Thematic Assessment on Digitalization for the Republic of Moldova

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Authored by:
Igor Bercu, Digitalization expert, Moldova
Hanna Jemmer, Team Lead
Raivo Ruusalepp, Team Lead
Melano Sirbiladze, Thematic Coordinator

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1 Executive summary

1.1 Introduction

This is an assessment of how digitalization supports and could support Republic of Moldova (hereinafter referred to as Moldova) in its green transition in accordance with its obligations under the Association Agreement with the EU and the European Green Deal (EGD). General digitalization building blocks such as the regulatory framework prioritising digitalization, connectivity, digital identity, e-government services, data management and interoperability, digital skills and the state of the Information and Communication Technology (ICT) sector need to be in place before digitalization in different sectors can be fully pursued. Some digitalization in Moldova is present in every sector we analyse. However, the developments are usually in the early phases. These sectors are energy, buildings and renovation, industry, circular economy and waste, smart mobility, environment (climate, biodiversity, zero pollution) and agriculture (farm to fork). There are not many examples of digital tools, but some developments can be recognised. Further, we assess how digitalization for green transition is funded, how to ensure the justness of green and digital transformation and how research, development and innovation contribute to digitalization for green transition purposes.

Methodologically, we have used document analysis, i.e. assessments made by different international organisations such as the European Union (EU), International Telecommunication Union (United Nations), Organisation for Economic Co-operation and Development (OECD), U.S. Agency for International Development (USAID), World Bank Group, etc. and governmental documents such as legal acts, strategies, and action plans related to digitalization, also in relation to different sectors. Secondly, a national digitalization expert in Moldova interviewed policymakers and non-governmental experts in Moldova to gain deeper insights on the status of the green transition, including gaps, needs and enabling conditions.

To provide an overview of the state of digitalization in Moldova, in terms of sectors and cross-cutting issues, we have divided the summary into three main parts. First, there is an overview of the general level of digitalization in Moldova, composed of seven sections (noted above). Secondly, we delve into the sectors to identify the main gaps and needs, and how digital solutions could contribute to fixing these gaps (eight sections listed above). Thirdly, we demonstrate the links to cross-cutting areas of Research and Innovation, Just Transition and Transition Finance. Then, we conclude with the main takeaways.

1.2 General level of digitalization in Moldova

1.2.1 National digitalization governance and strategies

ICT usage and coverage have increased in Moldova over the past decade due to strong government support for sector development through various strategies and regulations. Among them were the “Digital Moldova 2020” and its Action Plan for 2013-2020 (EC, 2023). Based on the European Commission’s 2023 report (EC, 2023), on the accession of Moldova, the country has achieved some level of preparation in digital transformation. The comprehensive digital transformation strategy for 2023-2030 was approved by government decision (Ekholm B., 2019), setting out a countrywide action plan. The Law on electronic identification and trust services (IPCC, 2023, p. 53) has entered into force and is broadly aligned with the EU acquis. The cybersecurity framework has been strengthened by passing the Law on cybersecurity (EIT-Digital, 2022), adopted during the reporting period, but Moldova should start implementing the law. Moldova needs to align its legal framework with the European Electronic Communications Code. Implementing legislation, including the laws on freedom of expression, personal data protection and access to information, also needs to be amended to align with the EU acquis. The country has clear strengths in digital transformation capacities, and the foundational elements are in place.

The **Moldova Digital Transformation Strategy** (MDTS) is a key component of the Government Activity Program of Moldova, which identifies digital transformation as one of the most important policy objectives for the next four years (EC, 2020). It is aligned with those of Europe's Digital Decade (EC, 2023). It has six general objectives:

1. Develop a digital society. Ensuring **widespread use of digital technologies** and services across all aspects of life. It further states that **digital literacy** and competencies need attention.
2. Create a robust and **competitive ICT environment** (strengthen the IT sector).
3. Create an **innovative and resilient digital economy** (encourage leveraging digital technologies for growth and innovation).
4. Establish an **efficient, smart and transparent digital state** (transforming public services to be more accessible, efficient, transparent, accountable, and user-friendly).
5. Create a secure **digital environment that is accessible and inclusive** (safe, secure, protects privacy, and all can participate).
6. Make Moldova a **trusted and reliable digital nation** (increase digital competitiveness and innovation internationally, integrate into the EU's Digital Single Market (DSM).

Main government stakeholders

Digitalization efforts are spearheaded by diverse stakeholders, including governmental bodies, private sector entities, civil society organisations, and international partners. **The Ministry of Economic Development and Digitization oversees ICT policies and fosters digital innovation in the country**. It plays the main role in coordinating digitalization efforts across different sectors. **The Information Technology Services and Cyber Security (ITSEC) ensures the security of cloud-based digital infrastructure and information systems** within the government sector, protecting it against cyber threats. **The Cybersecurity Agency** is the recently established competent national authority in the field of cybersecurity and is responsible for managing cybersecurity crises in Moldova. **The National Regulatory Agency for Electronic Communications and Information Technology (ANRCETI) regulates the telecom sector**, ensuring a competitive market. **The State Chancellery oversees the implementation of e-governance initiatives**. International partners and donors such as the EU, the World Bank, USAID, and the United Nations provide financial and technical assistance to support Moldova's digital transformation.

The Ministry of Economic Development and Digitization drives the government's digital transformation agenda and coordinates the digitalization efforts across the public sector. At the same time, the **E-Governance Agency (EGA) within the State Chancellery is mandated to develop the infrastructure for electronic governance and coordinate investments in the public sector´s ICT**. All institutions subordinated to the government are responsible for implementing their digital development agendas through reengineering and alignment with the government's activity program and MDTS.

Main strategic documents, assessment of later technological advancements

Over the last two decades, the digital transformation efforts of the Moldova have been guided by **several national and sectoral strategies**, such as the National Strategy of Information Society Building ”Electronic Moldova”, the National Strategy for Information Society Development "Digital Moldova" 2020, the Strategic Program for Technological Modernization of Government (e-Transformation), the Strategy for the IT Industry and Digital Innovation Ecosystem Development 2018–2023 (EC, 2020). Moldova is in the initial stages of developing a strategic framework for data governance and AI. Despite being a topic on the public agenda and involving various sectors - from government and local administrations to academia and businesses - concrete steps toward implementation are only beginning.

1.2.2 Connectivity

As of 2021, Moldova had 99.9% of the population covered by 3G and 98% with 4G/LTE (UNDP, 2021). As of 2023, the penetration rate, reported per 100 inhabitants of mobile Internet access services, reached 120.6% (EC, 2021). Moldova is among the top 10 countries in the world regarding accessibility and affordability of Gigabit Internet access. Users have access to unlimited Gigabit Internet for about EUR 15 per month. Internet access is relatively affordable and widespread, with 80% of the population accessing Internet services in 2021. 34.3% of those who are not connected invoked high prices as the main reason for being unconnected, while another 48.1% and 20.3% lack computers and/or smartphones (EC, 2030). The 5G implementation and rollout will happen in two stages. The first stage (2021-2022) foresees the consolidation of the current networks with spectrum refarming. The second one (2022-2025) envisages the creation of an enabling environment for implementing 5G networks (EC, 2021).

Current shortcomings and plans to overcome them

1. **High-speed home access to broadband is still challenging,** and the cost is perceived as problematic.
2. Strong government support exists for the ICT sector's development, but there is **a partial or fragmented vision** related to its further development.
3. **Limited efforts** by stakeholders **to increase cyber-resilience**.
4. **Many essential services to citizens are yet to be digitalized**, and further efforts are needed.
5. **There is little awareness regarding the use of open-source technologies in government procurement, indicating a gap and potential barrier regarding** the opportunity to expand the local ICT sector.
6. Further **work should be undertaken on customer orientation, monitoring and evaluation mechanisms** and addressing internal change resistance and bureaucratic barriers to deploy new services.

Cybersecurity

The country became a member of the Budapest Convention on cybercrime in 2009 and has worked to address Internet safety and cybercrime issues since then. There was also a **2016-2020 National Cybersecurity Program,** which resulted in **approved Mandatory Cyber Security Requirements for public authorities** and **established Government and Military CERTs** (Computer Emergency Response Team). The **2019-2024 Information Security Strategy and Action Plan was approved** as the next step towards cybersecurity resilience. It aims to establish the National CERT, transpose the NIS directive, ensure control and monitoring of the application of minimum cybersecurity requirements, define the national critical infrastructure and the measures needed to protect it, as well as set the framework for counteracting hybrid threats (EC, 2022).

According to the law on cybersecurity, **the government established the Cyber Security Agency in December 2023** (EC, 2022) which will act as a competent authority on cybersecurity and the national computer incident response team (EC, 2020). In February 2024, Moldova also unveiled the creation of the National Institute of Innovations in Cybersecurity "Cybercor".

1.2.3 Digital identity

In Moldova, the **government primarily provides the digital identity infrastructure: ID Card, E-signature, Mobile-ID, Mobile Signature** (EvoSign). Moldova was **among the first countries in the world to implement Mobile eID**. The new government service for mobile eID and signature, EvoSign, is a mobile app-based electronic identity solution. Its main goal is to provide a tool for authentication and signing electronic documents. **It serves as a digital wallet** where citizens can **store and access essential documents,** such as identity cards, driver's licenses, and registration certificates, on their mobile phones.

Government-provided digital identity solutions are used across both the public and private sectors. However, several banks have introduced their alternative identity solutions. There are still not enough uses of digital ID, which is one of the key enablers of more digital services being developed and more people using digital services (EC, 2022).

1.2.4 Digital services

Government services have undergone rapid digitalization with the establishment of the eGovernment Centre (now the E-Governance Agency) in 2010. The e-Government process in Moldova started in 2006 with the approval of the E-Governance Concept. However, until 2010, its implementation was in the pilot and experimental stage. The Strategic Program for Technological Modernisation of Government for 2011-2016 set the framework for the future e-Transformation process.

In December 2021, the Parliament approved the law on public services, establishing a legal framework for the public service delivery system. This framework includes standards and requirements to develop unified and user-centric digital services. Requirements for re-engineering, digitalization, and quality assessment were introduced in 2020, and **services are currently undergoing re-engineering and integration into the public services portal** (E-Gov, 2024).

A framework for a centralized system designed to manage data on government information resources, known as the Register of State Information Resources and Systems, received approval. EGA is responsible for maintaining the Register and ensuring that all public institutions register all governmental information systems within the Register, including those currently in development. In the area of digital transformation, the implementation of the now-expired Digital Moldova 2020 strategy has been only partially successful. Several reasons have led to these results, including limited financial resources, limited project management, and institutional implementation capacity (EC, 2020).

Only one in two respondents who accessed a public service has used an electronic service. The respondents have a considerable gap of 60% in educational levels and a 20% gap between the urban and rural populations. Young people aged 18-29 are the category that almost five times more often use electronic services than those aged 60-74 (EC, 2020).

Challenges range from financial constraints to regulatory gaps and skill shortages. Some of the challenges are low research and innovation expenditure, slow growth of innovative companies, lack of legal acts on new digital technologies, mismatch of digital skills and the industry needs, low digital awareness among the public, insufficient institutional capacities to implement the digital agenda, resistance to digital transformation, not enough finances, underdeveloped IT infrastructures in municipalities, low level of ICT investment in **small and medium-sized enterprises (SMEs)**, low involvement of local companies in governmental IT projects, insufficient pay to civil servants managing IT projects, not enough scientific research and not enough monitoring the process (Ministry of the economy, finance and industrial and digital sovereignty [MEFIDS], 2022).

1.2.5 Data management

In Moldova, **the basic registers exist digitally and are regulated and managed by responsible bodies. Most of the data is digitalized; however, there are still not fully digital registers.** Efficient data exchange within the public sector and between the public and private sectors is facilitated by implementing the Interoperability Framework. **The MConnect Governmental Data Exchange Platform is fully implemented to ensure system and data exchange coherence**. The platform's data exchange architecture is now fully established, supported by legal, technical, and institutional frameworks. MConnect's integration and effective utilization by authorities underscore its pivotal role in public administrative service modernization. As of 2023,

according to the EGA, 92 entities are using MConnect for data exchange, and the platform has handled over 1.3 billion data requests. The basic data policy principles (e.g., once only, digital by default, privacy by design, security by design principles) are implemented by EGA and supported by separate legal documents.

Moldova launched its **open government data portal (Portalul de Date)** in 2011. It **currently holds 1222 datasets** (DataSets, 2024). This step was taken to enhance transparency, administrative efficiency, public accountability, and to unlock the economic potential of data re-use. The Governmental Data Portal serves as a centralized information resource, aiming to deliver a seamless and comprehensive experience for those searching for data produced by governmental authorities, public institutions, and other governmental bodies. Moldova ranked 18th in the global open data ranking (Open Data Watch, 2024).

1.2.6 Skills

Digital literacy

Moldova has been actively working towards enhancing digital literacy and fostering a digital transformation throughout the country. In terms of digital literacy, **several initiatives have been undertaken to incorporate digital education into the school curriculum at all levels.** In 2018, a mandatory digital education module was introduced in primary schools. Standards on digital competences have been established for students across primary, secondary, and high school levels (OECD(a), 2023). Efforts have also been made to address the shortage of IT equipment in schools and improve teacher training. Digital tools are integrated into all levels of learning across Moldova (OECD(a), 2023), and educators use them to enrich their teaching skills. **The country has 20 higher educational institutions that offer IT-related studies.** Yet, despite the risk of implementing teaching methods focused on theory rather than practical implementation, IT industry professionals are not formally allowed to teach at universities unless they have advanced degrees and pedagogical certification.

Cybersecurity skills

Since Russia's invasion of Ukraine, Moldova has been subjected to several cyberattacks. **To build the country's defences against cyber-attacks, students are also being trained in information security at the Technical University of Moldova** – an education of heightened importance in today's world (The Swedish Development Forum, 2023). The education refers to the bachelor's program in Information Security, which allows students to work as specialists in infrastructure networks or as security managers in IT companies. This educational program was established in response to a pressing need. One challenge is that the level of skills does not meet the demand as the IT professionals pool is limited, and additionally, more coordination is needed in these efforts.

1.2.7 IT sector digitalization

Moldova economy is relatively open and closely integrated with the EU´s. Economic links between Moldova and the EU have strengthened since the entry into force of the Deep and Comprehensive Free Trade Area in 2016 (EC, 2021). **Moldova is progressing towards a comprehensive digital transformation, emphasising the private sector alongside governmental and civil society efforts.** The ICT sector is topping the list of the country's priorities as a productive sector and an enabler for economic and social development. **The ICT sector has become the primary driver of digitalization and innovation in Moldova and is growing fast** (MEDD, UNDP, 2023). In 2021, the IT industry reached a share of more than 4.25% of GDP (MEDD, UNDP, 2023). As of 2022, the number of ICT companies has exceeded 2300, while the number of employees has exceeded 24 000, registering significant growth for both indicators during the last five years (Danish Trade Union Development Agency, 2024). The number of employees in the industry is about 2% of the available labour force in the country, which is about two times lower than the EU average of 4.2% (Danish Trade Union Development Agency, 2024).

Moldova has updated its Digital Economy Roadmap for 2023. This roadmap promotes government-to-business online interactions, digitalizing the economy, and developing e-commerce infrastructure.

Shortcomings in the business sector:

- **Most businesses in Moldova (about 95%) are** SMEs, which are the main drivers of the economy. However, **less than 17% of SMEs have successfully integrated digital technologies into their work** (Koriavets M., 2023)**.**
- There is low cross-border e-commerce flow, and Moldova is under-represented on international marketplaces (Koriavets M., 2023).
- **SMEs rarely use enterprise resource planning (ERP) systems.**

1.3 Sectoral digitalization aimed at green transition

In all eight sectors, there are ways and examples of how Moldova can move towards green transition while using digitalization. This section assesses the status and impact of digital technologies in biodiversity conservation, agricultural practices (Farm to Fork), industry, circular economy and waste management, building and renovation, climate action, and energy, identifying key gaps, needs and enabling factors to further the green transition via digital means.

1.3.1 Biodiversity

Collecting data (via e.g. sensors, drones, satellites, cameras or audio recordings), storing data in databases and using AI-enabled solutions for data processing and management has been highlighted as a main digital enabler for reaching biodiversity

goals. In Moldova, the specific information on digitalization directly related to biodiversity is limited. Integrating existing governmental digital platforms and strategies into biodiversity management would be a step forward. The Ministry of Environment is **developing a new Environmental strategy**. The draft strategy outlines a comprehensive approach with specific sections focusing on biodiversity and the digitalization of environmental management. The **strategy emphasises implementing advanced digital monitoring systems to track biodiversity health across various ecosystems**. It proposes the creation of a **centralized digital platform that integrates all biodiversity-related data**. The strategy also suggests developing **digital tools for reporting and compliance** monitoring. These tools will **automate the reporting processes**. Further, using digital tools is foreseen for public engagement regarding conservation.

Currently, no biodiversity data and monitoring system exists, which could be resolved via digitalization, data management, integrated databases. Data collection for monitoring and reporting in protected areas is also lacking, which could be aided via digital data management solutions. The management review system could also be digitalized in the forestry sector to improve monitoring and reporting. However, the mentioned strategy seems to take steps towards these goals.

1.3.2 Industry for green and circular economy and waste management

Digitalizing the industry is preconditioned by excellent connectivity, development and deployment of new AI and Blockchain technologies, boosting digital skills, digital solutions aimed at sustainability, resource, and production efficiency. **Moldova is still in the early stages of development in terms of digitalization in industry and the application of the circular economy**. Moldova is working towards improving its circular economy and waste management practices, which also require digitalization through online platforms. **The waste management information system is partly in place**. Public services, such as **permit systems for waste management, have also been digitised**. The central waste management data information system for waste management data is the Waste Management Information System, but due to human and financial resources, maintaining the system has its challenges.

Key gaps include an **insufficient legal framework that does not currently support digitalization**. This issue should be addressed. **The industry sector´s readiness to apply digital solutions is relatively low**. Thus, raising awareness and educational programs could be helpful. The waste management system needs further digitalization and development, and the capacity to maintain that system needs to be increased.

1.3.3 Climate

In Moldova, the climate sector broadly encompasses activities and policies related to mitigating and adapting to the impacts of climate change. This includes sustainable agriculture practices, renewable energy adoption, efficient water management, and conservation of biodiversity, all aimed at reducing greenhouse gas emissions and

adaptation to climate change. In the context of Moldova, **digitalization plays a crucial role in transforming the climate sector**. Digitalization in the climate sector in Moldova involves improving data collection and analysis, which aids in accurate forecasting, risk assessment related to climate impacts, and the planning of resilient infrastructure. **Even though the developments are beginning, some initiatives can be highlighted**. For example, the **Moldova Sustainable Green Cities** project targets climate change issues to stimulate investments in low-carbon, environmentally friendly urban development through an integrated urban planning approach (UNDP, 2025). The "Agrotek Arena" project **promotes digital solutions for monitoring crops via sensors, drones, and data management solutions** (MERRM, 2024).

The gaps include **insufficient monitoring, reporting and verification systems,** which could be aided via a centralised digital system via real-time monitoring. There is **limited access to open data on** climate-related issues, as it is often not machine-readable. Improving the quality of data would make this information more accessible for decision-making. **Limited financial and institutional capacity** also plays a role, where digital governance solutions can lead towards effectiveness and clearer cooperation.

1.3.4 Energy

Moldova has aligned with the Energy Community's regulations and has received recommendations on digitalization as part of its National Energy and Climate Plan (NECP). This includes integrating digital technologies into the energy market to support the operation of renewable energy sources, promote energy efficiency, and ensure a secure energy supply (MOE, 2020). Some concrete examples include **a pilot project to install smart meters for electricity, which started in June 2023**. This helps transmit data automatically and benefits both energy companies and consumers. Moldova is also working on **developing smart grids to integrate renewables** better, as energy flows can be managed via data solutions (MOE, 2020). Building detailed models of energy assets based on big data sets and sensors to predict and manage performance under various conditions could also support the energy system.

One challenge is that the increased use of renewables can be demanding for the grid. Demand-response systems, smart meter deployment and tools for planning grid development are some digitalization options. **The reliability of emissions data is low, but better data quality could improve the situation.** Expertise to support the green transition is limited, so online tools to increase skills could be a way forward.

1.3.5 Farm to Fork

Digital technology unlocks enormous untapped potential for farmers, investors and entrepreneurs to improve the efficiency of food production and consumption. **The status of digitalization in Moldova's "Farm to Fork", particularly in agriculture, is still in its early stages**. However, the national strategy for agricultural and rural development for 2023-2030 foresees efforts towards digitalizing the agricultural sector to a greater extent (GD no.56, 2023). Several digital platforms have already been

developed. One example is the **Laboratory Information Management System, which streamlines the processing and management of laboratory data for agricultural products**. **The Management of Sanitary and Veterinary Measures platform helps track and manage health and safety protocols** across the agricultural industry. Additionally, there are registries such as the **Registry of Animals and the Farmers Registry, which maintain essential data on livestock and agricultural producers,** respectively.

Overall, there is a gap in data on many of the Farm to Fork indicators. More specific targets are needed, and **digital data collection could help set indicators** for better analysis and monitoring. Besides data collection for policy purposes, **agricultural businesses could benefit from online marketplaces**. **Awareness of healthy and affordable diets could be raised** via online channels.

