- Provide financial incentives (e.g., training vouchers) focused on skills that are in high need or shortage.
- Focus talent attraction efforts on regions and profiles that can address the national skills shortages.
- Compare detailed skills data with that of the Greater Region or other countries to identify opportunities for collaboration.

This initiative aligns with Luxembourg's strategic goals of fostering a future-ready labour force, addressing skills shortages, and supporting evidence-based policymaking. By leveraging AI technologies, the project aims to create a comprehensive and dynamic skills data ecosystem that benefits individuals, employers, and policymakers, ultimately contributing to economic growth and social cohesion.

[15] Luxembourg Government, OECD Skills Strategy: Recommendations for Improving Skills in Luxembourg, 02/2023

Education: A sovereign AI chatbot for education

Luxembourg's strategic vision for AI adoption emphasises responsible technology use, robust data governance, and strong privacy guarantees. In the education sector, multiple curricula exist for diverse tracks, grade levels, and linguistic contexts—creating complexity for teachers, policymakers, and other stakeholders. Current digital repositories are often static and fragmented, making it difficult to gain a holistic, real-time view of the curriculum landscape.

By building a dynamic, locally hosted database and coupling it with AI-driven tools, this flagship project aligns with Luxembourg's national AI strategy and data sovereignty goals. The solution not only streamlines curriculum exploration and planning but also enables future-proofed, learner-centred pedagogical approaches. Ultimately, it ensures that innovation goes hand in hand with the preservation of core values, such as privacy, autonomy, and equitable access to educational opportunities.

This flagship initiative aims to revolutionise how teachers, school administrators, policymakers, and students interact with Luxembourg's vast educational curricula by creating a locally hosted AI-driven platform. The core objective is to build a multidimensional database containing all curricula in Luxembourg's school system—fully interconnected and continuously updatable—and then layer on intelligent search capabilities and a Large Language Model (LLM)-powered chatbot.

Key ambitions include:

- **Sovereign data management:** Host the entire solution on Luxembourg-based servers to ensure data protection, privacy, and compliance with national and EU regulations.
- **Dynamic curriculum repository:** Develop a robust, multidimensional curricular database that allows easy updates, deep interconnections, and granular insights into educational pathways.
- **Empowered educators and policymakers:** Provide modular "widgets" and search functionalities, enabling users to discover cross-curricular links, identify transversal topics, and inform policy decisions.
- **AI-enhanced teaching and learning:** Leverage LLM technology to generate tailored lesson plans, differentiation strategies for mixed-ability classrooms, student support plans, and more.
- **Scalable capacity building:** Offer training and Continuous Professional Development (CPD) for educators, so they can utilise the new platform effectively and responsibly, fostering a culture of AI literacy across the educational landscape.

Through this project, Luxembourg positions itself at the forefront of educational innovation, showcasing how sovereign, ethically governed AI solutions can transform curriculum management and classroom practice while respecting data protection and human-centric values.

Mobility: Movement AI 1.0

AI Move 1.0 proposes an innovative approach to better understand mobility needs in the Grand Duchy. This will allow policymakers to target public investment into mobility services and infrastructure even more effectively. By streamlining data governance procedures and leveraging AI, AI Move 1.0 will bring together fragmented data sources, bolster their quality and accelerate their processing and interpretation. This will lead to improved data availability in the field of mobility, with the certainty that those data are fit for purpose, providing the insights policy makers require.

This initiative is a direct response to the need expressed by the coalition agreement 2023-2028 to strengthen the Observatoire digital de la Mobilité (OdM). Accompanying that reinforcement by AI will multiply the benefits for the government's mobility policy and the wider Luxembourgish mobility ecosystem. This project will roughly touch one eighth of the government's expense budget (13% of the budget 2023 allocated to the Ministry of Mobility and Public Works (MMTP)) as well as the investments into mobility by businesses and households.

Through better availability of high-quality data on mobility, AI move 1.0 unlocks the following benefits:

- **Social:** AI methods allow to dig deeper into existing and yet to be created mobility data, leading to a deeper understanding of the mobility needs of the people. Better knowledge of what needs to meet allows even more effective aiming of investments and to further improve access to mobility.
- **Economic:** there already is a strong demand for high quality mobility data. AI move will widen that scope and strengthen the community of mobility data producers and consumers in Luxembourg. This will create a fertile breeding ground for innovation.
- **Environmental:** accelerated meeting of modal split targets to less polluting means of transport can reap secondary environmental benefits.
- **Collaboration and synergies:** AI Move 1.0 aligns with European "intelligent transport systems" and mobility data space initiatives, fostering cross-border cooperation. As an example of how this is happening already, OdM's LuxMobil is carried out in close coordination with our French, Belgian and German neighbours to produce a unique international view on cross-border mobility.

Within this ecosystem, AI Move 1.0 places particular emphasis on public data producers. They constitute the main pillar of Luxembourg's mobility data landscape, simply because they provide by far the largest share of mobility services and infrastructures in the country. This focus does not diminish the contributions and importance of other actors in the ecosystem. AI Move 1.0 is conceived as an initial, foundational step—hence its name. It recognises that even the most sophisticated analytics require a robust and reliable data foundation, and that public data make up a large chunk of that foundation. As this foundation takes shape, new opportunities may emerge. Research institutions and private enterprises might lead the development of advanced analytics or contribute new kinds of data, either in direct contribution to OdM's central mission or in pursuit of their own initiatives.

Cybersecurity: Democratising cybersecurity

Cybersecurity threat intelligence data is seldomly shared and mostly stays in proprietary feeds. Such data is thus not available for innovation, thus strengthening the position of oligopolistic cybersecurity vendors. As a result, unaffordable prices leave SMEs (representing > 95% of the EU economy) vulnerable, posing significant risks to supply chains and economic stability. To strengthen economic resilience, SMEs therefore require access to affordable security solutions defending them against the ever-evolving threat landscape.

An effective way to address this market failure is to **open the cybersecurity data economy**. Today's data economy relies extensively on cloud infrastructures. Therefore, Luxembourg participates in the IPCEI Next Generation Cloud Infrastructure and Services (IPCEI-CIS) and its contribution will materialise through the macro project CLoud and dAta SecUrity reSource cENter (CLAUSEN), creating the first **Open Cybersecurity Data Space** (OCDS) in Europe. Such a data space fosters synergies by facilitating the collection and exchange of cybersecurity-related data like threat intelligence, vulnerabilities, and efficiency of protective measures. Furthermore, it nurtures AI Factories with cybersecurity data, which is indispensable for the creation of new autonomous cybersecurity tools that SMEs can afford.

As faster and more sophisticated cyber threats need quicker and more effective responses, the ambition of the present flagship project is to further support the cybersecurity ecosystem with AI, applied on vast amounts of raw and contextualised cybersecurity data. The aim is to enhance the readiness of all stakeholders by equipping them with the necessary knowledge and tools to handle cyber threats.

- **As a primary focus**, the project aims to gain a deeper understanding of adversaries by utilising existing threat intelligence gathering tools, and by shaping the collected raw data with the help of AI into threat intelligence. The integration of this data will enable quicker analysis of malicious behaviours and the processing of larger volumes of such activities. The resulting intelligence will be made available to the cybersecurity community, to law enforcement agencies, and to judicial authorities to support their efforts in identifying and combating cyber threats and securing companies and citizens. Finally, the gathered threat intelligence will be aggregated with the help of AI into cyber weather reports, which, among other benefits, increases the accuracy of risk management and improves the resilience of the Luxembourg economy.
- **A secondary focus** of the project aims at strengthening governance, risk, and compliance for SMEs. New risk information, including metrics, risk scenarios and mitigation techniques related to the adoption of new AI technologies, will be provided to the private sector. Moreover, the use of new and continuously updated models will democratise governance and risk management by providing easy-to-use AI-powered human interfaces. This will enable proactive and safe integration of AI into governance platforms to improve the accuracy of risk treatment decisions and investments. SMEs will be supported in their compliance journey by offering a platform that helps them design and implement tailored information security policies, procedures, and guidelines.
- **A third focus** lies on managing risks that accompany the emerging technologies. Those cover inherent vulnerabilities of AI systems, and the quantum threat for cryptography. To address these challenges, the Luxembourg ecosystem needs guidance, testing infrastructure and tools to adopt post-quantum cryptography (PQC), and mechanisms to evaluate AI implementations, models and machine learning processes.