1.3.6 Buildings and renovation

Moldova's approach to addressing its buildings-related challenges involves a combination of a regulatory framework, financial incentives, and strategic partnerships, aimed at modernizing its building stock, reducing energy consumption, and promoting sustainable development. **The status of buildings-related digitalization efforts in Moldova primarily focuses on enhancing energy efficiency and integrating renewable energy** sources through the regulatory framework and technological adoption. Several digital platforms are available, or initiatives are being developed. The **"Energy Vulnerability" platform is a resource for managing the compensation system for vulnerable energy users** by assigning them to an 'energy vulnerability' category. **The "Ecovoucher" module is a resource for administering financial aid** and promoting efficient energy consumption among vulnerable consumers. It can also be accessed via compensatii.gov.md. Several other energy efficiency-related platforms are helping to identify the benefits of energy efficiency for consumers, identifying excessive energy use, the energy performance certificates system and others.

The main gap is the ageing and inefficient building stock. Substantial investments are needed to improve energy efficiency and integrate modern energy solutions. There is a **lack of a comprehensive long-term renovation strategy and specific action plans** which need to be put in place, **considering the full spectrum of digital solutions** that could be used to upgrade the outdated building stock.

1.3.7 Smart mobility

Smart mobility entails the utilisation of different ICT tools, emerging technologies and modern solutions to optimise the transportation system. **Moldova is gradually introducing smart mobility solutions** as part of its commitment to align with the EGD. **Some cities have implemented Intelligent Transport Systems (ITS) like GPS monitoring and e-ticketing** to improve service efficiency and user experience (Transport Community, 2024). The adoption of electric and hybrid vehicles (EVs) has grown significantly in recent years. The private sector has begun developing electric

vehicle charging infrastructure, but the network remains insufficient to meet growing demand. The rail network remains fully non-electrified, with limited passenger kilometres and low-speed services. **The National Bureau of Statistics has made progress in digitizing transport data collection**, providing a foundation for further integrating big data analytics in mobility planning.

Data availability remains challenging in Moldova's transport sector, with gaps in collecting comprehensive transport data. **The government plans to develop new data collection and monitoring mechanisms for aviation, naval, and road transport agencies by 2024**. 5G technology is still in its early stages of deployment in Moldova. The government has granted licenses for 5G networks, but infrastructure development is limited. A comprehensive legal framework aligning with EU GDPR is crucial to secure personal data and maintain public trust in smart mobility applications.

1.3.8 Zero pollution

Under zero pollution are areas such as air quality and health, emission reduction, pollution prevention and control, water quality and conservation, soil protection, chemicals management, green technologies and innovation, environmental monitoring and reporting. The Ministry of Environment has an **online information system, the Pollutant Release and Transfer Register** (PRTR) (GD no.373, 2018). The platform enables operators to report their emissions data digitally. Also, there is an online platform for **reporting data on waste generation and waste management** (e-Gov, 2024). **Permit systems for air emissions, water use, and waste management have also been digitised**. The PRTR collects data on air, water, and soil pollution from operators. However, the information has to be supplemented by increasing reporting rates.

Despite these efforts, the Ministry of Environment lacks the financial and technical capacity to maintain the digital systems without external support. Not all companies report their data to the PRTR system, resulting in incomplete data. Better integration of environmental databases across sectors is also needed to improve data sharing. Still, Moldova is on the way to making data sharing through digital platforms more effective.

1.4 Links to just transition, research, development and innovation and transition finance

1.4.1 Just transition

The digitalization policy in Moldova's transition to a green economy addresses potential job losses and supports vulnerable groups (MDED, 2018). The policy recognizes that moving to a green economy can disrupt traditional jobs, especially in sectors like energy and industry. To mitigate this, the policy focuses on **reskilling and upskilling workers**, helping them transition to new opportunities in emerging sectors. Specific programs include professional training for the unemployed, subsidies for young people, women farmers, and returning migrants to start new businesses, and special support for women-owned enterprises. Additionally, **energy vouchers** are

provided to low-income families to help reduce energy costs. These measures aim to ensure a fair and inclusive transition, offering support and opportunities to those most affected by economic changes.

The move towards a greener economy will significantly impact employment structures, particularly in carbon-intensive sectors like energy and industry, resulting in job losses. However, job growth is anticipated in emerging sectors such as renewable energy, energy efficiency, and circular economy industries. **Programs supporting the digitalization of SMEs, enhancing energy efficiency, and promoting sustainable agricultural practices are designed to foster job creation in green and digital sectors** while ensuring a smooth transition for workers from traditional industries. Several **digital literacy programs** support skills development among vulnerable groups in Moldova. For instance, Tekwill focuses on enhancing women's IT skills and careers, with donor support, six tech hubs have been created to support tech education and career reorientation (EU4Digital, 2019). Companies and organizations in Moldova also have programs that support retraining employees to enhance their digital skills and ensure they remain competitive in the job market. Some of these programs are also related to the green transition. The programme of the Promotion of the Green Economy (2018-2020) supports SMEs through green efficiency and technology funding programmes. The Digital Transformation Programme for SMEs supports small and medium-sized enterprises in implementing digitization projects, enhancing their digital capabilities and competitiveness.

1.4.2 Transition Finance

Digitalization is central to Moldova's strategy for enhancing governance, public services, and economic competitiveness. Key focus areas include e-government, digital infrastructure, and digital skills enhancement. Transition finance is integral to these efforts, supporting financial activities that align with environmental and social sustainability criteria. Several policy documents highlight digital transition in relation to economic growth and environmental sustainability, i.e. the National Development Strategy "European Moldova 2030", Digital Transformation Strategy of the Republic of Moldova (2023-2030) and others, more sector-specific like the Low Emission Development Program and the National Climate Change Adaptation Program.

The funding sources include both internal and external mechanisms. **State budget allocations are managed by the Ministry of Finance, the Ministry of Economy and Infrastructure, and the E-Governance Agency.** The national budget funds many E-Government projects (i.e. MPass, MSign, MConnect, etc.). Connectivity projects in view of broadband expansion also receive partial funding from the state. **External funding from the EU**, such as EU4Digital, supports digital economy and society initiatives, including digital skills. **European Investment Bank provides loans** for large-scale digital infrastructure projects, and **European Structural and Investment Funds also allocate funds** to enhance digital capabilities. **World Bank, UN's Development Program and USAID also provide funding in the digital domain.**

State budget allocations are often insufficient to cover comprehensive digitalization needs. There is a lack of specialized funding schemes specifically tailored for digital projects. To ensure sustainable digital development, the government must implement strategies that attract private investments and enhance the capacity for self-financing digitalization projects. **Encouraging government and the private sector collaboration** can accelerate digital transformation by leveraging private sector resources and expertise. Developing a clear policy framework to facilitate Public-Private Partnerships (PPPs) and engaging with private sector stakeholders is essential. Moldova can further enhance its digital transformation by fully utilising EU funding.

1.4.3 Research, development and innovation

Moldova's strategic documents, particularly the **Digital Transformation Strategy 2023-2030, reflect a strong commitment to integrating Research and Innovation (R&I) in the digitalization process**. There is a clear link between digitalization and research and innovation in the context of the green transition, with a focus on sustainable development, green technologies, and collaborative efforts to drive innovation.

Moldova is making strides in integrating ICT skills into its workforce, which is essential for supporting digital and green transitions. However, notable challenges include a **significant skills mismatch and a need for more effective reskilling and adult training programs**. Several Moldova MA/PhD programs, research centres, and research and development projects work to support the green transition via digital skills. The Technical University of Moldova has an MA Program in Renewable Energy focusing on integrating digital skills to develop and manage renewable energy systems. Moldova State University has an MA program in Environmental Management to also equip students also with knowledge regarding technology for monitoring and ecological management. Research centres like the Moldova State University Research Centre for Digital Innovations in Sustainability also conduct research on leveraging digital technologies to promote sustainability. There is the National Centre for Sustainable Energy, dedicated to advancing sustainable energy solutions via digital means, and a Centre for Excellence in Construction, which specialises in energy efficiency and sustainable building practices via digital tools.

Moldova's digitalization sector has a solid foundation to support the green transition, thanks to robust growth in the ICT sector, supportive infrastructure like Moldova IT Park, and comprehensive educational initiatives. Both the private and the non-governmental sectors in Moldova are engaged in green and digital transition, with the **ICT sector leading in digital innovation and non-governmental organizations (NGOs) playing a crucial role in promoting sustainable practices**. However, challenges such as **low participation in vocational training, skills shortages in key sectors, and limited private sector innovation capacity** must be addressed to leverage this potential fully. Enhancing firms' absorptive capacity, improving practical

relevance in training programs, and fostering stronger industry-academia collaboration will be crucial.

1.5 Conclusion

For over a decade, Moldova has made significant investments to establish and enhance its digital public infrastructure and e-government architecture through interoperable, cloud-based platforms for the public sector (EU4Digital, 2023). **Moldova has laid a robust foundation for digitalizing the country with strategies** like "Digital Moldova 2020" and the digital transformation strategy for 2023-2030, which chart a course towards a digitally empowered future. The achievements in ICT coverage, with **nearly universal 3G access** and expanding 4G/LTE connectivity, coupled with initiatives to provide affordable Gigabit Internet, are milestones that underscore Moldova's commitment to digital inclusivity. Moldova continues to face challenges that must be addressed to realize the full potential of its digital ambitions. **A unified ICT vision, cybersecurity, digital skills and the digitalization of public services remain areas that require persistent effort and strategic focus**.

Establishing a Cyber Security Agency and introducing Mobile eID are proactive measures that showcase Moldova's resolve to secure its digital infrastructure and provide innovative digital identity solutions. **The digital divide**, particularly evident in the underutilisation of digital services by half of the Moldovan population, highlights the need for continued investment in digital literacy and education reform. This divide is more pronounced in rural areas, where efforts to increase digital literacy through targeted training and infrastructure development are crucial. **The ICT sector**, a vital engine of economic activity, **is experiencing growth but is constrained by a limited pool of IT professionals**. The Digital Economy Roadmap for 2023 aims to foster government-to-business collaboration and expand the digital economy, including e-commerce infrastructure, which is essential for Moldova's economic diversification and growth.

In relation to the green transition, integrating digital technologies across sectors such as energy, agriculture, and waste management facilitates adopting sustainable practices. **Initiatives like smart meter installations, sustainable urban planning, and digital agricultural platforms gradually embed digital support into environmental objectives.** However, renovating ageing building stock and expanding smart mobility solutions, including deploying electric vehicle charging networks, require comprehensive strategies that blend digital innovation with environmental sustainability. The transport sector's data collection deficiencies are being addressed, with the National Bureau of Statistics improving transport data digitisation. Yet, there is a pressing **need for more comprehensive data collection and monitoring schemes** that leverage big data analytics for effective mobility planning. The advent of 5G technology and the harmonisation of legal frameworks with EU GDPR standards indicate Moldova's steps towards technological modernity and data security.

Under the zero-pollution goal, digital tools effectively manage environmental concerns. The Ministry of Environment's oversight of digital reporting systems like the PRTR and digital permit systems for emission control, water management, and waste disposal is significant. However, challenges such as incomplete reporting and enhanced cross-sector integration for improved data sharing must be overcome.

More generally, data structures need to be centralised and standardized so that different sectors can use data for better decision-making. This can lead to a more rapid green transition. Uptake of digital services needs to be increased via digital skills training. IT specialists' skills need to be enhanced so that the ICT sector can grow and cybersecurity can be developed further.

In summary, Moldova's digitalization efforts are marked by significant achievements and untapped potential. To fully embrace the benefits of digital transformation, Moldova must continue to enhance its digital service usage, refine cybersecurity measures, spread digital literacy across all societal strata, and deepen strategies for AI, data governance, and digitalization in green sectors. Such progressive steps will enhance Moldova's digital competitiveness and foster closer integration with the EU and its green goals.

Table 1. Summary table

Main elements	Enabling conditions	Key gaps	Needs
National digitalization governance and strategies	ICT usage and coverage increased in Moldova over the past decade due to the strong government support for sector development through various strategies and regulations. Among them were the "Digital Moldova 2020" and its Action Plan for 2013-2020. The government approved the comprehensive digital transformation strategy for 2023-2030 by setting out a countrywide action plan. The law on electronic identification and trust services has been put into force and is broadly aligned with the relevant EU acquis. The MDTS is a key component of the Government Activity Program of Moldova, which identifies digital transformation as one of the most important policy objectives for the next four years. The Ministry of Economic Development and Digitization oversees ICT policies and fosters digital innovation in the country. The ITSEC ensures the security of cloud-based digital infrastructure and information systems within the government sector, protecting it against cyber threats.	Moldova needs to align its legal framework with the European Electronic Communications Code. Implementing legislation, including the laws on freedom of expression, personal data protection and access to information, needs to be amended to align with the EU acquis. Except for EGA, most authorities focus on operations rather than developing ICT projects. Many of the achievements in this sector are largely due to external funding and international assistance. This reliance indicates a lack of long-term sustainability, underscoring the need to prioritize internal financial resources for this sector.	As per the Association Agreement, legislation should align with EU regulations (EEC, NIS2, personal data protection, etc.). The Moldova Digital Transformation Strategy sets six general objectives: Develop a digital society. Ensuring widespread use of digital technologies and services across all aspects of life. Also states that digital literacy and competencies need attention. Create a robust and competitive ICT environment - strengthening the IT sector. Create an innovative and resilient digital economy (leveraging digital technologies for growth and innovation). Establish an efficient, smart and transparent digital state (transforming public services to be more accessible, efficient, transparent, accountable, and user-friendly). Create a secure digital environment that is accessible and inclusive (safe, secure, protects privacy, and all can participate). Make Moldova a trusted and reliable digital nation (increase digital competitiveness and innovation internationally, integrate into the EU's DSM. To ensure sustainable digital development, the government must implement strategies that attract private investments and enhance the capacity for self-financing digitalization projects. Better coordination among the authorities to ensure a favourable legislative environment
Connectivity, digital infrastructure	As of 2021, 99.9% of Moldova's population was covered by 3G and 98% by 4G/LTE. As of 2023, the penetration rate of mobile Internet access services, reported per 100 inhabitants, reached 120.6%.	34.3% of those who are not connected invoked high prices as the main reason for being unconnected, while another 48.1% and 20.3% respectively lack computers and/or smartphones.	Increasing connectivity, especially high-speed home broadband, and tackling cost-related restrictions to the use of technology and connectivity.

	Moldova is among the top 10 countries in the world in terms of the accessibility and affordability of Gigabit Internet access. Users can access unlimited Gigabit Internet for about EUR 15 per month.	High-speed home access to broadband is still challenging, and the cost is perceived as problematic. Strong government support exists for the ICT sector's development, but no joint vision or overarching strategy exists for further development. Few efforts by stakeholders to increase cyber-resilience. Many essential services to citizens are yet to be digitalized, and further efforts are needed. Little awareness exists of the use of open-source technologies in government procurement, indicating a gap and potential barrier to expanding the local ICT sector. Further work should be undertaken on customer orientation, monitoring and evaluation mechanisms and addressing internal change resistance and bureaucratic barriers to deploy new services.	Creating an overarching strategy for ICT sector development and further digitalizing public services. Raising awareness of open-source technologies for public procurements. Coordinating efforts by various stakeholders to increase cyber-resilience.
Digital identity	Moldova was among the first countries in the world to implement Mobile eID. Government-provided digital identity solutions are utilized across both public and private sectors. It is partially aligned with the EU Regulation on electronic identification and trust services for electronic transactions in the internal market.	Digital ID is not used enough, which is one key enabler of more digital services being developed and more people using them.	Boosting the use of digital IT will also enable greater use of digital services. The introduction of the new mobile app-based electronic signature is expected to expedite the adoption process further.
Digital services	The e-Government process in Moldova started in 2006 with the approval of the E-governance Concept. However, its implementation was in the pilot and experimental stage until 2010. The Strategic Program for Technological Modernization of Government for 2011-2016 set the framework for the future e-Transformation process.	Only one in two respondents who accessed public services have used an electronic service, and there is a 60 per cent gap in educational levels and a 20 per cent gap between urban and rural populations. Challenges range from financial constraints to regulatory gaps and skill shortages. Low R&I	Taking a strategic approach to digitalizing public services and ensuring their maintenance, awareness, and funding. Raising awareness and trust in electronic public services, especially among the rural population, to increase the uptake of digital services Enhance the interoperability of services.

	Requirements for reengineering, digitalization, and quality assessment were introduced in 2020, and services are currently being reengineered and integrated into the public services portal.	expenditure, slow growth of innovative companies, lack of legal acts on new digital technologies, mismatch of digital skills and the industry needs, low digital awareness among the public, insufficient institutional capacities to implement the digital agenda, resistance to digital transformation, not enough finances, underdeveloped IT infrastructures in municipalities, low level of ICT investment in SMEs, low involvement of local companies in governmental IT projects, insufficient pay to civil servants managing IT projects, not enough scientific research and not enough monitoring the process.	
Data management	According to the Global Data Barometer, Moldova ranks 47th in the data governance module, out of the 109 countries evaluated. Basic registers exist and are regulated and managed by responsible bodies and have most of the data digitalized. The MConnect Governmental Data Exchange Platform is fully implemented to ensure system and data exchange coherence. The basic data policy principles are implemented by EGA and supported by separate legal documents.	There are still registers which are not fully digital. There is a very low uptake of environmental data.	Strategically continuing the digitalization of critical registers to enhance interoperability Supporting the use and uptake of open data, such as environmental data.
Skills	Several initiatives have been undertaken to incorporate digital education into the school curriculum at all levels. A digital education module was introduced in primary schools in 2018 and is now mandatory. Standards on digital competences have been established for students across primary, secondary, and high school levels. The country has 20 higher educational institutions that offer IT-related studies.	Despite the risk of implementing teaching methods focused on theory rather than practical implementation, IT industry professionals are not formally allowed to teach at universities unless they have advanced degrees and pedagogical certification. The challenges are that the level of skills does not meet the demand, the pool of IT professionals is	Further aiding the education sector in giving digital education, including in higher educational institutions. Digital skills education programs IT education programs, especially cybersecurity

	Students are also being trained in information security at the Technical University of Moldova to build the country's defences against cyberattacks.	limited, and more coordination is needed in those efforts.	
State of digitalization of the private sector and overview of the IT sector	Moldova is progressing towards a comprehensive digital transformation, emphasising the private sector alongside governmental and civil society efforts. The ICT sector has become the main driver of digitalization and innovation in Moldova and is growing fast. In 2021, the IT industry reached a share of more than 4.25% of GDP. Moldova has updated its Digital Economy Roadmap for 2023. This roadmap promotes government-to-business online interactions, digitalizing the economy, and developing e-commerce infrastructure.	Most businesses in Moldova (about 95%) are SMEs, which are the main drivers of the economy. However, less than 17% of SMEs have successfully integrated digital technologies into their work. There is low cross-border e-commerce flow, and Moldova is under-represented on international marketplaces. SMEs rarely use enterprise resource planning (ERP) systems.	Taking measures to integrate digital technologies, including ERPs, into the work of SMEs. Supporting the growth of e-commerce and the representation of Moldova in international marketplaces.

2 Introduction

2.1 Background

The main objective of the project "Green Agenda for Armenia, Georgia, Moldova, and Ukraine" (GUMA) is to assist these countries in reaching climate neutrality goals through green transition aligned with the EU's new growth strategy – the EGD. The main objective is delivered through four specific objectives. The outcomes delivering specific objectives build national implementation plans for the agenda, containing a green transition roadmap, executing the agenda at the national level, specific actions in the form of project proposals, and the resources required to implement them.

The first project year focused on preparing the Country Green Transition Gap Assessment (CGTA) reports for each project country. These reports will serve as input for the later development of countries' green transition roadmaps and project proposals, as well as activities that could be implemented under the "technical assistance" (TA) and "capacity building" components during the second and third project years.

Table 2. Main objective, specific objectives and outputs of the GUMA project

Specific objectives	Outputs
• Specific objective 1: To enhance understanding of the connectivity of GUMA's policies with the EU through the EU EGD's lens and identify further alignment needs and opportunities • Specific objective 2: To provide technical support in EU accession (CEPA alignment for Armenia), where relevant	• Output 1: Developing national CGTA reports and a regional CGTA report • Output 2: Developing a national roadmap • Output 3: Identifying specific project proposals for TA, nationally and regionally
• Specific objective 3: To contribute to public awareness about green transition, its urgency and possible benefits • Specific objective 4: Enhance key stakeholders' capacity to support the countries' green transition further.	• Output 4: TA and capacity building • Output 5: Communication and engagement activities

2.2 Aims of the report

The EU has **developed specific roadmaps** to facilitate the change of various sectors to become climate-neutral by 2050 (EC, 2023). A key underlying principle in the EU sectoral strategies is the strong synergistic relationship between the green and digital transitions. Solving both challenges has been highlighted as essential to Europe´s future in high-level documents, often seen as intrinsically linked "twin challenges": neither can succeed without the other (EC, 2023). Digitalization could potentially serve as a transformative enabler across all sectors of the economy and plays a crucial role in

countries' transition towards climate neutrality within the EGD framework. Deploying digital technologies and data can, for example, help optimize resource use, enhance energy efficiency, or facilitate the integration of renewable energy sources into smart grids (EC, 2023). Digitalization can also empower industries to streamline production processes, minimise waste and reduce emissions (Ekholm B., 2019), (IPCC, 2023).