Energy: Enhancing Luxembourg's energy transition through near-real-time data integration

As Luxembourg progresses through the energy transition and shifts to a decentralised and a decarbonised energy system, its management becomes increasingly complex as new dynamics appear through an increasing number of producer-consumers, renewable sources, electrical assets and energy carriers.

The present project aims to establish a foundation for tackling challenges such as grid limitations, data expansion, volatile prices, fluctuating consumption, congestions, and multi-energy vectors in the next phase of the energy transition through applying a paradigm shift in how the country manages its energy system: near-real-time operation of the future Luxembourgish energy system.

The approach aims to position Luxembourg as a showcase of a small but efficient and digitalised energy system. An affordable, sustainable and secure energy system (i.e., regulated and non-regulated) will be guaranteed while unlocking the necessary system flexibility, reliability, and market adaptability. The vision is to enhance Luxembourg's energy system by harnessing the capabilities of AI, making it more robust, secure, resilient, and environmentally sustainable while ensuring affordable energy for all.

To achieve this objective, the following aspects will be covered:

- **Harnessing near-real-time energy data:** Gathering and utilising the vast amount of near-real-time data generated from various energy sources (e.g., electricity, gas, heat, and hydrogen) to create a highly optimised, economically viable, and sustainably driven energy management system. Existing data flow interactions will be mapped, and new ones created while ensuring harmonisation and cybersecurity.
- **Leveraging advanced computing and AI:** Developing AI-driven support tools that enable the near-real-time operation of the energy system. For example, fault detection, asset predictive maintenance, grid reconfiguration, multi energy vector monitoring, explicit real time dynamic tariffs, solar and wind optimisation, vehicle to Grid. Establishing an AI model sandbox for energy allowing developers and researchers to test the performance and behaviour of AI models, evaluate the trustworthiness of different AI algorithms, identify and mitigate potential risks and biases, and test regulatory compliance.
- **Developing near-real-time and bidirectional communication:** Implementing bidirectional communication channels to acquire data, monitor and optimally control energy system assets in near-real-time.

The expected broader impact of the initiative covers a multitude of aspects. Economically, the integration of AI-driven decision-making aims to reduce operational costs and create new market opportunities. Environmentally, operating in near-real time will allow Luxembourg to make energy decisions with the adequate balance of affordability, sustainability and supply security and resilience. By dynamically balancing supply and demand and optimising renewable energy production, storage and consumption, the present project will directly contribute to the country's climate goals. Socially, active citizen participation is empowered, enabling consumers to engage with energy markets, adjust consumption based on dynamic pricing, and benefit from demand response programmes. As a result, energy literacy is improved.

Climate science: Regional Digital Twin Climate Change

The rising economic impact of climate change underscores the urgency for innovative resilience solutions. As risks grow, the predictive risk analytics market is set to expand from $22 billion in 2019 to $55 billion by 2027.[16] The Regional Digital Twin Climate Change (RDTCC) project has the ambition to address this need by providing advanced climate services and risk management solutions for energy, finance, agriculture, and public services. The project will leverage data, AI, HPC, sovereign cloud, and EU platform interoperability to develop a comprehensive climate services portfolio.

Its main objectives are:

- Enhance resilience to climate change for government bodies and critical industries
- Advance AI algorithms for predictive and risk management applications
- Establish Luxembourg as a global leader in digital twin technology and climate services

The initiative will build on favourable European and national contexts, in alignment with Destination Earth (DestinE), an ambitious European initiative to develop a highly accurate digital replica of the Earth for monitoring, simulating, and predicting climate and environmental changes. It will leverage and pursue LSA- and ESA-initiated activities such as the 2024 Luxembourg Flood Digital Twin prototype and the 2025 RDTCC Architecture study and use cases. This strategic approach lays the groundwork for industrial development starting in 2026.