On the other hand, it is important to ensure that digital technologies do not consume more energy than they save (EIT-Digital, 2022). This is precisely why the 'twin transformations' must be implemented hand in hand: harnessing the opportunities of digital innovation for climate change mitigation and adaptation, while at the same time limiting the carbon footprint of the IT sector (EC, 2022).

The achievement of a digital green transformation promises substantial benefits for the economy, environment, and society. It will enhance productivity and improve safety, reduce the environmental impacts of current production and consumption, and pave the way for a sustainable future (EC, 2019). Unlocking systemic change will require collaborative, ambitious commitments and near-term action across all levels of society, from leadership and government to the private sector and individuals.

Several EU policies have strong links to digitalization, while striving for a transformation towards an innovative and sustainable society. In addition to the EGD and its initiatives (the New Circular Economy Action Plan (EC, 2020), the (EC, 2023) Biodiversity Strategy for 2030 (EC, 2020) and (EC, 2021). Numerous other important legislations, strategies and initiatives seek to maximise synergies between the green and digital transitions.

- The **Digital Decade Decision** (EC, 2030) aims to ensure that digital infrastructure and technologies, including their supply chains, become more sustainable, resilient, and energy- and resource-efficient, to minimise their negative environmental and social impact. The document also includes references to the targets regarding infrastructure sustainability, notably edge nodes and semiconductors. The Declaration on Digital Rights and Principles promotes digital products and services with a minimum negative impact on the environment and society, as well as digital technologies that help fight climate change.
- The **EU Environment Action Programme** (EC, 2021) It also recognizes the potential of digital and data technologies as "enablers" for attaining the EU´s priority objectives of climate neutrality and circular economy.
- The EU **Action Plan on the Digitalization of the Energy System** (EC, 2022) defines the ICT sector as a principal factor for growing investments in renewables and energy efficiency along the value chain. In December 2022, a declaration of intent was signed by the European Network of Transmission System Operators for electricity (ENTSO-E) and the Association of European Distribution System Operators (EU DSO Entity) for the creation of a digital twin of the European

electricity grid (EC, 2022). The latter will help to drive and coordinate investments in the digitalization of the electricity infrastructure.

- The **Commission´s Sustainable and Smart Mobility Strategy** (EC, 2020) is aimed at making European mobility and transport systems greener. Through digitalization and automation, European logistics chains and the transport sector can become more efficient, resilient, and sustainable.
- The Commission Notice on the Guidance to Member States for the Update of the 2021-2030 **National Energy and Climate Plans** (EC, 2022) encourages and assists member states in using existing tools to explore the full potential of the twin green and digital transitions while avoiding duplication.
- The various initiatives and measures implemented under the **SME Strategy for a Sustainable and Digital Europe** (EC, 2020) have strengthened the capacities of European SMEs to adapt to climate neutrality challenges while reaping the benefits of digitalization, reducing the regulatory burden that SMEs face, and improving opportunities to access finance.
- The **Europe Fit for the Digital Age Strategy** (EC, 2020)**,** where the Commission has set the climate neutrality of data centres in the EU by 2030 as a key aim.
- The **Right to Repair Directive** (EC, 2023), improving the circularity of digital devices and reducing e-waste.
- The **Call for Green and Digital Transition in the EU**, affirms countries' commitment to green transition and stating the intention to work with the EC to draft a horizontal and holistic strategy, including respective sectoral action plans and relevant KPIs "to use the full potential of digital technologies to foster digital transformation into a lever for the environmental transition, ensure the development of green tech as well as to monitor and optimise the environmental cost of the digital sector" (Ministry of the economy, finance and industrial and digital sovereignty [MEFIDS], 2022).

All legislative acts, strategies/roadmaps and initiatives above either explicitly or implicitly envision digital transformation as complementary to reducing the environmental footprint and transitioning towards a more resource-efficient and sustainable future.

The primary target audience of this report is national governments, national development institutions, and international donors. The secondary target audience is national and international businesses, NGOs, and academia. Another key group potentially utilising and building on the report is the national and international digital society community, from startups and investors to regulators. For the government officials, authorities, and development institutions, the report will provide information on investment gaps in horizontal and key thematic areas, as well as recommendations to address these. For donors, the report will provide an understanding of which

horizontal and key thematic areas most need assistance, as well as how to better synchronise funding efforts between donors.

2.3 Report structure

The report is structured into five chapters (excluding the executive summary as the first chapter). After the introduction, the third chapter serves as a digitalization assessment, also providing the relevant socio-political setting and a general digitalization overview of Moldova that affects the capacity to address digitalization related developments. The fourth chapter addresses Moldova's key digitalization-related capacities in detail, forming the basis of all sectoral interventions and improvements that could support the green transition of the societies across the eight sectors covered in the project. The fifth chapter matches the possibilities that digitalization offers with sectoral requirements regarding climate action, clean energy, buildings and renovation, smart mobility, industry for clean and circular economy, eliminating pollution, sustainable agriculture and farm to fork, as well as ecosystems and biodiversity. The sixth chapter assesses digitalization issues related to cross-cutting areas: just transition towards a green economy, transition financing and research and innovation.

3 Overview and trends

3.1 Scope

Assessing progress along the digital transformation maturity curve is a complex task at an organisational level, let alone on a country level. The EU has used the Digital Economy and Society Index (DESI) to track the digital performance of its member countries, with regular reporting on the State of the Digital Decade that focuses on four main pillars: digital skills, digital infrastructure, digitalization of businesses, and digitalization of public services. There is no agreed-upon methodology for assessing the maturity of the green digital transition. This report will explore the digitalization initiatives in GUMA countries that act as enablers for the green transition and discuss gaps where the support of digitalization for the green transition could achieve more. Despite being on the path to join the EU, GUMA countries do not necessarily have to copy European models and solutions, but have the opportunity to innovate using more modern technologies like AI solutions and service architectures like cloud, and through this leapfrog to the forefront of green technologies. This is why these examples, as they emerge, are highlighted in the report as examples of excellence.

Digitalization in GUMA countries is assessed in two broad categories: 1) the general level of digitalization, and 2) how different sectors are being digitalized for green transition purposes.

A basic level of digitalization is a precondition for all other developments, as general digital society building blocks are needed to advance digitalization in other sectors. The general digitalization assessment is divided into seven parts. These are:

Governance: covering stakeholders, the regulatory framework, and its maturity. A comprehensive regulatory framework for digitalization is a precondition for showing a country´s willingness/readiness to focus on digitalization. Strategies aimed at future digitalization efforts help us assess the current status and future actions in digitalization, as strategies identify shortcomings and future needs. Our local experts assessed at which stage the most relevant guiding documents are.

Connectivity and **cybersecurity**: Connectivity is the backbone on which anything digital functions. Seamless connectivity ensures that digital services and continuous data flows are functioning. Cybersecurity readiness means that any information exchanged is secure and safe, and thus it serves as a second important pillar for connectivity. In this section, we assess internet coverage (broadband, high-speed broadband, mobile networks- 4G, 5G) in the country and how much citizens access the internet to show the overall readiness to connect to the internet and online services. Regional and demographic disparities are investigated regarding ease of access and ownership of hardware. The existence of digital skills is also in focus.

Digital identity includes the uptake of digital signatures and eIDAS compliance assessment. Digital identity is needed for secure access to e-government services. Having trustworthy authentication and verification functionalities is necessary for countries aiming to digitalize their bureaucracies to reduce administrative burden and paper-based services. Therefore, in that section, we review digital identity-related developments in the country to assess its readiness to use e-services more. The eIDAS framework is an EU framework that sets certain standards for digital identity and digital signatures. This means that if a country has implemented the eIDAS framework, its eID solutions are compatible with those in the EU.

Digital services focusing on the uptake and level of public e-services. Instead of physical services, digital services to citizens mean convenience. Further, e-governance solutions can quicken service provision, done via eID, the services provide a trusted outlet. In short, digital services serve efficiency and convenience goals; they save time and paper for all involved parties, which is also relevant in different green sectors regarding their communication with the government (permits, data reporting, applications, etc.).

Data management includes information on data registries, standards, interoperability, open data, and personal data handling. For e-services to function, data flows between the services need to be flawless/ seamless. This means that data and data processing standards need to be in place, including personal data processing rules to safeguard privacy and sensitive personal information. Therefore, in this part, we assess how far the country has come to digitalize services for citizens and businesses. We look at the number and character of digitalized services, how much the population uses these services, identify centralised standards for data collection and management and look into how open data provision is set up. This chapter is relevant to sectoral digitalization as data is often collected regarding different green sectors to monitor for compliance and reporting purposes. Different stakeholders can use open data to build services and applications to further the green transition of the sectors. Therefore, the availability and maturity of open data portals are also important to assess. We map how many datasets are available, whether there is a central framework for providing open data and how open data provision functions technically (if there is a portal and how citizens can ask/ access data).

Skills regarding digital and data literacy and cybersecurity education: Digital skills are needed for providing and using online services. If a country prioritises the uptake of digital services for efficiency and convenience reasons, citizens should be able to use the services. Another aspect here is data literacy among the population, which is important for services being built using (open) data, for example, citizens need a particular technical understanding to access and acquire data for further use (analysis or use in a digital solution). Therefore, in this part, we look at the percentages of digital skills among different population segments to assess people's readiness to use e-

services. Secondly, we identify initiatives in the country aimed at increasing digital skills to map the motivation of the governments to support citizens in adapting to digital services. We also cover cybersecurity skills education (the programs and initiatives in place in the country).

The state of **digitalization of the private sector**: The private sector, especially the ICT sector, has an important impact on digital service provision in the country. The more active the role it takes in digitalising services and providing applications, the more growth the ICT sector experiences. Also, the more innovative the technologies explored by the private sector, the more forward-looking the digital solutions tend to be, and those relevant for the green transition. So, to map the general level of digitalization of the private sector, we look at the uptake of enterprise resource planning (ERP) software by SMEs, e-commerce activity and use of AI, Blockchain and other new technologies.

This chapter, therefore, provides a picture of the country's general level of preparedness to support digitalization in different sectors related to the green transition.

The scope of Chapter 5 is broad. We cover digitalization efforts in eight sectors: biodiversity, climate, energy, farm to fork, circular economy, waste management, buildings and renovation, smart mobility and zero pollution. Within each sector, we first describe the best practices for digitalising the sectors to have a benchmark in mind when assessing the progress made by GUMA countries. Secondly, there is a section on the main gaps of the sector where digital solutions could increase sustainability. Thirdly, we provide a section on the status of digitalization of the sector in the country, covering the existing capabilities and outlining further needs based on the benchmark and the gap assessment.

Digitalization level **of businesses** for the green transition is reviewed primarily through best practice cases. Typical market barriers represent baseline examples, validated through national expertise on local practices. A separate focus is put on the countries' capacity to support innovation in digital green transformation and adoption of new technologies in value chains across the thematic areas. The role of the start-up community and the adoption of their greentech/cleantech solutions is included in the assessment.

Chapter 6 demonstrates links between digitalization and domains such as research, development and innovation, just transition, and transition finance. All these aspects are interlinked to ensure that GUMA countries move toward the Green Transition. Digitalization is a significant part of the countries' RI developments, which need funding. Also, the green transition needs to be conducted in a just and fair way. Hence, no social group or region suffers from these developments and digitalization can be one mechanism to ensure this.

3.2 Profile and statistics

EU cooperation with Moldova in digitalization

Moldova has seen developments in digitalization over the last decade or so. Existing digital initiatives and further work regarding digital transformation can help Moldova transform its economy into a greener and sustainable one. Besides the climate and sustainability goals stemming from EGD and similar documents, the EU has collaborated with the Eastern Partnership countries regarding their digital transformation.

The Strategy on Shaping Europe's Digital Future indicates that digital transformation can enable growth and drive sustainable development for the EU and partner countries. The EU is therefore investing in Moldova's digital transformation. A Joint Staff working document “Recovery, resilience and reform: post-2020 Eastern Partnership priorities” (EC, 2021) identifies four areas of cooperation:

- **Digital infrastructure** - access to affordable high-speed internet, securing 5G networks, reducing roaming fees and ensuring spectrum alignment with the EU.
- **E-Governance** - making public services available online through interoperable platforms, recognising e-signatures between the country and the EU.
- **Digital economy and innovation** - increasing cross-border e-commerce, alignment with the EU’s e-commerce regulations, digital education platforms, investments into digital innovation.
- **Cyber resilience -** Cybersecurity alignment with EU regulations and standards, and with EU and international data protection standards.

The Economic Investment Plan proposes specific country flagship initiatives for digital development in each partner country to make a meaningful difference to individuals and businesses in the Eastern Partnership region and maximise the impact and visibility of digital transformation efforts. Priority steps for Moldova aim to improve connectivity by anchoring the country in the TEN-T network (Koriavets M., 2023). It should be noted that the EU candidate status of Moldova also enables the government to adopt important legislative acts in the digital field that are aligned with EU requirements/recommendations (new laws on e-signature and copyright). Furthermore, the EU supports the country's digital infrastructure (Koriavets M., 2023).

Since 2019, the EU4Digital Facility has focused on increasing each country's digital capacities. The first phase, from 2019 to 2022, focused on strengthening coordination and a common approach to roaming, regulation, and mobile spectrum usage. In the current second phase of EU4Digital, one of the first steps towards better connectivity in the region has focused on understanding the current availability of fixed and mobile broadband internet access services. (EU4Digital, 2023). Focusing on infrastructure is a precondition. Connectivity ensures that e-services and data flows for greening efforts function properly. Without good connectivity, digital innovations cannot advance. Central to the EU4Digital Initiative is the three-year EU-funded EU4Digital Facility Phase

II (2022-2025). In this phase, the focus is on the following: telecom rules, eTrust and cross-border digital services, eTrade, eHealth, ICT Innovation and Start-Up Ecosystems, and digital skills (EU4Digital, 2019).

Statistics
The GUMA countries are being added to monitor digital transformation via the Digital Decade indicators (formerly DESI), as is the practice with the EU member states. However, for now, the methodologies are aligned with no tangible assessments of GUMA countries yet. Still, to provide a picture of where GUMA countries stand in relation to digital transformation, we use the UN's E-government Development Index (UN, EGDI, 2022) and the OECD 2022 assessment on service delivery and design in the European Neighbourhood Policy East Region (Thijs N., 2022). It needs to be remembered that the OECD report is from 2022 and reflects ITU statistics from 2020, which do not consider rapid developments in recent years. However, for the lack of a better comparative source, we rely on this report.

In Moldova, 65% of households have internet access, 100% of the population is covered with mobile networks, and 61% of households have a computer at home (Thijs N., 2022). According to the Republic of Moldova Digital Transformation Strategy 2023-2030, 80% of the population accessed Internet services in 2021. 34.3% of those who are not connected invoked high prices as the main reason for being unconnected, while another 48.1% and 20.3% respectively lack computers and/or smartphones (MEDD, UNDP, 2023). The Public Services Portal streamlines navigation through 697 public services, of which 299 are available online (E-Gov, 2024). Only one in two respondents who accessed a public service has used an electronic service, with a huge gap of 60 percent in educational levels and a 20 percent gap between urban and rural populations. Young people aged 18-29 are the category that almost five times more often use electronic services than those aged 60-74 (MEDD, UNDP, 2023). Official statistics reported that 525 Moldovan companies have e-stores. Internet banking is becoming increasingly popular. In EGDI, Moldova ranks 72nd in 2022 (UN, EGDI, 2022).

4 Digitalization to support the transition

4.1 National digitalization governance and strategies

ICT usage and coverage increased in Moldova over the past decade due to the strong government support for sector development through various strategies and regulations. Among them were the "Digital Moldova 2020" and its Action Plan for 2013-2020 (MEDD, UNDP, 2023).

Based on the European Commission's 2023 report (EC, 2023) on the accession of Moldova, the country has achieved some level of preparation in digital transformation. Good progress was made during the reporting period. The government decision approved the comprehensive digital transformation strategy for 2023-2030 (GD nr. 650,

2023), setting out a countrywide action plan. The Law on electronic identification and trust services (Law no. 124, 2022) has entered into force and is broadly aligned with the relevant EU acquis. The cybersecurity framework has been strengthened through passing of the law on cybersecurity (Law no. 48, 2023), adopted during the reporting period, but Moldova needs to start implementing the law. Moldova needs to align its legal framework with the EU Electronic Communications Code. Implementing legislation, including the laws on freedom of expression, personal data protection, and access to information, also needs to be amended to align with the EU acquis.

According to the Moldova Digital Readiness Assessment (UNDP, 2021), Moldova scored 4.1 points out of a maximum of 5, putting it at the Differentiating Stage – the fourth of five stages of digital transformation readiness. **This means the country has clear strengths in digital transformation capacities, and the foundational elements are in place**. Furthermore, USAID's FY2024 Moldova Country Roadmap (USAID, 2024) indicators for commitment and capacity were at 0.58 and 0.66, which indicates that Moldova has the capacity to fulfil the assumed commitments, including the commitments included in the MDTS. These trends are also reflected in the World Bank GovTech Maturity Index study, according to which Moldova surpassed the maturity index of countries with a significant focus on GovTech and entered the group of leading GovTech countries in the last two years (Word Bank [WB], 2022). The MDTS is part of the Government Activity Program of Moldova, which identifies digital transformation as one of the most important policy objectives for the next four years (GD nr. 650, 2023).

Current plans regarding digitalization (based on the MDTS adopted in September 2023)

Moldova has continued to advance in building the main components for its digital economy and society. The main areas of intervention planned within the Republic of Moldova Digital Transformation Strategy for 2023-2030 are aligned with those of the EU's Digital Decade (EC, 2030), to which a cross-dimensional integration aspect into the digital single market is added. The components are:

1. A population with digital skills and highly qualified professionals in the digital field.
2. Secure and sustainable digital infrastructures.
3. Digital transformation of enterprises.
4. Digitalization of public services.
5. Integration into the EU's digital single market (GD nr. 650, 2023).

MDTS focuses on six general objectives that will guide the activities under the strategy:

7. **Develop a digital society.** Ensuring widespread use of digital technologies and services across all aspects of life to prevent exclusion and reduce digital divides. This objective focuses on making digital literacy and competencies

available to all members of society, enhancing internet access, and ensuring the benefits of digital transformation are accessible to everyone.

8. **Grow a robust and competitive ICT environment.** Strengthening the ICT sector to drive innovation and digital transformation across the economy and society.
   1) **Create an innovative and resilient digital economy.** Fostering an economy that leverages digital technologies for growth, innovation, and resilience across all sectors.
   2) **Establish an efficient, smart, and transparent digital state.** Transform public services through digital means to be more accessible, efficient, and user-friendly, ensuring transparency and accountability in governance.
   3) **Create a secure, digitally accessible, and inclusive environment.** Building a digital environment that is safe, secure, and respects privacy, where all individuals can participate fully and confidently.
   4) **Make Moldova a trusted and reliable digital nation.** Enhancing the country's digital competitiveness and innovation internationally and facilitating its integration into the European digital market (GD nr. 650, 2023).

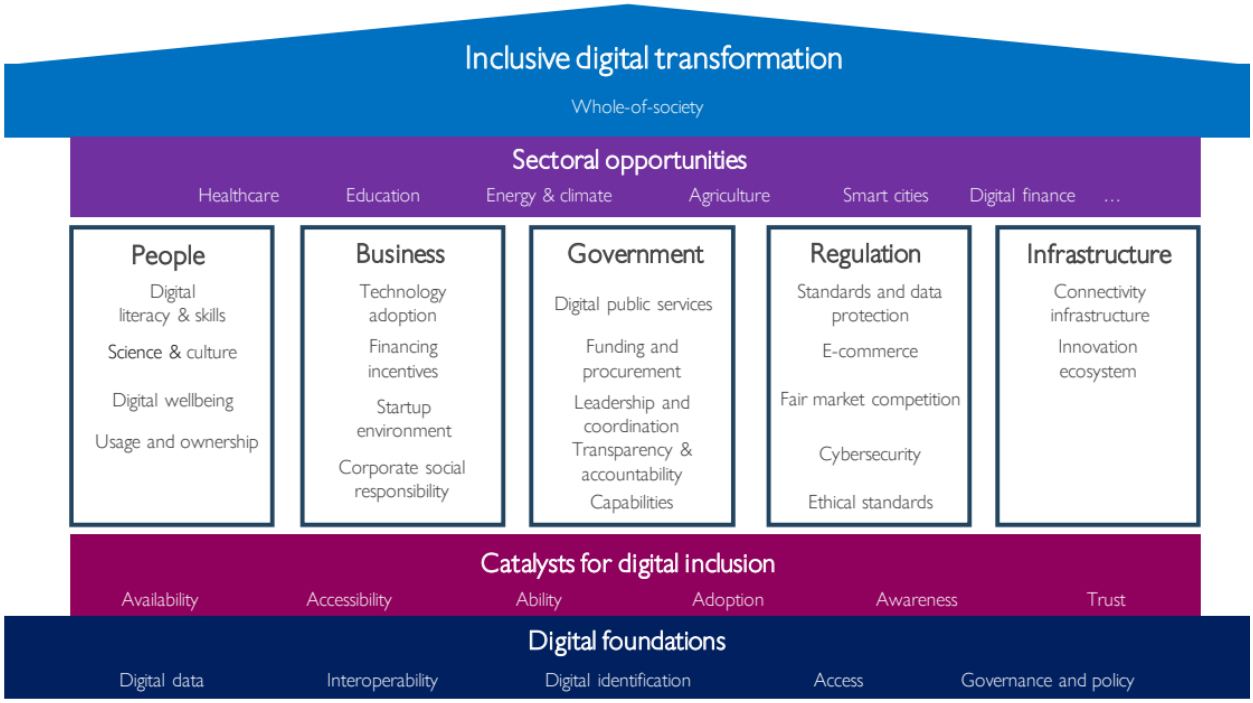

Figure 1. Framework of the Republic of Moldova Digital Transformation Strategy (GD no. 650, 2023)

4.1.1 Main government stakeholders

In Moldova, digitalization efforts are led by diverse stakeholders, including governmental bodies, private sector entities, civil society organizations, and international partners.

The Government of Moldova assumes a central role in driving digital transformation initiatives. It establishes policies, regulations, and strategies to promote digitalization across sectors and coordinates the efforts of various stakeholders.

The Ministry of Economic Development and Digitization oversees ICT policies, fosters digital innovation in the country, and coordinates digitalization efforts across different sectors.

The National Digital Transformation Council (NDTC), established in November 2023 (MEDD, order No. 165, 2023), is the main digital governance structure under the Ministry of Economic Development and Digitisation, responsible for **implementing the MDTS**, ensuring alignment with national priorities and international trends. It involves high-level representatives from various sectors, facilitating cross-sector collaboration and strategic oversight. NDTC identifies and recommends a list of services to be digitised annually to the EGA.

The EGA aims to integrate leading technologies into the government, rethink processes, improve public services, and make them work for the benefit of citizens.

The Information Technology Services and Cyber Security (ITSEC) ensures the security of cloud-based digital infrastructure and information systems within the government sector, protecting them against cyber threats.

The Cybersecurity Agency is the recently established competent national authority in the field of cybersecurity and is responsible for managing cybersecurity crises in Moldova.

The National Regulatory Agency for Electronic Communications and Information Technology (ANRCETI) **regulates the telecom sector**, ensuring a competitive market, fair access to digital infrastructure, and protection of user rights in the digital space.

The State Chancellery oversees the implementation of E-Governance initiatives, aiming to improve public service delivery, enhance transparency, and promote citizen engagement through digital channels.

International Partners and Donors such as the **EU, the World Bank, USAID, and the United Nations provide financial and technical assistance** to support Moldova's digital transformation. They contribute to policy advice, best practices, funding for digital projects, and capacity-building initiatives.

Civil Society Organizations, including non-profits and NGOs focused on digital inclusion, internet governance, and digital rights, advocate for inclusive digital policies,

promote digital literacy among the population, and ensure that digital transformation efforts consider the needs of all citizens.

Overall, through existing stakeholders, the government ensures an acceptable level of digital governance, positioning the country at a relatively high level of digitalization. The authorities appear to collaborate to implement the objectives set by the Government Action Plans. However, except for EGA, most authorities focus on operations rather than developing ICT projects. Many of the achievements in this sector are largely due to external funding and international assistance. This reliance indicates a lack of long-term sustainability, underscoring the need to prioritize internal financial resources for this sector.

To ensure sustainable digital development, the government must implement strategies that attract private investments and enhance the capacity for self-financing digitalization projects. This approach will reduce dependence on external funding and ensure the continuity of digital initiatives. Additionally, establishing a legislative and institutional framework that supports innovation and facilitates public-private partnerships is crucial. These measures will increase the resilience and efficiency of digital governance in the long term, consolidating the country's technological progress.

4.1.2 Central coordination vs sectoral responsibilities

The Ministry of Economic Development and Digitization drives the government's digital transformation agenda and coordinates the digitalization efforts across the public sector. In short, the Ministry is centrally responsible for policies. At the same time, **EGA within the State Chancellery has the mandate to develop the infrastructure for electronic governance** and coordinate investments for public sector ICT. (GD no. 544, 2019). It implements what is set in the policies. The Chancellery oversees EGA activities but is not directly involved in digitalization initiatives. All institutions subordinated to the government are responsible for implementing their digital development agendas by reengineering and aligning them with the government's activity program and MDTS.

To accelerate and facilitate the digitalization of public services, the EGA offers a complex infrastructure for electronic governance based on microservices and a platform for developing electronic services. (GD no. 717, 2014). Digitalization and the reengineering of internal processes are the responsibility of both central and local authorities.

4.1.3 Main strategic documents

Over the last two decades, the digital transformation efforts in Moldova have been guided by **several national and sectoral strategies**, such as the National Strategy of Information Society Building “Electronic Moldova”, the National Strategy for Information Society Development “Digital Moldova” 2020, the Strategic Program for

Technological Modernization of Government (e-Transformation), the Strategy for the IT Industry and Digital Innovation Ecosystem Development 2018–2023 (GD no. 904, 2018), the Information Security Strategy of the Republic of Moldova 2019–2024, the National Research and Innovation Program 2020–2023, the Radio Spectrum Management Program 2021–2025 and the minimum exposure values of generic frequency blocks for allocation through the competitive selection procedure. There was also a Broadband Development Programme for 2018–2020, and its action plan was approved. Currently, there is **one main document on the country's digital transformation that Moldova has prepared about its digitalization goals and efforts: the MDTS)** (GD no.650, 2023).

The current Government Activity Program includes digitalization among 15 sectoral priorities (GD nr. 650, 2023). The National Development Strategy "European Moldova 2030" is aligned with both the European Union Association Agreement and the United Nations 2030 Agenda for Sustainable Development and dedicates a special Chapter to the digital transformation of the government and economy (GD nr. 650, 2023). There is broad alignment with the EU Directive on e-commerce. Moldova is not aligned with the EU acquis on geo-blocking, platform-to-business relations (P2B), the Digital Services Act and the Digital Markets Act (EC, 2023).

Moldova is in the initial stages of developing a strategic framework for data governance and AI. Despite being a topic on the public agenda, involving various sectors from government and local administrations to academia and business, concrete steps toward implementation are just beginning. The country ranks modestly in AI readiness, ranking 83rd in the AI Readiness Index 2022. Compared to the previous year, there is a marginal improvement, from 86th to 83rd. However, observations from the AI Policy Observatory of the OECD show that Moldova needs to develop sectoral policies in the field of artificial intelligence (AI) more substantially (MEDD, 2024). The only available document is The White Book on Data Governance and Artificial Intelligence, developed by the Ministry of Economic Development and Digitization (MEDD, 2024).

Some laws, strategies, programs, and action plans are implemented fully and effectively, while others are only partially completed. For instance, according to the 2021 evaluation report (Ministry of Economy and Development and Digitalization [MEDD], 2021) on implementing the Broadband Development Programme for 2018–2020, the majority (approximately 63%) of the planned actions have been completed, 32% are in progress, and only 5% (a single action) have not been completed.

Regarding the National Strategy for Information Society Development "Digital Moldova 2020", positive developments have been noted in creating conditions for implementing and using electronic services and developing digital skills. However, there have also been delays and a lack of success. Implementing the Strategy and Action Plan faced

numerous challenges and problems due to objective and subjective circumstances, including insufficient funding, lack of resources, delays, and inaction (MEDD, 2021).

4.2 Connectivity, digital infrastructure

4.2.1 Connectivity in numbers

As of 2021, Moldova had 99.9% of the population covered by 3G and 98% with 4G/LTE (UNDP, 2021). As of 2023, the penetration rate, reported per 100 inhabitants of mobile Internet access services, reached 120.6% (ANRCETI, 2023).

According to Speed Test Global Index (Speedtest Global Index [SGI], 2024), which provides a monthly comparison of Internet speed data for a benchmark of 100 countries around the world, Moldova is ranked fifty-eighth in terms of mobile broadband speed (with a download speed of 38 Mbps compared to the global average of 48 Mbps), and is ranked thirty-eighth in terms of fixed broadband speed (with a download speed of 106 Mbps – higher than the worldwide average of 98 Mbps). **Moldova is among the top 10 countries in the world in terms of accessibility and affordability of Gigabit Internet access**, where users can access unlimited Gigabit Internet for about 15 EUR per month.

With 98% of the population covered by a 4G signal and similar fibreoptic backbone network penetration, users can choose their preferred connectivity. Internet access is relatively affordable and widespread, with 80% of the population accessing Internet services in 2021. 34.3% of those who are not connected invoked high prices as the main reason for being unconnected, while another 48.1% and 20.3% respectively lack computers and/or smartphones (GD no.650, 2023).

The 5G implementation and rollout will happen in two stages. The 1st stage (2021-2022) foresees the consolidation of the current networks with spectrum refarming. The 2nd one (2022-2025) envisages the creation of an enabling environment for implementing 5G networks. Mobile network operators support this implementation plan and have initiated various pilots (UNDP, 2021).

According to the Annual National Survey 2023 (WB, CBS AXA, 2023), 88.1% of households are connected to the Internet and the level of Internet connection is 30% higher than the computer availability of households. The variations across socio-demographic categories are the same as in the case of computers, although much less pronounced. **Internet penetration levels decline with age, is lower in rural areas, and is positively correlated with education and income levels**.

In 2021, the percentage gap between urban and rural populations was 20%; in 2023, it was only 8%, reducing the gap by 13%.

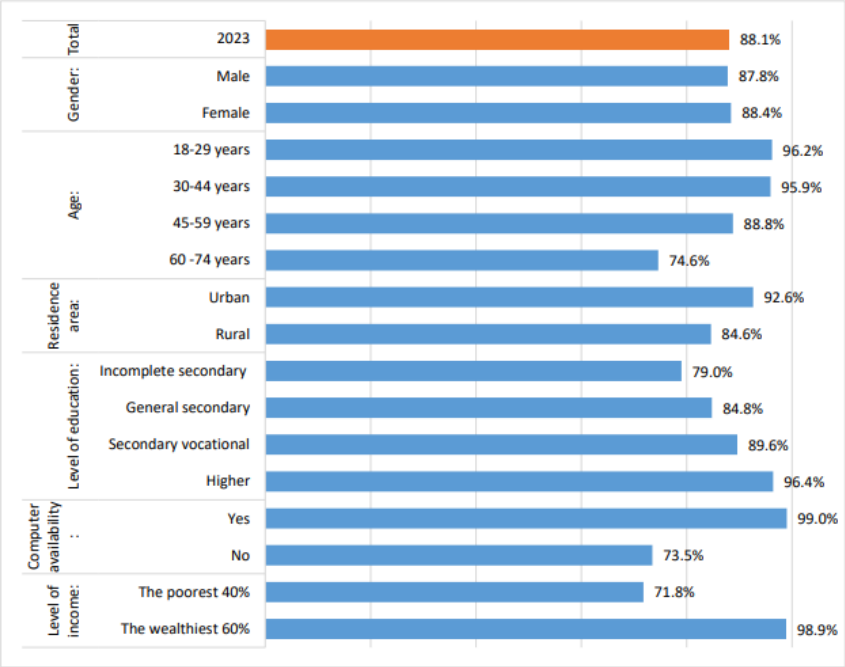

Figure 2. Internet connection in households

4.2.2 Cybersecurity

According to the Estonian E-Governance Academy, Moldova is in 63rd position in the Global Cybersecurity Index, having progressed in recent years, for example, around cyber policy and cybersecurity education (NCSI, 2023). The country became a member of the Budapest Convention on cybercrime in 2009 and has worked to address Internet safety and computer crime issues since then. There was also a 2016-2020 National Cybersecurity Program, which resulted in approved Mandatory Cyber Security Requirements for the public authorities and **established Government and Military CERTs**. The 2019-2024 Information Security Strategy and Action Plan was approved as the next step towards cybersecurity resilience. **It aims to establish the National CERT, transpose the NIS directive**, ensure control and monitoring of the application of minimum cybersecurity requirements, define the national critical infrastructure and the measures needed to protect it, and set the framework for counteracting hybrid threats (NCSI, 2023).

On cybersecurity, the Information Technology and Cybersecurity Service is the government's computer security incident response team. It provides the administration, maintenance and development of public authorities' IT infrastructure and telecommunications systems. **The Law on cybersecurity**, adopted in 2023, sets out a strengthened cybersecurity framework. The law aims to increase the cyber resilience of the country's public sector organizations and critical infrastructure actors.

According to the law on cybersecurity, **the government established the Cyber Security Agency** in 2023 (GD no.1028, 2023) as a competent authority on cybersecurity

and the national computer incident response team (EC, 2023). In 2024, Moldova also unveiled the creation of the National Institute of Innovations in Cybersecurity "Cybercor". Launched during the inaugural Moldova Cybersecurity Forum, these initiatives solidify the country's commitment to building a secure and resilient digital future. Overall, **Moldova has focused on increasing its cybersecurity level and is implementing changes at a reasonable pace by using best-case** examples from the EU member states.

4.3 Digital identity

4.3.1 State-developed solutions and private sector offerings

Moldova has been actively working on implementing and enhancing digital identity solutions as part of its broader digital transformation agenda. Digital identity in Moldova aims to provide secure and efficient ways for citizens and residents to access various services using electronic identification (eID) systems. However, not enough people use digital ID, which is one of the key enablers of more digital services being developed and more people using digital services. (GD nr. 650, 2023).

In Moldova, the government primarily provides the digital identity infrastructure, with the private sector involved in certain types of digital identity. The infrastructure is built on the Public Key Infrastructure (PKI). The Route Certification Authority is managed by the Security and Intelligence Service under Parliament, while the Certification Authority is overseen by ITSEC under the government. ITSEC serves as the sole certification authority in the country, issuing end-user certificates for all digital identity types. Key components of digital identity infrastructure include:

- **ID Card (national identity card):** The national ID card in Moldova, which contains biometric data, is a primary form of identification and can be used for various purposes, including as a travel document within certain regions.

9. **E-Signature (USB token):** An e-signature is a physical device-based signature that stores cryptographic keys and other sensitive information for authentication and secure access. It is used to sign electronic documents and transactions, thereby enhancing the efficiency and security of digital interactions.
10. **Mobile ID:** Moldova was among the first countries in the world to implement Mobile eID. Mobile eID, also known as mobile signature, works as an ID in the virtual world, allowing users to authenticate themselves in cyberspace, to prove their identity with the help of a cell phone or electronically sign a legally binding transaction or document. For regular users, the advantage of mobile eID lies in its simplicity, since no separate card reader or drivers are needed, as the phone already performs these functions. Implementation of Mobile eID in Moldova was part of a larger digital transformation initiative supported by a 20 million US dollar World

Bank–funded loan as part of the Governance e-Transformation Project (GeT) (WB, 2018).

- **Mobile Signature (EvoSign):** The new government service for mobile elD and signature, EvoSign, is a mobile app-based electronic identity solution. Its main goal is to provide a tool for authentication and signing electronic documents, including through integrated information systems with the government's electronic signature service, MSign and the government's authentication and access control service, MPass (GD no. 324, 2022).

Moreover, Moldova recently launched **the EVO application, which serves as a digital wallet where citizens can store and access essential documents such as identity cards, driver's licenses, and registration certificates on their mobile phones, as per the Law adopted by the Parliament in** November 2023 (Parliament of Moldova, 2023). According to the Law, national Identity cards, driver's licenses and registration certificates will be digitized. With the dedicated EVO app, citizens can save, access and present a digital version of their Identity card, driver's license, and registration certificates. A citizen’s digital identity card will contain data taken automatically and in real time from a person’s profile in the state population register. In addition, it will have an identifier in electronic form (QR code) (Infotag, 2023).

The initial uptake of eID was quite low, (WB, 2018) primarily due to associated costs and the limited availability of digital services. However, **the uptake is increasing** as more services become digitally available. Additionally, introducing the new mobile app-based electronic signature is expected to expedite the adoption process further.

4.3.2 Uptake of public sector solutions by the private sector

Government-provided digital identity solutions are utilized across both public and private sectors. Additionally, **several banks have introduced their alternative identity solutions**.

When obtaining a digital identity, a citizen or a company gains access to various online public services, including tax reporting, national statistics, and medical and social services, streamlining its interactions with governmental institutions. Acquiring a digital identity enables individuals to interact with government institutions.

According to ITSEC data, by the end of 2023, the number of active qualified advanced electronic signatures reached 266,155 units, which is more than double the count from 2022 (129,384 units) (Gridina, 2024). This figure encompasses all certificates issued, including USB tokens, Mobile IDs, and ID cards. Notably, out of the total electronic signature certificates issued by ITSEC, 28,148 signatures, or 25.78%, were issued to public servants to submit declarations of wealth and personal interests to the National Integrity Authority (IPRE, 2024).

4.3.3 eIDAS compliance

Progress has been made to ensure that trust and security services for creating and validating electronic signatures in the country are compatible with the EU's electronic identification, authentication, and trust services (eIDAS). The Law on electronic identification and trust services entered force on 10 December 2022. It sets out the legal framework for electronic signatures, electronic seals, electronic time stamps, electronic documents, registered electronic distribution services and certification services for authenticating web pages. **It is partially aligned with the EU Regulation on electronic identification and trust services for electronic transactions** in the internal market. Moldova should join the "Third Countries' trusted list", which facilitates the validation of electronic signatures or seals created in Third Countries as advanced electronic signatures and seals in EU member states, as a first step towards pursuing mutual recognition of qualified trust services once the new eIDAS Regulation is adopted. (EC, 2023).

4.4 Digital services

4.4.1 Overall maturity of public and private sector services

In December **2021, the Parliament approved the law on public services, establishing a legal framework for the public service delivery system.** This framework includes standards and requirements aimed at developing unified and user-centric digital services (Law no. 234, 2021). Requirements for re-engineering, digitalization, and quality assessment were introduced in 2020, and services are currently undergoing re-engineering and integration into the **public services portal** (Law no. 234, 2021).

A framework for a **centralized system designed to manage data on government information resources, known as the Register of Information Resources and Systems** (e-Gov, RSIS, 2024), received approval. Currently, EGA is responsible for maintaining the Register and ensuring that all public institutions register all governmental information systems, including those currently in development.

In the area of digital transformation, the implementation of the now-expired Digital Moldova 2020 strategy has been only partially successful. Only 6 of the 12 targets set in the strategy have been achieved. There were particularly weak results in the share of public services available online (12% vs the 100% objective) and in the level of acceptance of electronic public services (49% vs the 70% objective). Several reasons have led to these results, including limited financial resources, project management, and institutional implementation capacity (EC, 2023).

Government services have seen rapid digitalization rates with the establishment of the eGovernment Centre (now the E-Governance Agency) in 2010. The e-Government process in Moldova started in 2006 with the approval of the E-

Governance Concept. However, until 2010, its implementation was in the pilot and experimental stage. The Strategic Program for Technological Modernization of Government for 2011-2016 set the framework for the future e-Transformation process and put in place most of the critical elements of the system, like the e-Transformation subdivisions in all central public administration authorities (UNDP, 2021).

The E-Governance infrastructure implemented within this strategic programme boosted the public administration reform and changed how public services are delivered. This process was guided by the National Program for Modernization of Public Services for 2014--2016 and the National Action Plan on reform of modernization of public services 2017--2021. **The project for the modernization of government services 2018-2023 contributed to eliminating outdated public services**. It consolidated several services to increase quality in line with citizens' expectations. At the same time, access to public services at the local level is expected to be facilitated through digital channel improvement, reduction of the number of mandatory documents, as well as minimising the duration of public service delivery (UNDP, 2021).

Moldova's E-Governance infrastructure promotes standardization and best practices, as part of its cloud computing strategy and its taxonomy (SaaS, PaaS, IaaS) (GD no. 414, 2018). It defines the components and capabilities required for deployment and a vocabulary for consistent communication with public service providers. The referenced infrastructure aims to provide a proven template solution for project teams within the government who can apply it to specific domains. It includes a set of capabilities and microservices described in the conceptual architecture.

Figure 3. Moldova e-Governance infrastructure (Source: E-Governance Agency)

The current Moldova E-Governance infrastructure includes a cloud computing platform and a set of microservices used to digitalize public services.

- MCloud© – governmental cloud infrastructure
- MConnect© – governmental data exchange and interoperability platform
- MPay© – governmental service for electronic payments
- MLog© – governmental journaling service

- MPass© – governmental authentication service
- MSign© – governmental electronic signature service and others
- MNotify© – governmental electronic notification service
- MCabinet© – the citizens' and businesses' portal
- MPower© – registry of authorizations
- MDelivery© – governmental delivery service

Progress has been achieved in making electronic public services available through the Public Services Portal, which serves as a single access point for individuals and businesses seeking information on administrative public services offered by Moldova's institutions. The portal has an average of over 0.5 million unique visitors per year. This portal streamlines **navigation through 697 public services, of which 299 are available online,** allowing users to find details swiftly and effortlessly regarding specific services (E-Gov, 2024).

To expedite the digitization agenda, in 2022 the government launched **the Front-Office Digitization (FOD) framework, containing a collection of visual components and integration libraries that enable rapid design and development of digital government services front-offices**. Designed to focus on user experience, FOD components are used to easily configure and develop a thin back-office for governmental service providers. Optionally, FOD could be integrated with any existing service provider's back office. The primary beneficiaries of FOD-based services are citizens, businesses, and foreigners. FOD includes components used to easily configure and develop thin back-offices for governmental service providers. Also, FOD could be integrated with existing service provider back-offices through an API. In 2023, the FOD framework was awarded by GovStack with the WSIS Digital Service Design Special Prize (GovStack, 2023).