By leveraging the expertise and technological advancements developed through the Space Hub of the Luxembourg AI Factory, the RDTCC will apply AI and HPC to optimise regional climate impact assessments, enabling precise risk analysis and decision-making. The system integrates satellite imagery, local in-situ measurements, topographic maps, and auxiliary regional data, automatically ingesting and processing them by using MeluXina(-AI) and hosting capabilities on Luxembourg sovereign cloud solutions. A key feature is its interoperability with DestinE, which provides the global climate scenarios that the RDTCC will refine into high-resolution and region-specific models.

The project will further **enhance multi-sectoral climate services, delivering AI-driven predictive models and scenario simulations** tailored for energy, financial services, and digital infrastructure, and will support sector-specific digital twins such as those for energy and transport, ensuring a cohesive and scalable digital ecosystem. Additionally, AI-powered tools, including virtual assistants and advanced search functions, will enable real-time insights and efficient data retrieval, empowering businesses and policymakers to anticipate and mitigate risks.

The consortium is composed of key Luxembourgish actors in AI, Cloud, and HPC such as research centres, academics, private companies, European AI Factories and other national agencies having relevant expertise/ needs and confirming interest to take part to the project.

[16] Fortune Business Insights, Risk Analytics Market Size to Touch USD 54.95 Billion by 2027 (23.06.2020)

Space: Sustainability in Space

Space technologies and applications play a crucial role in our daily lives from enabling GPS navigation, weather forecasting, to global communications. Due to the increasing number of satellites launched, space is becoming crowded; therefore, to continue benefiting from space technologies, ensuring a sustainable space is a must. Luxembourg's position in the Space Sector is well established with large, stabilised operators, an extended ecosystem of startups and SMEs as well as a legal framework for space activities.

The present project will tackle complex problems related to space sustainability in different phases:

- **Space Situational Awareness (SSA):** Improve SSA through the development of AI-based tools for object identification, manoeuvre optimisation and collision risk avoidance. The use of Earth-based observations and radars in combination with space-based data is foreseen. In the SSA-context, the development of SSA data curation capabilities ranging from collection, aggregation over error detection, bias estimation to standardisation and archiving is encouraged. Further, the creation of SSA databases to be hosted on a sovereign cloud infrastructure and a SSA marketplace will be explored.
- **Satellite Health:** Enhance spacecraft maintenance. AI is expected to become a game-changer in analysing satellite health by using ML, predictive analytics, and anomaly detection. AI could monitor satellite telemetry data in real time and detect anomalies that could indicate sensor malfunctions, communication issues, deviations from patterns, unexpected energy consumption or attitude control problems. AI could potentially flag the need for actions (predictive maintenance) from historical telemetry, from environmental factors such as space weather, or from previous anomalous behaviours.
- **On-board autonomy and In-Orbit-Servicing:** Improve sustainability in space by allowing to (i) plan efficient routes and make real-time decisions for space missions as well as (ii) extend spacecraft life, reuse modules, and de-orbit objects that cannot manoeuvre to graveyard. AI will play a crucial role in IOS by enabling autonomous, precise, and efficient operations for repairing, refuelling, relocating, and deorbiting satellites. This involves computer vision, edge computing and machine learning for real-time object recognition. Robotic control may be used to execute dedicated operations that cannot depend on the latency that human oversight would require.
- **In-Space Manufacturing:** This phase will set the cornerstone for a future in-space economy. Advancements of 3D printing, in-space assembly, reuse of debris and edge computing in space are foreseen.

The realisation of the present project, significantly driven by initiatives from private companies, will involve the launch of three calls for projects, covering the first three phases of the 'Sustainability in Space' initiative. These calls are expected to encourage industrial R&D projects in the domains of 'AI for Space Situational Awareness', 'AI for Satellite Health' and 'AI for on-board autonomy, for In-Orbit-Servicing' through attractive financial aid intensities.

Cultural heritage: A strategic framework for integrating AI into Luxembourg's cultural sector

Cultural institutions ensure an essential balance between technological progress and human values. The flagship project *Intelligent Heritage* aims to position Luxembourg's cultural sector as both a consumer and actor in the development of AI solutions, by establishing the appropriate policy framework.