FOD includes integration blocks with services described above from the E-Government infrastructure, like MPass, MSign, MPay, MNotify, MLog, MPower, MDelivery, MConnect, PSP, and MCabinet. This means that services developed using the FOD platform automatically reuse these integrations, thus making the development process more efficient and the solution more reliable.

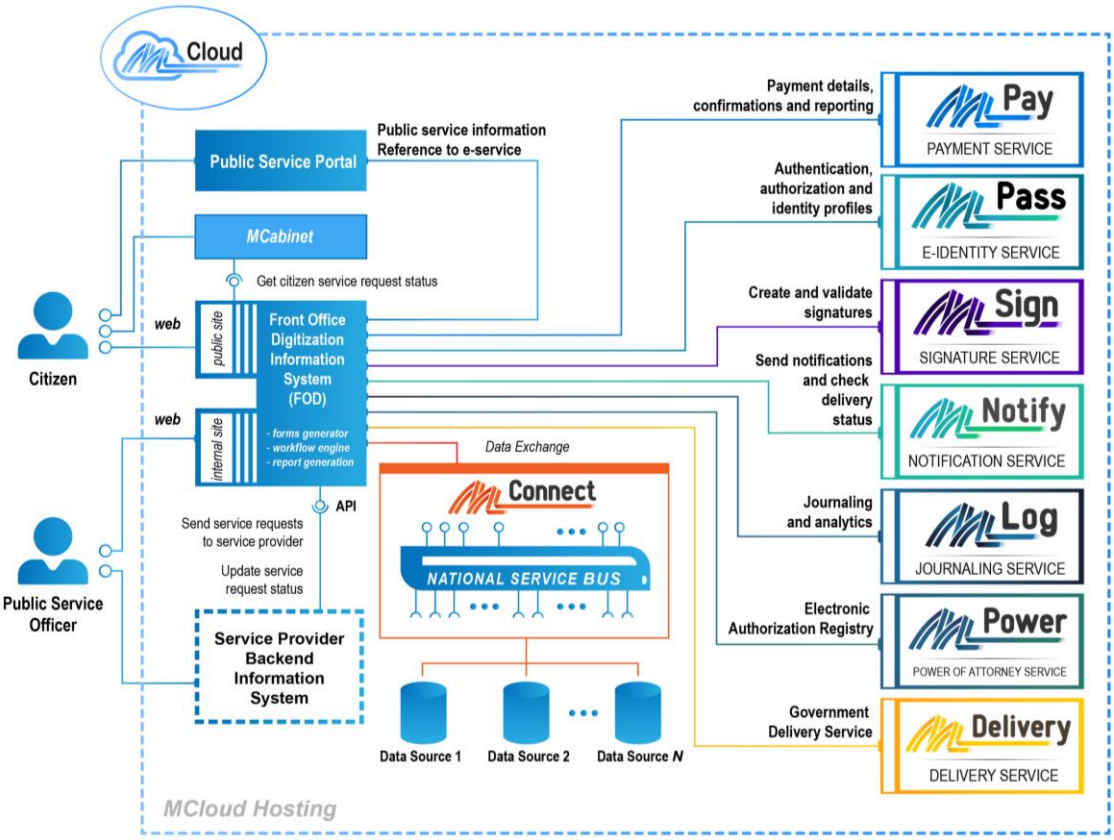

Figure 4. FOD Architecture (e-Gov, 2024)

The platform is now well developed and has already been used to digitalize over 40 of the most popular and requested public services of different complexity, in less than 9 months (e-Gov, 2023). Digital services are now heavily used by nationals from inside the country or abroad. It has been a successful undertaking where the following steps are the digitalization of new public services and the continuous upkeep of the platform.

The EGA is also implementing a "Unified Public Service Centres (CUPS)" project, which offers common access points to a wide range of public services in electronic format. (EC, 2023). The CUPS operators provide citizens with informational and technical support, helping the rural population submit their service requests to service providers using available online platforms and obtaining a certain public service more easily via the CUPS office in their locality or nearby. **The number of e-services is continuously increasing** as they become available.

Only one in two respondents who accessed a public service has used an electronic service, with a huge gap of 60 percent in educational levels and a 20 percent gap between urban and rural populations (EGOV, 2023). Young people aged 18-29 are the category that almost five times more often use electronic services than those aged 60-74 (GD nr. 650, 2023).

Several key challenges and limitations have been identified when assessing Moldova's current digital transformation landscape. These obstacles encompass various aspects, from financial constraints to regulatory gaps and skill shortages. The following bullet points outline the critical issues hindering the advancement of digitalization efforts in the country:

- Mismatch of digital skills and an insufficiently skilled workforce in the industry and central public authorities, especially the local public authorities.
- Low level of digital skills and awareness among the population.
- Emerging level of digital readiness of Moldova’s education system (level 2 of 4) (WB, 2022);
- Insufficient institutional capacities for the implementation of the digital transformation agenda.
- Reluctance to digital transformation within service providers.
- Shortage of financial resources.
- Underdeveloped IT infrastructure in local public authorities.
- Low involvement of local companies in government-financed IT projects.
- Insufficient remuneration of public servants responsible for managing the ICT infrastructure and digitization projects.
- Insufficient presence of scientific research in developing and monitoring policies aimed at developing the information society (GD nr. 650, 2023).

4.4.2 Current shortcomings and activities in place to reach goals

As outlined in the final report on the implementation of the Digital Moldova 2020 action plan, there have been positive developments in terms of creating conditions for the implementation and use of electronic services, the development of digital skills, improving connectivity and network access and eliminating critical constraints on the ICT of the business environment.

However, infrastructural and connectivity-related shortcomings include (GD nr. 650, 2023):

- A well-developed mobile infrastructure is present in the country, but **high-speed home access to broadband is still challenging**.
- Affordable mobile Internet access exists, but the **fixed broadband basket cost does not yet meet the Commission’s target**.
- There is strong **government support for the ICT sector development, but no joint vision** or overarching strategy related to its further development.

- There have been a few efforts by stakeholders to increase cyber-resilience, but there is **a clear need for active engagement in strengthening the country's cyber defence capabilities**.
- **Many essential services to citizens are yet to be digitalized** (MEDD, 2023), and further efforts are needed.
- **There is little awareness of the use of open-source technologies in government procurement,** indicating a gap and potential barrier to expanding the local ICT sector.

Further work should be undertaken on customer orientation, monitoring and evaluation mechanisms and addressing internal resistance to change and bureaucratic barriers to deploying new services. In this regard, some actions were undertaken, such as passing the law on public services or developing the FOD platform. The law on public services requires authorities to provide public services digitally while FOD offers a boilerplate framework to digitalize interaction between citizens, entrepreneurs and public services providers.

4.5 Data management

4.5.1 Registries, data composition

According to the Global Data Barometer, Moldova ranks 47th in the data governance module, out of the 109 countries evaluated (The Global Data Barometer [GDB], 2024). Data management in Moldova is characterized by several initiatives to improve the efficiency, accessibility, and interoperability of public and private sector data. In **2012**, the Government of Moldova endorsed the **Interoperability Framework Program.** (GD no. 656, 2012). This program aimed to **streamline the delivery of public services**, both offline and online, and enhance government efficiency as outlined in the Strategic Program for Technological Modernization of government (e-Transformation). The main goal of this initiative is to **improve interoperability** within the public sector, easing administrative processes and optimizing government services by eliminating the need for citizens to exchange data between authorities physically.

In Moldova, **the basic registers exist, are regulated and managed by responsible bodies and have most of the data digitised**. At the same time, data in the register on property and land is not fully digital; the register containing data on business and other organisations has historic data that is not digital either.

Unique identifiers exist for person, organisation/business, property/land, location and economic activity. **The basic data policy principles** (e.g., once only, digital by default, privacy by design, security by design principles) **are implemented** by EGA and supported by separate legal documents (e.g., about registers; about consolidation of data centres and rationalisation of state information systems; about inventory of the existing state information resources and systems; about optimisation and efficiency of

public sector data centres). A pricing model for government data utilization has been established, covering the public and private sectors' fee structure and payment conditions for digital data reuse. (GD no. 211, 2019).

4.5.2 Data exchange through services

Efficient **data exchange within the public sector and between the public and private sectors is being facilitated by implementing the Interoperability Framework, regulated by the Law on data exchange and interoperability, the government decision on the interoperability platform (MConnect), and the** government decision on the "**Semantic Catalogue" information system**. In 2023, the Parliament passed a new Law on Access to Information of Public Interest. The introduction of this new law aligns with the Action Plan for executing measures recommended by the European Commission in its Opinion regarding Moldova's application to join the EU. EGA is responsible for overseeing the implementation of the interoperability framework. This framework aligns with the European Interoperability Framework, covering organizational, legal, semantic, and technical interoperability.
To boost internal efficiency and ensure system and data exchange coherence, the **MConnect Governmental Data Exchange Platform was initiated as a pilot (2014-2018) and later fully implemented**. The platform's data exchange architecture is now fully established, supported by legal, technical, and institutional frameworks. The MConnect Platform's objectives include ensuring public sector information resource interoperability, enhancing decision-making through real-time access to accurate administrative data without burdening citizens, and fostering an environment conducive to public service optimization and electronic service expansion through information reuse and process automation.
MConnect’s integration and effective utilization by authorities underscore its pivotal role in public administrative service modernization. The ongoing process of public and private entities connecting to MConnect is expected to expand the number of connected systems and participants and the scope of integrated projects and data exchange scenarios. As of 2023, according to the EGA, 92 entities are using MConnect for data exchange, and the platform has handled over 1.3 billion data requests. MConnect connects all national registries. Also, **almost 90% of public institutions consume data through MConnect**, which is a success.

The Semantic Catalogue (GD no. 323, 2011) **was developed as a result of an analysis of current data management practices to improve overall data quality, use, coordination and alignment** with international practices. To enhance the quality of data and data description and to implement international best practices, it was necessary to identify the most efficient and centralized way of systematizing and managing metadata on data. The solution was the Semantic Catalogue, which is a key information system for the configuration, management and recording of semantic assets managed by entities and institutions in Moldova, to provide up-to-date information about available semantic assets, as well as relevant metadata for data

exchange through the Interoperability Governmental Platform MConnect. The development of the Semantic Catalogue was a first step in the implementation of semantic interoperability, but also of the strategy of streamlining data exchange in general, by structuring and systematizing information about datasets from existing information resources and systems, used in their activity by both public and private legal entities and natural persons (e-Gov, 2024).

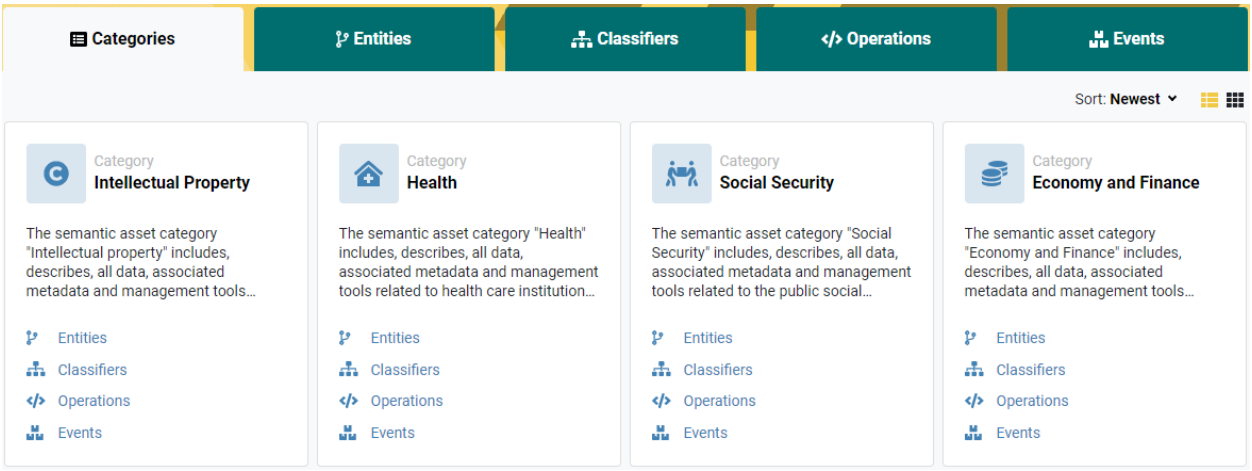

Figure 5. The Semantic Catalogue

Additionally, in 2020, the Citizens and Entrepreneurs Government Portal (MCabinet) was launched, consisting of a set of interconnected information resources and technologies, designed to provide citizens with an efficient and modern mechanism for obtaining official information about themselves. The information is obtained from data providers' registers and information systems and delivered through a single access point.

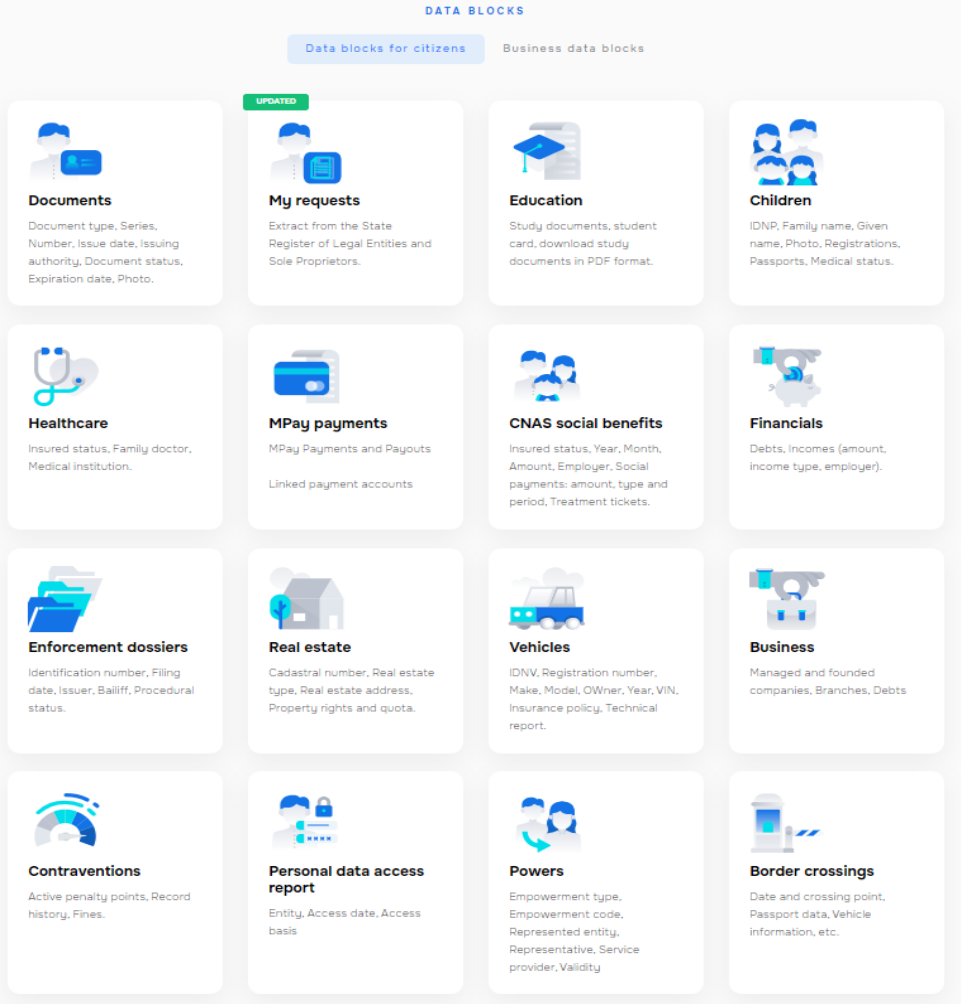

Figure 6. MCabinet blocks

In 2024, the government approved the concept of the **EVO mobile application**. Through it, citizens can access information and functionalities for individuals and companies.

The EVO app was officially launched during the Moldova Digital Summit 2024 and is already available for free download via the Play Store and App Store online platforms and stores.

The current version of the application provides information to and about individuals and companies, providing and integrating the following modules (e-Gov, 2024):

11. **Digital ID wallet** - a digital wallet for carrying digital documents (ID card, driver's licence, registration certificate) that may be verified via QR code.
12. **Document verification** - a module that initially allows users to check digitised documents available in EVO according to predetermined criteria and subsequently check other documents as well.

13. **Payments** - MPay integration, with the option to attach payment cards, integrate alternative payment solutions, such as Google and Apple Pay, and manage accounts for receiving government payouts.
14. **Personal data** - integration of MCabinet functionality and reflection of available datasets for both individuals and companies.
15. **Public Services** - Integrating information on the Public Services Portal to quickly access electronic services, information about the types of public services available, and storage of digitally obtained services.
16. **Powers of Attorney**—MPower integration to provide, revoke, review, and store powers of attorney.
17. **E-Appointments** - appointments to services available in the e-Appointments system and other services.
18. **Health** – to provide information on the status of the insured person, family physician, information about vaccines, etc.

4.5.3 Open data and personal data protection

In April **2011, Moldova initiated its open data movement with the launch of the open government data portal, currently including 1222 datasets** (DataSets, 2024). This step was taken to enhance transparency, administrative efficiency, public accountability, and to unlock the economic potential of data re-use. Embedded within the broader agenda of promoting open government principles, this initiative is a cornerstone of the Strategic Programme for Technological Modernization of Government (e-Transformation).

The Governmental Data Portal serves as a centralized information resource, aiming to deliver a seamless and comprehensive experience for those searching for data produced by governmental authorities, public institutions, and other governmental bodies. Its core mission is to furnish users with pertinent information in an accessible and timely manner, effectively acting as a single point of access for a wide array of public sector data. **The portal's objectives include broadening the range of data available for consumption and reuse, expanding its user base, enhancing the user experience in data visualization and interaction, and diversifying access methods** to publicly held data.

This portal combines information from numerous public sources while excluding data safeguarded by state secrets or specific legislation. It symbolizes the integration of three pivotal government initiatives in Moldova’s data landscape:

19. **Open Data Sets Publication:** The portal aligns with the global Open Government Partnership goals by facilitating the release of open datasets from ministries and central public administration bodies. It aims to boost public access to data and foster citizen engagement in governance. Open government data is available for anyone to

use, copy, transmit, distribute, modify, or republish freely, without restrictions or control measures.

1. **Public Data Access and Search Mechanisms:** The portal offers user-friendly tools for accessing and searching public data, ensuring an efficient and effective data retrieval process.
2. **Controlled Access for Authorized Entities:** While promoting open data principles, the portal also provides controlled access to certain information for entities with a legal mandate and specific objectives, maintaining a balance between open access and the need for regulated information dissemination.

Currently, the State Chancellery is responsible for open data policies. (GD no. 700, 2014).

A new version of the open data portal was launched on March 5, 2024. This new version includes several performance improvements, enhanced user experience, and advanced technological capabilities **to host data from over 50 public institutions**. Currently, the portal hosts around 1200 datasets covering various fields such as health, environment, justice, economy, education, and more. Open data is being reused for analysis, research, forecasting, the development of start-ups, and creative and informative solutions. However, **there is a very low uptake of environmental data** (more in Chapter 5). The MTender electronic public procurement information system also publishes public procurement data. Based on this data, a Business Intelligence (BI) digital analysis tool has been developed (OCP, 2024).

4.5.4 Data analysis and application in policy planning

Advancing digital transformation in Moldova results in a great deal of data, which the Moldovan Government can leverage for better decision-making and governance. The experience of providing on-bill compensation to reduce energy vulnerability of the Moldovan public, which United Nations Development Programme (UNDP) Moldova supported, proved a successful first major example of how data can be used to automate government processes.

This was initiated by UNDP and followed by work to create a Data Governance Framework to help decision-making in health, agriculture, social security, and justice sectors (UNDP, 2024).

Following the inauguration of Moldova's first Data Review Room in Ștefan Vodă, a second Data Review Room was opened on February 24, 2023. Located within the Ministry of Labor and Social Protection (MOLSP) in Moldova's capital of Chișinău, the new facility is designed to serve as a central hub of the Ministry's response to the refugee crisis as well as a platform to anticipate and prepare for future emergencies. The Data Review Room will support the MOLSP and its partners in providing

accommodation, access to cash allowances, basic services, and support for over 100,000 refugees who remain within Moldova's borders (UNHCR, 2024).

Much like the one in Ștefan Vodă, this Room is an example of the Moldovan government's **efforts to integrate data-driven decision-making more effectively into their strategic planning and emergency response**. **The Data Review Room in the MOLSP will allow its users to aggregate real-time information across a wide range of data sources**, such as refugee databases, information systems of the Government, Blue Dots databases, and police records and, using the Room's analysis and visualization dashboard, to make more impactful interventions informed by available data. The central theme of the opening event was the Moldovan government's commitment to data review and use as a critical element in the decision-making process. (USAID, 2023).

As per Law No. 71/2007 on registers, access to register data is governed by existing data exchange and interoperability laws. Furthermore, according to Law No. 467/2003 concerning informatics and state information resources, key information resources include the State Register of the Population and the State Register of Legal Entities. Information resource holders are mandated to provide access to state information resources through the interoperability platform, adhering to current legislation.

Also, data analysis-based policymaking has been effectively utilized in various sectors. For example, the MTender system enhances public procurement transparency, National Health Insurance Company (CNAM) data optimizes healthcare resource allocation, and educational data guides improvements in school performance. Environmental data helps enforce pollution controls, while labour market data shapes employment policies. During the Covid-19 pandemic, epidemiological and economic data informed targeted lockdowns and resource allocation. These initiatives illustrate how data analysis drives informed decision-making across multiple domains in Moldova. References include the MTender system, CNAM, Ministry of Education and Research, Ministry of Environment, National Bureau of Statistics, and the Ministry of Health.

4.6 Skills

4.6.1 Digital literacy: overview, issues and initiatives

According to the data collected within the Generations and Gender Survey 2020 carried out by UNFPA, **the digital gap between the elderly and young people in Moldova is large** – only 34% of the population aged between 60 and 79 used the Internet, compared to 82% of those aged 15-59. Launched soon after the outbreak of the pandemic in 2020, the Digital Skills Connect Generations project aims to narrow the generational digital divide and help older Moldovans access the services they need, while fostering intergenerational dialogue in the process (EECA, UNFPA, 2022). A similar

initiative launched by Moldova State University aims to encourage older people to acquire digital skills (UN, 2023).

General shortcomings related to the population's digital skills (MEDD, UNDP, 2023):

- Citizens' capacity to develop technical capabilities is expanding. Still, it does not meet the level of demand, and there do not seem to be rewards or incentives to encourage entrepreneurial mindsets or further societal adoption.
- IT professionals in Moldova have good qualifications, but the size of the talent pool is very limited and not integrated; a mismatch of skills exists.

20. The government and other stakeholders undertake significant efforts to ensure an enabling environment for the digital inclusion of women and girls. However, barriers remain for career advancement; programs do not target the inclusivity of the most vulnerable groups.

21. Moldova has a solid mandatory education system that lays the foundation for advanced professional digital skills. Yet, there are still too few programs that can attract sufficient talent into pursuing STEM careers (STEM refers to Science, Technology, Engineering and Mathematics) and address the population's lack of specialized IT skills.

- National stakeholders engage actively in promoting online protection, but there is a need for a more robust and coordinated approach.

As per Moldova's Digital Education Readiness Assessment 2021-22 by the World Bank, four strategic areas are ripe for digitalization in the country's education system: (a) supporting learning including targeted remediation services; (b) improving effectiveness by strengthening the management, monitoring and evaluation of the system and digital pedagogic practices as well as enhancing ICT-related science, technology, engineering, and mathematics (STEM) training; (c) improving equity and inclusion by improving access to digital learning environments at home and at school for the vulnerable and disadvantaged; (d) improving resilience by strengthening the digital readiness of the education system to absorb and pivot quickly in the face of future shocks (WB, 2022). Reform efforts should be prioritized based on urgency and importance to address the above goals while carefully considering the risks and returns.

In terms of digital literacy, several initiatives have been undertaken to incorporate digital education into the school curriculum at all levels. A digital education module was introduced in primary schools in 2018 and is now mandatory in primary schools. Standards on digital competences have been established for students across primary, secondary, and high school levels (MERRM, 2022). Efforts have also been made to address the shortage of IT equipment in schools and improve teacher training, which is crucial for successfully implementing digital skills policies. Initiatives such as "Tekwill in every school" have been launched to develop interactive digital

content and new pedagogical methodologies focused on critical thinking, creativity, and interpersonal skills (Tekwill, 2024). Also, the National Digital Literacy Program is implemented under the aegis of the Ministry of Education and Research with financial support from USAID, Sweden and the UK through the Future Technologies Project and the Orange Moldova Foundation.

Digital tools are integrated into all levels of learning across Moldova, and educators use them to enrich their teaching skills. The country has 20 higher educational institutions that offer IT-related studies. Yet, IT industry professionals are not formally allowed to teach at universities without advanced degrees and pedagogical certification. This means that many valuable IT specialists do not have the opportunity to teach practical skills.

In Moldova, women are significantly under-represented in ICT education, with only 4.6% of girls in higher education choosing STEM. As a result, women and girls account for 31% of jobs in the ICT sector but only 19% of digital professions (UNDP, 2021). Their salaries in this sector are 33% lower than the salaries of men. GirlsGoIT Program was created and led to the establishment of girls-led local clubs in 13 regions in Moldova, and the "Empowering Women in ICT Skills" initiative was launched (MEDD, order No. 165, 2023) (UNDP, 2021).

Previously, the "Education Development Strategy 2014-2020" and "Digital Moldova 2020" strategies generated many programs and initiatives to support digital skills development. These include the ICT Centre of Excellence "Tekwill", "Tekwill in Every School" program, the National Digital Literacy Program for Teachers, "Future Classroom Lab", etc. Moreover, to overcome the pandemic, several online or hybrid platforms such as "Studii.md", "Education Online" and "Învăț Online" were launched. Several universities and colleges provide ICT degrees, but they make up a small proportion of the total (UNDP, 2021).

Data literacy is highlighted as an issue that needs to be solved. This indicates that data literacy is not highly developed. In the PISA (OECD, 2024) 2022 assessment, Moldova's performance in mathematics, reading, and science was below the OECD average. Specifically, 15-year-olds from Moldova scored an average of 414 in mathematics, 411 in reading, and 417 in science, compared to OECD averages of 472, 476, and 478, respectively, in these subjects (OECD, 2023).

The European Commission has developed a Digital Competence Framework for Citizens (DigComp) (Vuorikari R., 2022), which provides a common understanding of digital competence across the EU and beyond and provides a basis for framing digital skills policy and adapting digital education programs. Moldovan activities under this objective should be aligned with the European Union's Digital Competence Framework (MEDD, UNDP, 2023).

4.6.2 Cybersecurity programmes

Since Russia invaded Ukraine, Moldova has been subjected to several cyberattacks. To build the country's defences against cyberattacks, students are also being trained in information security at the Technical University of Moldova - an education of heightened importance in today's world. (FUF, 2023). The education refers to the bachelor's program in Information Security, which allows students to work as specialists in infrastructure networks or as security managers in IT companies. This education program was born out of necessity.

There was a demand from the private and public sectors to train competent experts to deal with the rising number of cyberattacks in the country. To encourage students in their studies, universities carry out so-called "Capture the Flag" competitions at the national level. Different teams or individuals compete against each other in a simulated virtual environment. The goal is to find and exploit vulnerabilities in various computer systems and applications to "catch" flags, which consist of text strings or files. Sweden is also involved in and supports Moldova's work with cybersecurity through the Future Technologies Activity (FTA) program, which has created a cybersecurity academy within the Technical University of Moldova. The support is about giving personnel in the public and private sectors basic knowledge of IT security (FUF, 2023).

4.7 State of digitalization of the private sector and overview of the IT sector

Moldova is a relatively open economy that is closely integrated with the EU. Economic links between the two have strengthened since the entry into force of the Deep and Comprehensive Free Trade Area in 2016 (EC, EU-Moldova DCFTA). **Moldova is progressing towards a comprehensive digital transformation, emphasising the private sector** alongside governmental and civil society efforts. MDTS encapsulates a whole-of-society approach, aiming to develop a thriving local digital ecosystem founded on inclusivity, sustainability and accountability. The strategy includes all segments of society to ensure broad participation in the digital economy. (MEDD, UNDP, 2023).

4.7.1 IT sector

The ICT sector is topping the list of countries' priorities as a productive sector and an enabler for economic and social development. An advanced ICT sector is crucial to an innovative and efficient economy and a higher quality of life. **The ICT sector has become the main driver of digitalization and innovation** in Moldova and is growing fast. In 2021, the IT industry reached **a share of more than 4.25 percent of GDP**, exceeding 10 billion MDL of sales, with the **ICT sector being over 7.6 percent of GDP in 2021**.

As of 2022, the number of ICT companies has exceeded 2300, while the number of employees exceeded 30 thousand, registering significant growth for both indicators

during the last 5 years. The number of employees in the industry is about 2% of the available labour force in the country, which is about two times lower than the EU average of 4.2%, discouraging further growth (ATIC, 2021).

In 2018, the first IT park in Moldova started operating (Government Decision No. 1144/2017), a platform created by the Government to stimulate investment and development in IT businesses, research, development, and digital innovation.

"Moldova IT Park" offers several advantages and incentives to its residents:

- Simplified taxation model (flat tax of 7%).
- Virtual operating regime (residents work in their offices in any Moldova location).
- Extended list of eligible IT and related activities (software development, IT services, graphics and digital design, research and development, educational projects).
- Simplified interaction with public authorities.
- Opportunities to attract long-term foreign specialists through the "IT visa" (MEDD, 2018).

As of 2024:

- There are over 2000 registered companies.
- More than 22 000 professionals involved (MITP, 2024).

Moldova has updated its **Digital Economy Roadmap for 2023. This roadmap promotes government-to-business online interactions, digitalizing the economy, and developing e-commerce infrastructure** (EU4Digital, 2023). Efforts are aimed at creating technological platforms for remote customer identification, digital notary services, and legal clarifications for remote working, among other things. These initiatives are part of a broader strategy to stimulate the electronic commerce sector and facilitate digital transactions (EU4Digital, 2023).

Shortcomings related to the business sector: (MEDD, UNDP, 2023)

- There is little awareness of the use of open-source technologies in government procurement, indicating a gap and potential barrier to expanding the local ICT sector.
- Lack of coordination between governmental agencies and lack of a concrete vision results in technical problems in system architectures, interoperability, and service integration. Further work should be undertaken on customer orientation, monitoring and evaluation mechanisms and addressing internal change resistance and bureaucratic barriers to deploy new services.

4.7.2 Use of ERPs by SMEs

Most businesses in Moldova (about 95%) are SMEs (EC, 2023). SMEs are the main drivers of the economy. However, **less than 17% of SMEs have successfully integrated digital technologies in their work**, which unveils huge untapped potential

and highlights an urgent need for SMEs to transform their businesses (EC, 2020). The Covid-19 pandemic has amplified the importance of enterprises' digitisation, and a special focus was put on e-commerce as a large share of the country's SMEs are active in trade (UNDP, 2021).

To appropriately respond to the SMEs´ needs, the Strategy for the Development of the Small and Medium Sized Enterprise Sector provided the **long-term and medium-term policy framework for 2012-2020**. This Strategy was followed by the Support Program for businesses with high potential for growth and internationalisation, approved in 2020. Based on these strategic documents, the government has put in place a wide range of projects to support SMEs like the Efficient Business Management Program, "PARE 1+1" Program, the Women in Business Program, Start for Youth Program, etc (UNDP, 2021).

The government recently expanded the definition of a 'small and medium-sized enterprise' so that more businesses qualify for support programmes, including those managed by the Organisation for the Development of Entrepreneurship (a government agency). The Digital Transformation Programme, approved in 2022, sets out measures to support SMEs to invest in digitalising their operations (EC, 2023).

Despite all these efforts, **several barriers, particularly related to e-commerce, are still considered limiting in the SMEs' transformation process.** Among them is a lack of e-fulfilment solutions; export processes are slow and costly. Also, there is low cross-border e-commerce flow, and Moldova is under-represented on international marketplaces (UNDP, 2021).

Issues: (MEDD, UNDP, 2023)

- **SMEs** are the backbone of the economy, with huge untapped potential, but with an **urgent need to digitally transform their businesses.**
- Entrepreneurs can easily create a business in Moldova and the country ranks very positively in the domain of ease for building a business, but this contrasts with **the lack of credit and financing for the private sector and for new ventures**, which is limited in the country and discourages the emergence of new start-ups and business models.
- **The start-up sector is a key source of innovation, but few initiatives are in place** to grow newly created businesses.
- The ICT sector is generally a driving force for development and digital transformation, but private enterprises benefit too little from its advantages.

The level of telecommunications development in general and high-speed Internet coverage, in particular, is relatively high in Moldova. There is a developed information infrastructure and access to modern universal and specific systems, but SMEs rarely

use such integrated solutions as ERP systems. This is due to the high requirements for the staff and management qualification of enterprises, as well as the high cost of software and hardware components associated with implementing an ERP system. Due to such limitations, serious, complex software solutions are available mostly to large companies that have sufficient financial and human resources, and are rarely used by SMEs (Gagauz V., 2022).

4.7.3 Level of use of e-commerce in companies

In 2017, the Parliament of Moldova adopted changes and additional chapters to the original Law on e-Commerce (Law no.284, 2004), which were developed in accordance with the Directive of the European Parliament and Council 2000/31/EC on the Information Society and Electronic Trade. Furthermore, the government aims to accelerate the national economy and the development of e-commerce through Digital Economy Roadmaps that are updated annually (Economic Council MD [ECMD], 2022) (ECMD roadmap, 2023).

The Moldovan e-commerce sector has expanded as internet access becomes more widely available. The Covid-19 pandemic has underscored the need to develop online payments and online banking systems. The use of e-mail for business communication is becoming increasingly common. Most companies have their websites. A growing number of local businesses also use social media for marketing purposes. Official statistics reported that 525 Moldovan companies have e-stores (International Trade Administration, 2024). **Internet banking is becoming increasingly popular.** Access to wired Internet and mobile Internet is increasing as smartphones have spread, and some local operators are already considering upgrading their infrastructure to 5G. Most large Moldovan banks offer online payment integration methods. The government is currently drafting a package of laws to stimulate e-commerce development.

Moldovans shop online primarily for clothing, shoes, electronic appliances, food, and travel (International Trade Administration, 2024). Payments are usually rendered upon receipt of merchandise, rather than online. The total amount of purchases made online by Moldovans in 2020 was USD 277 million (International Trade Administration, 2024).

Moldova passed a law on e-commerce in 2004, regulating the main aspects of transactions over the Internet and introducing such terms as electronic contracts. New changes to the law were passed in line with Moldova's EU Association Agreement/Deep and Comprehensive Free Trade Area (Association Agreement/DCFTA), focusing primarily on personal data protection. **The government has developed a national digitisation roadmap, which focuses on the development of e-commerce, the promotion of online stores, the attraction of international e-commerce actors, and the** facilitation of cashless payments.

There are a few domestic e-commerce aggregators that compare prices on products sold online (such as Allprices), digital sales of tickets for different public and social events (like iTicket, MTicket), deliver restaurant food (Straus, iFood) and help deliver products purchased online from a wide range of U.S. retailers to Moldova (Pesoto, BayShop) (ITA, eCommerce, 2024).

Figure 7. E-Commers users in Moldova (Indrivo, 2023)

4.7.4 Level of use of AI, big data, blockchain and other new technologies

Moldova is currently at the first iteration of developing the strategic framework in the field of data governance and AI. However, this topic has been on the public agenda for several years, affecting all levels, from the governmental to local public administrations and areas from academia to business. There are necessary preconditions for developing an ecosystem of data governance and AI in Moldova that would align with the actions of the EU member states and represent a vector for economic growth.

Governmental initiatives regarding AI include **the development of the White Book on AI and Data Governance,** which aims to align Moldova with the initiatives promoted by the international community and, in particular, those of the EU, so that Moldova can

contribute to and benefit from the development of an ecosystem of data governance and AI, effectively using human capital and financial and technical resources currently available, as well as those that may be attracted as a result of aligning with global developments and trends (MEDD, 2024).

In 2021, the Parliament of Moldova approved the Government Activity Program "Moldova of Good Times", which also contains a section dedicated to digital transformation. The notions of artificial intelligence, intelligent municipality, intelligent instruments, etc., are covered. However, the provisions of the program are limited to "Studying and exploitation of initiatives and programs of EU countries in the field of adopting artificial intelligence technologies, robotics, blockchain, smart contracts and other emerging technologies to modernize public and private digital infrastructures with the purpose to deliver better services, operational effectiveness, and strengthening of the country's cybernetic capacity".

According to Recommendation No. 3 from the white book **on data governance and artificial intelligence**, the government must take a central role in facilitating the development and implementation of AI technologies in society, assuming the following roles (MEDD, 2024):

- **Regulation and oversight** - It is recommended to establish rules and regulations to ensure AI's ethical and responsible development, design, use, and deployment. This should include protecting personal data, preventing abuse and ensuring transparency in AI-based decisions.
- **Investments in research and development** - It is recommended that financial resources be allocated for research in AI, thus supporting innovation and the development of new technologies.
- **Education and training** - It is recommended that specialized training and courses be developed and delivered to ensure the workforce is ready for the AI-based economy.
- **Promoting ethics in AI** - It is recommended that committees or bodies be established to debate and establish ethical standards in the development, design, use, and deployment of AI.
- **Public-private partnerships** - collaboration between the public and private sectors is suggested to promote the development, design, use and deployment of AI solutions, thus leveraging the expertise and resources of both parties.
- **Infrastructure** - developing appropriate infrastructure, including fast data networks and data centres, to support AI-based operations is supported.
- **Public awareness** - it is recommended that information campaigns be launched to educate the general public about the benefits and risks associated with AI.

- **Economic policies** - it is recommended to create policies that encourage investments in start-ups and companies that develop AI technologies, thus supporting economic growth.

5 Sectoral assessment

5.1 Biodiversity

5.1.1 Sector definition, role of digitalization

"Biological diversity" means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (The Convention on Biological Diversity (CBD) entered into force on 29 December 1993)

When achieving climate neutrality, consideration of preserving ecosystem balance and ecosystem services is necessary. Additionally, it is important to ensure that actions towards the green transition would not adversely affect biodiversity.

This thematic area will focus on the subthemes of nature conservation (mainly in situ measures), which are central to the topic. Nature restoration is increasingly needed in the efforts to safeguard biodiversity and ecological processes. It is one of the key targets of the green transition and is covered by the biodiversity thematic area.

One of the focal strategies on biodiversity at the European level is the EU Biodiversity Strategy 2030 (A. Hedberg, 2020). It does not address digital transformation in the sector, but lists the digital functionalities that support reaching sectoral aims:

- Data availability must be ensured in combination with the EU Forest Strategy to produce up-to-date assessments of the condition of European forests and link all EU forest-data web platforms (section 2.2.4 of the strategy).
- In marine ecosystems, stepping up data collection on bycatch for all sensitive marine species (section 2.2.6 of the strategy).
- Ensuring overall data availability to support the strategy’s quantitative visionary targets related to the share of protected land and marine areas, freshwater ecosystem restoration, pesticide use and other agricultural practices, and reforestation.

Collecting data (via sensors, drones, satellites, cameras, or audio recordings), storing data in databases, and using AI-enabled solutions for data processing and management have been highlighted as the main digital solutions for reaching biodiversity goals. This includes, for instance, the EU’s Copernicus programme, which uses satellites and in situ observations to monitor the Earth and its ecosystems; the Biodiversity Information System for Europe. Digital solutions in farming also contribute to biodiversity preservation (A. Hedberg, 2020).

5.1.2 Main biodiversity-related challenges in target countries

Table 3. Main biodiversity challenges

Moldova		
Please list one to three main biodiversity-related gaps in the country.	**How can digitalization help overcome this gap?**	**Is a European regulation or other framework applicable in the country that should be followed (e.g. harmonised data structure)?**
Biodiversity data: Moldova has no developed biodiversity data and monitoring system for flora and fauna species and habitats in a digital format. The Environmental Protection Agency and the Forestry and Moldsilva Agency have low technical and human capacities to ensure digitalization.	The digitalization of the data management of species, including red species and Emerald species and habitats, forest ecosystems, as well as protected areas, will assist a long-term data collection, monitoring and reporting processes that will ensure informed decision making, communication, research, civil society participation, integration to the EU data management systems, clearing house mechanism and reporting to the related conventions.	According to Law 1515/1993 on Environmental Protection (revised in 2023), article 15, one of the main task of the central authority for natural resources and environment (Ministry of Environment) is developing the necessary legal framework for achieving environmental protection objectives, ensuring its compatibility with international treaties to which Moldova is a party and with the EU legislation, as well as developing public policies in the field, ensuring their implementation, monitoring, evaluation, and reporting on their fulfilment (Law no. 1515, 1993). Moldova implements the INSPIRE Directive, which guides the sharing of environmental spatial information among EU countries and aligns with broader European data practices (GD no. 663, 2023).
Protected areas: Data collection, management, monitoring, and reporting in protected areas are not developed and maintained. Open data related to biodiversity has been published on the open data portal, but it has not been updated since 2015-2016 (Protected Areas [PA], 2016), (EN species, 2015).	The Moldovan data management system in the field of protected areas, species and habitats, invasive species, endangered species, forest management, forest extension and restoration, must be developed and harmonized with the European regulation and data management structure	

Forestry sector: The state forestry fund includes a management planning review system for forest areas, which is revised every 10 years. However, forest restoration, monitoring, and reporting data management is not digitalized and accessible online.	Utilize remote sensing technology and GIS (Geographic Information Systems) to digitally monitor forest changes and degradation, enabling more timely interventions and detailed ecological assessments across Moldova's forested regions.	

5.1.3 Status of digitalization in biodiversity

In Moldova, **specific information on digitalization directly related to biodiversity is limited. Integrating** existing governmental digital platforms and strategies into biodiversity management would be a step forward, building on the country's general digital progress to address specialized environmental and forestry management needs.