AI opens up unprecedented perspectives: connecting disparate collections through intelligent metadata, detecting patterns in multilingual archives, or making vast sets of historical data accessible. The project aims to bridge the digital divide between major institutions and local archives through scalable AI tools, shared technical infrastructure, and knowledge transfer mechanisms. Sections dedicated to ethics, protection of creation, innovative tools, inclusion, and public engagement will strengthen critical thinking and promote digital sovereignty at the national level. By leveraging AI capabilities, we will democratise access to Luxembourg's multilingual heritage, strengthen the links between citizens and collective memory, and make the country a leader in AI-enhanced heritage management, in line with the national AI strategy.

Context:

Since a survey conducted in 2018 by the Ministry of Culture, the Luxembourg cultural heritage sector has shown varying levels of digital maturity. The LuxTIME project has deepened this diagnosis by proposing a decentralised consortium to structure research activities. This flagship project, recognised for its strategic relevance, aims to address the challenges and seize the opportunities related to AI in the cultural field.

Here are the objectives of the project:

- **Strengthen the archives and collections:** Support cultural institutions in the qualitative and sustainable management of their data, while enhancing their interoperability. In a data-driven economy, it is important to recognise these skills and expertise as crucial strategic assets.
- **Facilitate research and development:** Improve the internal processes of heritage institutions and offer innovative user-centred services. The associated projects facilitate intelligent research, metadata enrichment, semantic links, and multilingual access.
- **Establish an ethical framework:** Create transparent legal frameworks to ensure that AI innovation respects the rights of creators. Support the GLAM sector (Galleries, Libraries, Archives and Museums) by establishing an ethical framework conducive to responsible and sustainable innovation.
- **Raise awareness and train the public:** Position the State as a strategic catalyst for innovation in the cultural sector through the creation of internal experimentation spaces, targeted awareness and training actions for small GLAM institutions.
- **Implement a collaborative governance model:** Establish a flexible and adaptive governance model that can evolve with the needs of stakeholders and the rapid pace of AI advancements, while ensuring strategic coherence and fostering innovation.

Part 5. Conclusion

Looking ahead

Accelerating AI deployment thanks to a culture of experimentation

To fully understand Luxembourg's ambition in AI readiness, relying on just one strategy document alone wouldn't be sufficient. For decades, our national culture has embraced ingenuity, technology and a skills-driven economy.

This same spirit is reflected in this strategy's approach to innovation, where the tough questions are systematically tackled first, setting the stage for discussions around ethical and regulatory implications. Due to the Grand Duchy's agile size, tech-forward vision and close collaboration between regulators, ministries, organisations and the private sector, Luxembourg itself is an innovation sandbox, accelerator and incubator, always with a view on the broader EU market and beyond. This is one of the country's greatest strengths, making it a prime catalyst to bring new AI applications and solutions to the market. Luxembourg's identity is that of an advanced information society, experimentation hub and developer in AI ethics.

Years of pivoting, experimenting and specialising have taught us how to prioritise what matters: cultivating the skills of our people, providing them with the infrastructure for innovation and, always, protecting human rights and freedoms. Our regulators understand the challenges that entrepreneurs face, as well as how to co-create a way forward that protects both individual rights and innovation. As a pioneer in financial technology, for example, Luxembourg tackled the ethical and regulatory question marks required to bring security and confidence to an age-old industry undergoing rapid transformation. Furthermore, to push new technologies forward, Luxembourg is focusing on solutions that impact the daily lives of its people. This has been done time and time again, whether via calls for projects (e.g. 5G pilot projects), funding (e.g. Digital Tech Fund) or new facilities (e.g. MeluXina).

Across the government, Luxembourg's public servants know how to collaborate. Their unity has allowed for the allocation of funds needed for upskilling the labour force and deploying next-generation infrastructure, such as ultra-high-speed broadband for every household.