At the same time, the Ministry of Environment has **developed a new Environmental strategy** for 2014-2030, approved on 12th June 2024 (GD draft, 2024). The draft strategy outlines a comprehensive Environmental Strategy for Moldova with specific sections focusing on biodiversity and the digitalization of environmental management. Here are **the main actions detailed for the digitalization of the biodiversity sector within the strategy**:

22. The strategy emphasizes implementing **advanced digital monitoring systems** to track biodiversity health across various ecosystems. This involves using **remote sensing** technologies and **geographic information systems** (GIS) **to collect real-time data** on forest coverage, wildlife populations, and water quality.
23. The strategy **proposes creating a centralized digital platform that integrates all biodiversity-related data**. This platform is intended to be accessible to various stakeholders, including government agencies, research institutions, and the public, facilitating informed decision-making and promoting transparency.
24. The strategy suggests developing **digital tools for reporting and compliance monitoring**. These tools will automate the reporting processes for environmental impact assessments and other regulatory requirements, streamline compliance checks, and enhance the enforcement of environmental laws.
25. The strategy aims to **use digital tools to increase public engagement in biodiversity conservation** efforts. This includes using **mobile applications and social media** platforms to **raise awareness, report environmental incidents**, and involve citizens in conservation activities.

In conclusion, this sector is underdeveloped in terms of digitalization. However, the Ministry of Environment aims to focus on digitalizing this sector in its comprehensive draft strategy.

5.2 Farm to Fork

5.2.1 Sector definition, role of digitalization

This thematic area covers the entire food system (Farm to Fork) - from input supply and production of crops, livestock, fish, and other agricultural commodities to transportation, processing, retailing, wholesaling, and preparation of foods to consumption and disposal. It should be noted that we include foods produced from agriculture, fisheries and farmed fish (aquaculture).

Our focus is aligned around the EU Farm to Fork strategy, which includes:

- Building the food chain that works for consumers, producers, the climate, and the environment;
- Ensuring sustainable food production (a focus on an organic and agroecology transition, plus reductions in the use of fossil fuel fertilizers and pesticides);
- Ensuring food security;
- Stimulate sustainable food processing, wholesale, retail, hospitality, and food service practices;
- Promoting sustainable food consumption and facilitating the shift to healthy, sustainable diets;
- Reduce food loss and waste;
- Combating food fraud along the food supply chain.

For more information, we have a detailed Farm 2 Fork briefing document here, which includes key Farm to Fork targets.

Digital solutions that are necessary to support the green transition in agriculture include digital registries with EU-central-registries-compatible data (e.g. organic farming including organic certificates, farm animals, drugs register) and various precision farming-related technologies.

5.2.2 Main "Farm to Fork" thematic area-related challenges in target countries

Table 4. Main thematic area related challenges

Moldova		
Please list one to three main gaps in the country related to the 'Farm to Fork' strategy.	**How can digitalization help overcome this gap?**	**Is a European regulation or other framework applicable in the country that should be followed (e.g. harmonised data structure)?**
Overall, there is a substantial gap in data on many of the Farm to Fork indicators. More specific targets are needed to promote sustainable food consumption and facilitate the shift to healthy, sustainable diets, reduce pesticide and fertilizer usage, reduce food waste, tackle AMR, enable transition, especially regarding financing and sustainable transition models, and promote the global transition.		Moldova's national strategy for agricultural and rural development for 2023-2030 references commitments to align with European regulations, notably within the context of the EU's Common Agricultural Policy (CAP) and the EU-Moldova Association Agreement. Moreover, the strategy envisages alignment with the EU Farm to Fork strategy (GD no.56, 2023).
Another possibility for the agri census that the government aims to create.	An interactive database with software that helps to introduce, analyse and provide statistically relevant recommendations for agri-subsidies: where we have all the information on agri practices and agri inputs applied by producers to keep track of those who do better both economically and ecologically.	
Besides existing economic instruments, other instruments, for example, better communication, improved dissemination, voluntary standards and norms are either missing or insufficiently developed – How	Digital technologies and solutions have great potential for different organisations and companies to sell products and services related to organic agriculture and agroecology.	

Moldovan citizens can move towards healthy and sustainable diets and influence their own food choices (more healthy fresh fruit and veg for example) is also a big challenge/opportunity		
Improved access and awareness of healthy, sustainable and affordable diets that reduce food-based greenhouse gas emissions and improve human and animal health		

5.2.3 Status of digitalization in “Farm to Fork”

The status of digitalization in Moldova's "Farm to Fork", particularly in agriculture, is still in its early stages but is gradually progressing. Moldova has initiated some steps towards digital transformation within its agricultural sector through government-led initiatives such as the National Strategy for Agricultural and Rural Development for 2023-2030. The general objectives of the Strategy 2023-2030 include, for each component, measures related to the cross-cutting objective of the EU's Common Agricultural Policy aimed at modernizing the agricultural sector by stimulating and sharing knowledge, promoting innovation and digitalization, adapting to climate change, and the sustainable development of rural areas (GD no.56, 2023).

Several digital platforms have been developed by agencies under the Ministry of Agriculture to enhance the digitalization of the agricultural sector, which supports the implementation of the Farm to Fork strategy. These include the **Laboratory Information Management System**, which streamlines the processing and management of laboratory data for agricultural products. The **Management of Sanitary and Veterinary Measures platform** helps track and manage health and safety protocols across the agricultural industry. Additionally, the **Registry of Animals** maintains essential data on livestock. The **National Wine & Vine Registry** plays a critical role in the documentation and quality control of the viticulture sector. Finally, the Moldova **LEADER Information System** supports rural development initiatives by providing comprehensive data management and resource planning tools. These systems collectively aim to modernize Moldova's agricultural sector, making it more efficient, sustainable, and aligned with EU standards.

There is also an innovative initiative “**Agrotek Arena**” developed by the Technical University of Moldova in partnership with the Agency for Agricultural Development and Modernization and the Future Technologies Project, funded by USAID, Sweden, and the United Kingdom. Currently, at Agrotek Arena, 13 companies **have implemented various irrigation, support, and monitoring systems tailored for diverse agricultural crops**, which are flourishing on the premises. Additionally, an **operational weather station on-site is equipped with various sensors**. These tools comprehensively monitor soil conditions, climate variables, humidity, and plant diseases. The facility also utilizes agricultural drones for several functions including spraying pesticides, surveying farmlands, identifying potential issues, and enhancing overall production efficiency. Furthermore, Agrotek Arena's laboratory boasts **integrated management systems that handle agricultural operations and data**, providing vital analytics and actionable advice to farmers (MERRM, 2024).

Currently, the **Government of Moldova aims to implement the Integrated Administration and Control System (IACS) to modernize agricultural administration and subsidy distribution**, aligning with EU regulations (EU 2116/2021). **The Farmers' Register**, the first component, will centralize farmer and

agricultural activity data, automate state aid applications, and ensure data interoperability through the National interoperability platform (MConnect). However, significant **financial investment is needed** to implement IACS fully, and Moldova's agricultural infrastructure requires substantial upgrades to meet modern standards and leverage digital systems effectively.

Securing enough funding and upgrading old infrastructure are crucial to greening Moldova's agricultural sector through digitalization. Creating long-term plans and updating regulations will help with the digital transition. Ensuring different digital systems work well together will improve data sharing and efficiency. Continuous technical support and maintenance are necessary to keep these systems running smoothly.

Training programs are essential to help farmers learn how to use digital tools. Establishing ways to share knowledge will keep everyone updated with the latest technology. Moldova can boost agricultural productivity, sustainability, and economic resilience by addressing these challenges. Advanced digital tools will help use resources more efficiently, open new markets, and support sustainable farming practices, leading to a greener and more prosperous agricultural sector that meets international standards and promotes sustainable development.

5.3 Industry for clean and circular economy

5.3.1 Sector definition, role of digitalization

This thematic area covers two main subareas:

- Manufacturing industry (and main subsectors)
- Circular economy/waste management sector

The focus is on the EGD policies that drive industrial sectors to lower their carbon footprint:

- Industrial decarbonisation (evaluating efforts to decarbonize industrial processes through carbon capture and storage, carbon capture and utilization, and other innovative technologies for emissions reduction)
- Reducing greenhouse gas emissions from energy-intensive industries (e.g. chemicals, steel, paper, plastics, mining, extraction and quarrying, refineries, cement, wood, rubber, non-ferrous metals, glass and ceramics industries)
- Improving energy efficiency in the industry (implementing energy-saving technologies, optimizing production processes, and promoting energy management systems) and promoting the transition to renewable energy sources.

In addition, the assessment investigates the transition from a traditional, linear economic model toward a circular economy that creates less pollution and makes

industry processes more efficient and cost-effective. The focus is on assessing the industry's circular economy and resource efficiency developments and the waste management system on a broader scale (including other waste streams – municipal waste, construction waste, etc) in the respective country.

The long-term visions related to European industries are set in the EU's Industrial Strategy (European Commission, 2020b). Regarding the twin transition of digital and green transformations, the European Commission has proposed the following interventions:

- Sector- and country-specific transition pathways to identify the actions needed to achieve the twin transitions, giving a better understanding of the scale, benefits and conditions required;
- Investments to advance and build capacities;
- Cross-country collaborations, projects and partnerships;
- Analysis of the European steel sector to ensure a clean and competitive steel industry;
- Abundant, accessible, affordable decarbonised energy through accelerated investments into renewables and grids, and address barriers.
- In industries' digitalization, the following have been identified as critical areas of reform and investments (European Commission, 2021) :
- Connectivity, with the aim of reaching the goals of the Gigabit Society Strategy (Towards a Gigabit Society);
- Development and deployment of advanced digital technologies, such as AI, blockchain, cloud, edge infrastructure and services, HPC, and quantum;
- Human capital, focusing on digital skills at all levels, to boost social inclusion, help workers meet the needs of a labour market in transition and increase the pool of digital specialists;
- Digitalization of businesses, by accelerating the sustainable take-up of digital solutions and a cyber-resilient digital transformation across all sectors;
- E-government aims to modernise public administration, increase its efficiency and infrastructure security and resilience, and stimulate online interaction between administrations, citizens, and businesses.

5.3.2 Main industry and circular economy-related challenges in target countries

Table 5 Main industry and circular economy-related challenges

Moldova		
Please list one to three main gaps related to the industry green transition and circular economy in the country.	How can digitalization help overcome this gap?	Is a European regulation or other framework applicable in the country that should be followed (e.g. harmonised data structure)?
Industry decarbonization and green transition		
No digital solution for industry decarbonization due to a lack of a legal framework for industry decarbonization	Digital solutions for optimizing industrial production processes at all stages of production are expected to improve energy and resource efficiency. The digitalization of the industrial sectors may solve the problems associated with migration and the lack of workers.	There is a draft Climate Law that partially transposes EU regulation (ETs, MRW, etc)
Poor digital skills and knowledge of enterprises as well as a lack of readiness of industry enterprises (especially SMEs) for implementing digital technologies	Further analysis is needed to understand the barriers faced by enterprises (SMEs) and design targeted initiatives to enable their digitalization. Development and adoption of digital tools by industries (support and advisory system)	
Circular economy and waste management		
Poor infrastructure for waste management, lack of technologies and solutions for waste management, lack of innovative circular business models and services	Creation of an electronic platform/ marketplace/ e-trading of industrial waste, by-products, secondary raw materials or used materials that would link the waste generators and the potential waste managers or other enterprises that can use waste as secondary materials.	General conditions are included at the end of the waste statute. By-products are established in the Waste Law.

Administrative pressure on enforcement authorities	Digitalize all the forms that need to be filled in and submitted to the Environment Agency (for instance, the waste transport form)	Regulation on waste shipment is enforced.
No or little artificial vision or artificial intelligence, often supported by robotic classifiers, can generate information about the selected materials.	These technologies are rapidly spreading across Europe to speed up waste sorting and improve the accuracy with which waste is selected for further treatment and recovery. These technologies aim to make the second phase of the waste management process (sorting) automated, easier, faster and safer, for example, by reducing human exposure to potentially hazardous waste streams and working with waste from all sectors, from food to pharmaceuticals.	

5.3.3 Status of digitalization in industry, application of circular economy

Moldova's transition to a circular economy requires a comprehensive and interdisciplinary approach, leveraging sector digitalization and technological advancements, consumer participation, industrial symbiosis, and policy measures to drive sustainable change.

The obstacles in applying sustainable industrial practices in Moldova include a lack of awareness and understanding of the benefits of sustainable practices, a lack of financial resources, and challenges in sector digitalization. The Government of Moldova is working to address these obstacles by providing training and support to companies and organizations, by developing financing mechanisms for sustainable practices, and by promoting the use of renewable energy sources.

In terms of digitalization, Moldova is committed to digitalize its economy and industries. The Digital Transformation Strategy for 2023-2030 (GD nr. 650, 2023), sets a vision for Moldova's digital development and citizen-centric society, aligning with the European integration agenda. The strategy aims to fully digitalize public services, including digitalization of the Economy, Energy and Climate, Agriculture sectors, focusing on improving digital access for entrepreneurs and citizens. Currently, the e-governance infrastructure built by the government is available to be used and speed up sectoral digitalization.

In applying digitalization to industry and the circular economy, Moldova is still in the early stages of development. Moldova transposed Regulation (EC) No 166/2006 of the European Parliament and the Council of 18 January 2006 concerning establishing a European Pollutant Release and Transfer Register. In this sense, **an online platform for reporting emissions was developed** – https://retp.gov.md. Through this platform, operators that undertake one or more of the activities specified in Annex 1 (similar to Annex 1 of Regulation 166/2006) shall report annually to the competent institutions the following data:

- releases to air, water or land of any pollutant specified in Annex 2 (similar to Annex 1 of Regulation 166/2006)
- off-site transfers of hazardous or non-hazardous waste for any operations of recovery or disposal, with some exceptions. For transboundary transfers of hazardous waste, the name and address of the recycler or the disposer of the waste and the respective recovery or disposal site shall be indicated
- off-site transfers of any pollutant specified in Annex 2 in wastewater destined for wastewater treatment.

Unlike the E-PRTR, the national PRTR has no thresholds for the economic operators, and all are subject to reporting. The system will also be used to hone the obligations regarding reporting VOCs in accordance with the relevant legislation.

Moldova is working towards improving its circular economy and waste management practices, which also require digitalization through online platforms, information management systems, and databases. The waste management information system is partly in place. Public services, such as **permit systems** for waste management, have also been digitized. There is still a need to build interaction between waste generators and companies working in waste disposal and recycling, as well as other industrial entities.

The main information system for waste management data is the **Waste Management Information System** (GD no. 501, 2018). The system represents an online platform for reporting waste generation and waste management data by the waste generators and waste management operators (authorized for collection, recovery and disposal of waste and the Extended Producer Responsibility organizations). The system has been developed and maintained so far with the support of technical assistance projects. Due to limited human and financial resources, the Ministry of Environment faces challenges in maintaining this platform.

The roadmap for the digitalization of Moldova's economy, updated for 2023, includes objectives like developing remote interaction with authorities, enhancing e-commerce infrastructure, and facilitating fiscal and customs procedures to promote the digital economy, e-commerce, and e-exports.

Key gaps

Key gaps in introducing digitalization in the industry are the following:

- Insufficient legal framework that supports the digitalization in the area of industrial decarbonisation.
- Insufficient application of digital technologies by industries (readiness is low).
- Lack of awareness and skills about the digitalization of industry processes, especially among SMEs.
- Lack of support and financing.

Key gaps in introducing digitalization in the waste management sector:

- The national-level waste management reporting, information management systems, and databases/registers still need further digitalization and development. Authorities that are supposed to develop the data/information systems lack the capacity (including financing) to develop and maintain the system.

The waste management sector is still very conventional (and underfinanced); therefore, few attempts have been made to introduce innovative digital solutions/services.

Needs

Industry Digitalization

Enhance Legal Framework: Develop and strengthen regulations that support digitalization specifically in the area of industrial decarbonization. This could include incentives for adopting digital technologies and penalties for non-compliance.

Capacity Building Programs: Implement training programs focused on digital skills for SMEs. Partnerships with technology providers and educational institutions could facilitate workshops, webinars, and courses that explain digital technologies and illustrate their benefits and applications in industrial processes.

Funding and Support Mechanisms: Establish dedicated funds or subsidies to support SMEs adopting digital technologies. This could be paired with a mentorship program that connects industry leaders with smaller businesses to foster digital adoption.

Waste Management Digitalization

Investment in Technology: Secure funding, possibly through public-private partnerships, to develop and upgrade digital infrastructures like national-level waste management reporting systems and databases. Ensuring these systems are user-friendly and comprehensive can enhance their utility and adoption.

Promote Innovation through Incentives: Introduce incentives for waste management companies to invest in digital solutions. These could include tax breaks, grants, or innovation competitions to develop digital tools to improve waste management efficiency.

Capacity Building for Authorities: Develop specific training programs for personnel in relevant authorities to build their capacity in managing and maintaining digital systems. This could be supported by international cooperation with countries with advanced digital waste management practices.

5.4 Climate

5.4.1 Sector definition, role of digitalization

In Moldova, the Climate sector broadly encompasses activities and policies related to mitigating and adapting to the impacts of Climate Change. This includes sustainable agriculture practices, renewable energy adoption, efficient water management, and biodiversity conservation, all of which aim to reduce greenhouse gas emissions and adapt to climate change.

In Moldova, the objectives and priorities of the EGD are integrated into the strategic planning documents, such as the National Program for Adaptation to Climate Change until 2030. (GD no.624, 2023).

The EU4Climate project, funded by the EU and implemented by UNDP, has developed a national program for low greenhouse gas emissions development in Moldova. Moldova strongly supports the EU's goal of achieving climate neutrality by 2050 and is determined to take all possible measures to transform its economy in this direction. To honour its commitments under the Paris Agreement on climate change, Moldova has set, with EU support, new targets for reducing Carbon Dioxide emissions: it has committed to unconditionally reducing greenhouse gas emissions by 70% compared to 1990 levels by 2030, or by 88% if it receives technical and financial assistance (EU4Climate, 2021).

In the context of Moldova, digitalization plays a crucial role in transforming the climate sector. Digitalization in the climate sector in Moldova involves improving data collection and analysis, which aids in accurate forecasting, risk assessment related to climate impacts, and the planning of resilient infrastructure. Overall, integrating digital technologies in the climate sector is vital for enhancing Moldova's sustainability and its response to climate change.

According to the Action Plan for implementing the National Program for Adaptation to Climate Change until 2030, Moldova is focused on enhancing the accessibility and usability of climate-related data. The plan outlines specific measures to digitize existing climate and meteorological data held by the State Hydrometeorological Service and other data owners. This initiative aims to facilitate better data sharing and improve the decision-making process regarding climate action strategies. By making these data readily available and easily accessible, Moldova intends to support informed policy development, scientific research, and public awareness of climate change impacts and adaptations. (GD no.624, 2023). According to the action plan (action 2.3.2), the data are expected to be digitized from 2023 to 2026. The responsible institutions are the Ministry of Environment and the State Hydrometeorological Service. The costs are covered by the national budget and external funding (SIDA - Swedish International Development Cooperation Agency).

5.4.2 Main climate-related challenges

Table 6. Climate related challenges

Moldova		
Please list one to three main gaps in the country related to climate action.	How can digitalization help overcome this gap?	Is there an applicable European regulation or another framework that should be

		followed in the country?
Inefficient Monitoring, Reporting, and Verification (MRV) Systems. Moldova's systems for checking and reporting on climate action are not well-developed. These systems mainly depend on reports from donors, which causes problems with data management and makes it harder to see the progress in climate action.	Implement a centralized digital MRV system that standardizes data collection, processing, and reporting across all sectors. This platform should support real-time data analytics to provide up-to-date insights into climate action progress.	Regulation (EU) No 601/2012
Limited access to Open Data on climate change. Moldova's current climate action framework lacks open access to climate-related data, which impedes public engagement and informed decision-making in climate action efforts. Currently, climate-related data is compiled into various thematic reports with donor support. However, this data is often not machine-readable. Additionally, even when available in digital formats, it is not accessible to the public.	Opening access to climate-related data enables efficient access, facilitates advanced analytics, and supports informed decision-making processes, while also enhancing engagement with global initiatives to improve Moldova's data management and align with international best practices.	European legislation on open data
Limited Financial and Institutional Capacity for Implementing Climate Actions. Climate projects mainly depend on the public budget and public institutions, which have limited capacity and limited involvement from the private sector.	Strengthen institutional capacity through digital governance solutions, ensuring effective operation and coordination within the National Commission on Climate Change.	

5.4.3 Status of digitalization in tackling climate change

The Association Agreement between the European Community and Moldova commits Moldova to comprehensive economic, judicial, and financial reforms to align with EU policies and legislation. The agreement includes a dedicated chapter on climate change, addressing mitigation, adaptation, carbon emissions trading, research and development, integrating climate aspects into sectoral policies, and enhancing climate awareness through education and training. It also introduces a Program of Action for European Integration, emphasizing adaptation to climate change and policy alignment with EU standards.

The EU's Multiannual Indicative Programme (MIP) for Moldova (2021-2027) aims to support sustainable development and resilience in Moldova. It focuses on building a resilient economy, promoting the rule of law, enhancing climate resilience, supporting digital transformation, and fostering inclusive societies. The MIP aligns with global initiatives such as the Paris Agreement and the UN 2030 Agenda for Sustainable Development, particularly emphasizing climate action across various sectors.

In 2023, the Moldovan Government approved the National Action Plan for EU accession covering 2024-2027. (GD no. 829, 2023). This plan outlines specific measures for EU integration, detailing responsibilities, timelines, and funding sources across 33 chapters, including a dedicated chapter on Environment and Climate Change, which aims to implement actions in line with EU Acquis environmental standards.