This AI Strategy is based on perspectives and recommendations from all industries, ministries and segments of society. If anything, it is holistic, recognising that AI represents not just a new technology, but a new age in computer-human collaboration—a new age that has already begun, and Luxembourg plans to be ready for it.

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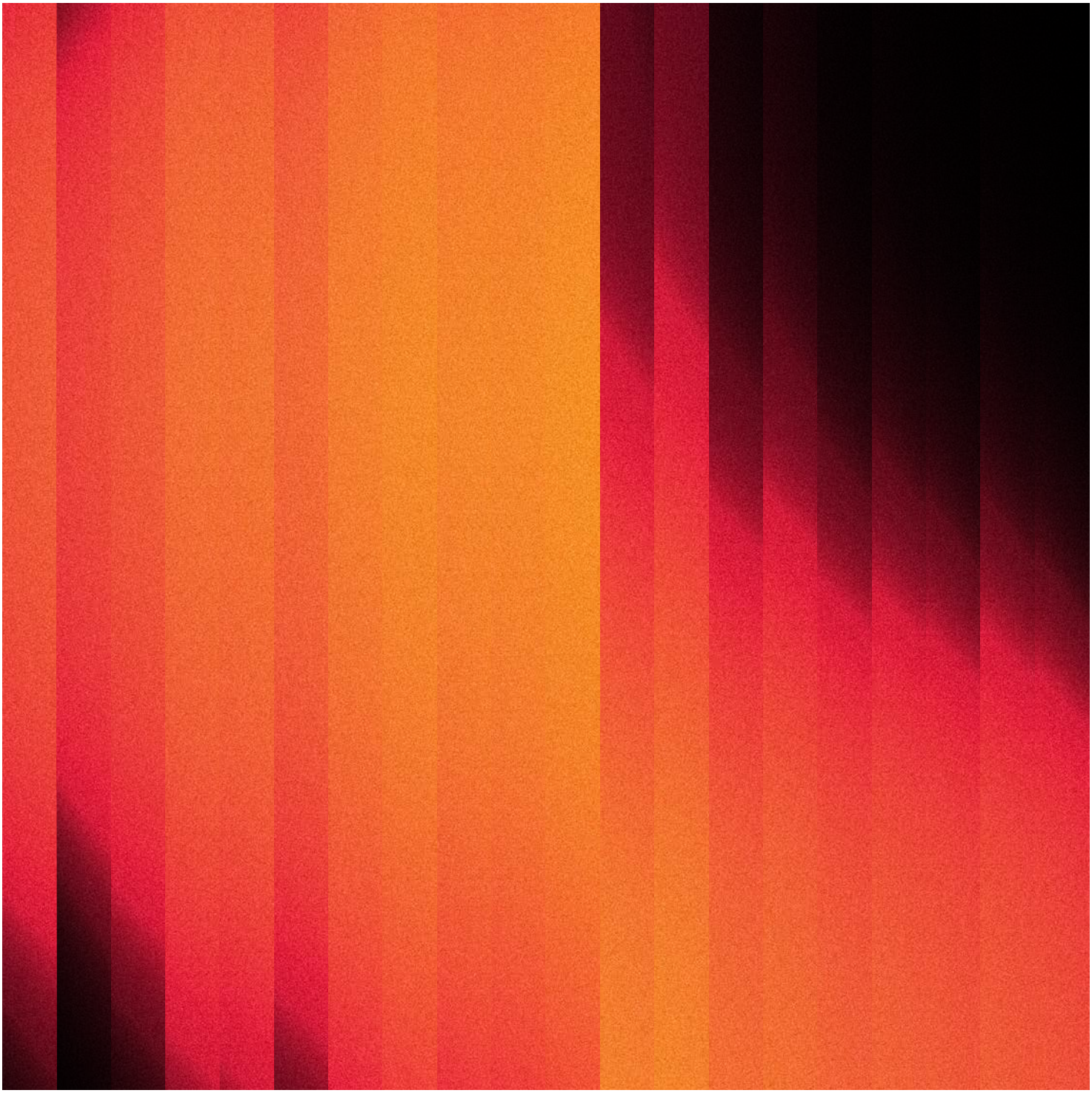

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