Overall, Moldova's digital technology landscape on climate change may be nascent compared to some other countries. There are opportunities for the private sector to leverage technologies such as IoT, blockchain, cloud solutions, and biodegradable input 3D printing to support sustainability and resilience efforts in sectors like agriculture, manufacturing, and environmental monitoring. These initiatives can contribute to Moldova's broader goals of addressing climate change impacts and promoting sustainable development.

In particular, an innovative initiative "**Agrotek Arena**" developed by the Technical University of Moldova in partnership with the Agency for Agricultural Development and Modernization and the Future Technologies Project, funded by USAID, Sweden, and the United Kingdom. Currently, at Agrotek Arena, 13 companies have implemented **various irrigation, support, and monitoring systems tailored for diverse agricultural crops**, which are flourishing on the premises. Additionally, an **operational weather station on-site is equipped with various sensors. These tools comprehensively monitor** soil conditions, climate variables, humidity levels, and plant diseases. The facility also utilizes agricultural drones for several functions including spraying pesticides, surveying farmlands, identifying potential issues, and enhancing overall production efficiency. Furthermore, Agrotek Arena's laboratory boasts integrated management systems that handle agricultural operations and data, providing farmers with vital analytics and actionable advice (MERRM, 2024).

Moldova's e-Transformation Strategy 2030 focuses on advancing digitalization and leveraging ICT to drive economic growth, improve governance, create smart cities, and enhance public services. Smart cities constitute a pivotal pillar of the strategy's vision for the future. By **prioritizing smart cities as a core pillar of its e-Transformation Strategy 2030**, Moldova demonstrates its commitment to embracing innovation, sustainability, and inclusive growth.

The Moldova Sustainable Green Cities project, initiated by UNDP Moldova for the period 2018-2022, is a good example of a collaborative effort involving the Ministry of Environment, the Ministry of Infrastructure and Regional Development, the Municipality of Chisinau, the Energy Efficiency Agency, the Technical University of Moldova, and the E-Government Agency. Chisinau City Hall is the primary beneficiary of this initiative, primarily targeting Climate Change, Environment and Energy issues. The project aims to stimulate investments in low-carbon, environmentally friendly urban development through an integrated urban planning approach. This approach is

intended to foster innovation, participatory planning, and partnerships among diverse public and private sector stakeholders.

A key component of the project involves the establishment of the **Green City Lab** (GCL, 2021), which is envisioned to serve as a premier knowledge management and networking platform. The lab will function as a clearinghouse, facilitating the exchange of ideas and expertise while also serving as an intermediary for financing. Its ultimate goal is to drive sustainable, low-carbon urban development in Moldova, particularly in Chisinau and other urban centres. The envisioned outcome is the transformation of these cities into modern, green, and smart European cities, characterized by enhanced quality of life for their residents and showcasing opportunities for sustainable economic growth.

Moldova has initiated important steps towards digitalizing its climate action efforts, targeting to reduce greenhouse gas emissions and commit to climate neutrality by 2050. Digitalization is crucial in enhancing data collection, analysis, and implementation of resilient infrastructure. However, so far, most data sources in this sector are available in the national communications reports to various international conventions, making it difficult to analyse these data deeply. Also, **challenges remain, such as inefficient Monitoring, Reporting, and Verification (MRV) systems, limited access to open climate data, and insufficient financial and institutional capacity.** Moldova needs to implement a centralized digital MRV system, develop open data platforms, strengthen institutional capacities, and foster public-private partnerships to leverage digital technologies fully. Addressing these gaps will be essential for Moldova to achieve its climate goals and enhance sustainability efforts.

5.5 Energy

The objective of the energy thematic area is to understand the current internal energy market of the countries, and this section is dedicated to assessing digital energy solutions and their development in the countries to align the energy market with the EGD. The energy objectives in the EU are decisive: producing cleaner energy thanks to technological research and innovation, and investing in renovated, energy-efficient buildings are set as priorities.

In terms of carbon intensity, the energy sector is responsible for approximately 72% of all Moldova's greenhouse gas emissions (10.46 Mt CO_2 eq out of 14.68 Mt CO_2 eq in 2021) (UNFCCC, 2010) Moldova's Government understands the importance of the energy sector and, in 2023, created the new Ministry of Energy. The government aims to reach climate neutrality by 2050 as stated in Law no. 74/2024 on climate action and with that a shift to lower carbon energy is also foreseen (electrification, increase in renewable energy generation) (UNECE, 2024).

The local energy resource is biomass (mainly wood), which is used in rural areas for heating. Power generation facilities on the right bank can only cover up to 20% of the needed electricity (in Chisinau (258 MW and 68 MW) and in Bălţi (24 MW and 13.4 MW). Another 80% are imported: approximately 67% from the Transnistria region (Moldova thermal power plant (MGRES) or Cuciurgan), and the rest from the free market, mainly from Romania. In March 2022, Moldova's power system was connected to ENTSO-E, which allows for diversifying energy sources (ENTSOE, 2022). To reduce electricity imports, Moldova is planning to increase renewable electricity production significantly (over 400MW capacities, GD no. 401/2021), which means the electricity system needs to adapt to integrate these capacities. There, digital means (collecting and using data) for planning and integrating renewables are helpful.

5.5.1 Sector definition, role of digitalization

Generally, the energy sector covers areas such as energy sources and production (electricity, gas, heating, fuels, energy storage); energy security (mix of sources, independent production, security of supply, cybersecurity of grid management); renewable energy (wind, solar, hydro, biomass, geo-thermal, tidal); and energy efficiency. The effectiveness and efficiency of electricity distribution have been the main area regarding the digitalization of the energy sector. Some of the most common digital energy solutions are:

- devices and networks that monitor and control the flow of electricity, gas, and heat, enabling better demand response, grid stability, and integration of renewables.
- Software and hardware solutions that help consumers and businesses optimize their energy consumption, production, and storage, reducing costs and emissions
- platforms that aggregate and coordinate distributed energy resources, such as solar panels, batteries, electric vehicles, etc., providing flexibility and ancillary services to the grid
- technologies that enable secure and transparent transactions of energy and data, facilitating decentralized and participatory energy markets

26. The two main documents in the EU emphasising digitalization of energy are the EGD and the EU’s Digital Strategy. The EU has been supporting the digitalization of the energy system through various policies, initiatives, and projects. For example, the EU has:

- Launched an action plan for digitalising the energy system in 2022, which aims to promote connectivity and interoperability, foster coordinated investments in smart grid technologies, empower customers, enhance cybersecurity, and design effective governance (EC, 2023).
- Other actions include establishing a Smart Energy Expert Group, which brings together experts from the energy and digital sectors to advise on implementing the

action plan, and funding energy digitalization projects under the Horizon 2020 programme (IEA, 2023).

5.5.2 Main energy-related challenges

Table 7. Energy-related challenges

Moldova		
Please list one to three main gaps related to the country's energy sector.	How can digitalization help overcome this gap?	Is a European regulation or other framework applicable in the country that should be followed (e.g. harmonised data structure)?
Increasing the use of renewable energy will put more demands on the energy grid and the energy system in general.	Demand response systems, smart meter deployment, and better tools for planning grid development based on the needs of renewable energy deployment.	EU action plan on Digitalising the energy system
Low reliability of emission-related data	Support in getting better quality data on energy sector emissions	
Limited experts to support the green transition in the energy sector	Online educational tools to support the increase of green skills.	

5.5.3 Status of digitalization in the energy sector

Moldova has aligned with the Energy Community's regulations and has received recommendations on digitalization as part of its National Energy and Climate Plan (NECP). This includes integrating digital technologies into the energy market to support the operation of renewable energy sources, promote energy efficiency, and ensure a secure energy supply. To increase energy efficiency, several support schemes are in place, increasing renewables in the energy mix are planned (i.e. in the electricity sector to reach 84,5% by 2050), and regarding energy security, Moldova has started the construction of overhead lines from Moldova to Romania. Increasing renewables and connections (which is happening) also helps with energy independence and security, so integrating renewables is vital, and digitalization helps.

Moldova is revising its **Energy Strategy 2030 and developing the Energy Strategy 2050. The strategies emphasize integrating digital solutions within the energy sector, including developing smart grids and implementing digital monitoring systems** for energy consumption and production.

The Government of Moldova launched 2023 **a pilot program to install smart meters for electricity** (ME, 2023). The pilot program is part of the national plan for digitising the energy sector. It is carried out with the support of the United Nations Development Program in Moldova and other development partners. A first batch of smart meters is

currently being installed for consumers in several localities as part of a pilot programme carried out by the Ministry of Energy with the support of UNDP Moldova. **The programme will be extended later**, thanks to the financial support of the Italian government, which is provided through UNDP. Smart meters will measure consumption at short intervals and transmit the data automatically, securely, and without errors to the energy distributor, without the need for employees of the supply companies to physically read the meters. At the same time, the supplier will bill the actual energy consumption, not an estimated one, and will be able to identify accidents more quickly and reduce the intervention time (UNDP, 2024).

Moldova is working on developing smart grids, primarily to support the increased integration of renewable energy sources. This includes adopting technologies for better energy flow management on the grid, reducing losses, and enhancing the reliability of the energy supply. There is an emphasis on using advanced data analytics and modelling to optimize energy flows within the grid. This includes building detailed models of energy assets based on big data sets and sensors to predict and manage performance under various conditions. **There is a pilot project where consumption data will be collected automatically from consumers.**

With smart grids (currently in the pilot phase), customers will have more freedom in choosing the supply offer and can opt for flexible tariffs, as the smart meter allows for storing six types of tariffs. Thus, consumers will be able to use household appliances during the hours when energy is cheaper. Smart appliances can automatically "read" the meter tariffs and decide the most convenient time to switch on.

In conclusion, Moldova is enacting changes on the policy level that combine greening the sector with the help of digitalization; but also testing different digital solutions in practice. For example, the smart grid pilot, which will help to integrate renewables into the energy mix, is vital considering Moldova’s current energy dependence and emissions targets for 2050. Digital data solutions will also help to plan energy flows better, which is especially relevant during peak consumption hours. This could be complemented by demand-response systems where consumers’ awareness via these digital solutions will guide them to direct their energy consumption. Digital monitoring systems for energy consumption and production are included in policy documents regarding the energy sector (Energy Strategy 2030 and Energy Strategy developed for 2050). However, the first necessity is to fully deploy smart metering in the country, which is a development in progress.

5.6 Smart mobility

5.6.1 Sector definition, role of digitalization

As per the EU’s mobility strategy from 2021, all transport modes need to become more sustainable, with green alternatives widely available and the right incentives to drive

the transition (EC, 2021). EU efforts cover modes of transport such as road, rail, air and sea. Making transportation smart means reduced emissions, congestion and travel times and increased safety.

To make transport smart, the strategy states that innovation and digitalization will shape how passengers and freight move around in the future if the right conditions are implemented.

In the digitalization report, we will complement the work under the smart mobility theme and focus on enabling factors crucial in reaching smart mobility goals. For that purpose, there are other EU documents relating to smart mobility and the needed preconditions. In short, these initiatives have to do with:

- The European strategy for data, enabling secure data flows that protect personal data, facilitating data sharing and collaboration between different actors in the mobility sector;
- The digital transformation of the transport and mobility sector requires further efforts related to data availability, access and exchange;
- 5G for Europe action plan to ensure the highest level of performance of digital infrastructure, which enables a higher level of automation across different mobility applications;
- Interoperability of systems- Technical specifications for interoperability (TSIs) to encompass new technologies like 5G and satellite data, and provide a readily upgradeable and common system architecture;
- Furthermore, the key digital enablers should be in place, including electronic components for mobility, network infrastructure, cloud-to-edge resources, data technologies, governance, and Artificial Intelligence;
- The opportunities presented by connected, cooperative, and automated mobility (CCAM), which can provide mobility for all, give back valuable time and improve road safety, mean further harmonisation and coordination of relevant traffic rules and liability for automated vehicles. Data portability should protect the users and offer them a clear and transparent view of how the data can be used or transferred.

5.6.2 Main smart mobility-related challenges

Moldova has initiated various measures to enhance its smart mobility landscape, characterized by advancements in public transportation and efforts toward environmental sustainability. **The government’s focus on public transport modernization, electric vehicles (EVs), and sustainable urban mobility plans (SUMPs) reflects its alignment with the EGD. However, Moldova's progress is hindered by substantial barriers, including outdated policies, infrastructural deficits, financial constraints, and insufficient digital capabilities**. Growth

opportunities are evident in enhancing policy frameworks, adopting advanced technologies, and leveraging international support.

Moldova's smart mobility infrastructure prominently features an ageing public transport fleet dominated by trolleybuses and buses, alongside a growing number of electric and hybrid vehicles. By 2022, recent policy incentives doubled the registration of EVs, underscoring a shift towards low-emission transport options. Cities like Chisinau have begun adopting SUMPs, though national strategies for non-motorized transport are limited.

Despite these initiatives, several barriers impede further development. **The transport sector's reliance on outdated policies and fragmented strategy implementation across documents hampers comprehensive mobility planning. Financial limitations** are stark, with a significant portion of government funding earmarked for road maintenance, and a notable funding gap exists for necessary investments in infrastructure and technology. Furthermore, Moldova's digital infrastructure lags, with limited deployment of Intelligent Transport Systems (ITS) and inadequate data handling capabilities, affecting the efficiency and sustainability of mobility solutions.

Main challenges:

- Data availability to understand and model passenger and freight transport mobility needs.
- Lack of knowledge on how automatization and digitalization can be used to achieve sustainability goals, shortage of skilled workers to apply innovative solutions and low level of expertise in (public)institutions
- Possible low inclusiveness of new technologies, regarding elderly people or people with a low degree of digital knowledge

5.6.3 Status of smart mobility

Moldova is gradually introducing smart mobility solutions as part of its commitment to align with the EGD. The capital of Chisinau has modernized its public transport system with an extensive network of trolleybuses and buses, accounting for over 95% of public transport. **Some cities have implemented Intelligent Transport Systems (ITS) like GPS monitoring and e-ticketing to improve service efficiency and user experience. The deployment of electronic ticketing and GPS monitoring in Chisinau's trolleybuses and buses reflects the initial steps toward intelligent transportation.**

The adoption of electric and hybrid vehicles (EVs) has grown significantly in recent years. From just seven units in 2004, the number of electric and hybrid vehicles increased to 14,737 by 2019. Incentives such as import duty exemptions and the elimination of road taxes doubled EV registrations in 2022 compared to 2021. However,

despite this growth, electric vehicles only represent about 1.5% of Moldova's total vehicle fleet**.**

Several cities, such as Chisinau, Ungheni, and Cahul, have adopted sustainable urban mobility plans (SUMPs) to promote walking, cycling, and public transport use. These plans align with the EU's smart mobility goals and include the implementation of dedicated bicycle lanes and pedestrian zones. The work is ongoing.

The private sector has begun developing electric vehicle charging infrastructure, but the network remains insufficient to meet the growing demand. Moldova has also improved its rail network, aligning it with the Trans-European Transport Network (TEN-T) standards. However, **the rail network remains fully non-electrified, with limited passenger kilometres and low-speed services.**

Big data analytics are helping urban mobility planning by analysing travel patterns and predicting transport demand. They also assist in the predictive maintenance of transport infrastructure. **The National Bureau of Statistics has made progress in digitizing transport data collection, providing a foundation for further integration of big data analytics in mobility planning.** There are no initiatives or concrete steps yet towards using the transport data.

Cloud computing facilitates the scalable operation of transport applications and real-time data analysis. The GPS monitoring and electronic ticketing systems implemented in Chisinau rely on cloud computing for real-time data management. These applications enable efficient route management, fare collection, and passenger information dissemination.

5G technology is still in its early stages of deployment in Moldova. **The government has granted licenses for 5G networks, but infrastructure development is limited to Chisinau and other major cities.** Although 5G promises enhanced connectivity and continuous data flows crucial for real-time applications in smart mobility, achieving comprehensive 5G coverage and ensuring its benefits extend to rural regions remains a significant challenge.

Artificial Intelligence (AI) and big data have significant potential to transform traffic management and urban planning. By analysing traffic data, AI systems can optimize public transport routes and predict congestion patterns. However, the implementation of these technologies remains limited, and detailed action plans have yet to be established.

Data availability remains challenging in Moldova's transport sector, with gaps in collecting comprehensive transport data. The National Bureau of Statistics adheres to

rigorous standards but faces limitations in collecting and processing comprehensive data.

Regarding data security, the National Bureau of Statistics follows strict government reporting standards to ensure data integrity. However, national legislation does not fully align with EU General Data Protection Regulation (GDPR) standards. Privacy and data protection frameworks need strengthening, especially with the rise of digital technologies and smart mobility solutions. **A comprehensive legal framework aligning with the EU's GDPR is crucial to secure personal data and maintain public trust in smart mobility applications.**

5.7 Zero pollution

5.7.1 Sector definition, role of digitalization

The "Zero Pollution Action Plan", adopted by the commission in 2021, intends to achieve no pollution from "all sources", cleaning the air, water and soil by 2050. The Environment Quality standards must be fully met, ensuring all industrial activities are conducted in a toxic-free environment. Agricultural and urban industries' water management policies will be looked at to suit the "no harm" policy. Harmful resources such as micro-plastics and chemicals, such as pharmaceuticals, that threaten the environment aim to be substituted to reach this goal. The "Farm to Fork" strategy aids pollution reduction from excess nutrients and sustainable methods of production and transportation, complementing the achievement of zero pollution.

Under zero pollution are areas such as air quality and health, emission reduction, pollution prevention and control, water quality and conservation, soil protection, chemicals management, green technologies and innovation, environmental monitoring and reporting. EU regulations/ policies cover these areas. For example, most broadly theEGD advises revising measures to address pollution from large industrial installations, there's a chemicals strategy for sustainability aiming for toxic free environment, EU's Restrictions Roadmap aiming to restrict up to 12 000 harmful chemicals and other goals such as non-toxic material cycles, ensuring availability of information on chemical content and safe use, strengthening EU's resilience to supply disruptions to increase EU's strategic autonomy.

Regarding digitalization, zero pollution efforts can be in the areas of:

- Greening and digitalising the production of chemicals
- Data-driven decision making (for example, monitoring and measuring pollution; modelling and prediction)
- Enabling technological solutions (clean technologies for renewable energy, precision agriculture, and electric vehicles/ smart mobility)

- Improving efficiency and transparency (sharing data and information between different sectors, improving the efficiency of bureaucracy and therefore reducing pollution)

5.7.2 Main zero pollution-related digital challenges in target countries

Moldova is working to align its environmental policies with the EGD, particularly in chemical production. One of the key initiatives in this regard is the National Program for Sound Management of Chemicals (2023-2030). This program provides a framework for reducing the hazards of chemicals and improving safety. However, it must still fully align with the European Union's Chemicals Strategy for Sustainability. The Moldovan government is working on updating the program to include indicators from the EGD and to enforce the 2019 Law on Chemicals by developing secondary legislation like the Classification, Labelling and Packaging (CLP) regulation and REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals).

Another significant effort is the new Law on Industrial Emissions (2024), which aims to regulate pollution from industrial sources and aligns with the European Union's Industrial Emissions Directive. It requires companies to obtain integrated environmental permits based on the Best Available Techniques (BATs). However, the law's implementation still needs secondary legislation and guidance on granting and enforcing permits.

The PRTR, which started in 2018, is a positive development in monitoring chemical pollution. This system requires companies to report their emissions online, providing data that helps identify major polluters and trends in emissions. However, **the data are not comprehensive because not all companies report as required.** As a result, enforcement is problematic.

Moldova has also ratified international conventions, such as the Stockholm, Basel, Rotterdam, and Minamata Conventions, which show its commitment to reducing toxic chemicals and hazardous waste. Every year, Moldova fulfils its reporting obligations under these conventions.

The Small and Medium Enterprises Greening Program (ODA, 2023), implemented by the Entrepreneurship Development Organization, supports businesses in adopting greener practices. The idea is to move from the traditional consumer model to a model where enterprises integrate green economy measures (such as resource efficiency, circular economy, etc.) in various sectors. It provides technical support and financial incentives, primarily targeting small and medium-sized enterprises.

Moreover, **Moldova's National Environmental Fund** allocates resources for environmental protection. However, much of its **focus has been on water supply and sanitation rather than chemical management**.

5.7.3 Status of zero pollution digitalization efforts

Regarding digitalization, the **Ministry of Environment has an online PRTR that enables companies to report their emissions data digitally.** However, some reporting also happens on paper. Also, there is an **online platform for reporting data on the waste generation and waste management** by the waste generators and waste management operators (authorized for collection, recovery and disposal of waste and the Extended Producer Responsibility organizations).

Permit systems for air emissions, water use, and waste management have also been digitized, streamlining the process and improving data collection. Despite these efforts, **the Ministry of Environment struggles to maintain these systems without external financial support, which leads to a** lack of technical support.

Aligning Moldova's chemical management policies with the EGD is a priority. However, **gaps remain, particularly the lack of secondary legislation for the Law on Chemicals and the Law on Industrial Emissions. The National Program for Sound Management of Chemicals requires further alignment with EU standards.**

Moldova's draft National Environmental Strategy (2023-2030) emphasizes the importance of data collection and evaluation to guide policy implementation. It includes a methodology for identifying nutrient-sensitive areas and measures to prevent nitrate pollution.

Moldova is gradually improving its use of data for decision-making to reduce pollution and emissions, although the system still requires significant development. The **PRTR collects data on air, water, and soil pollution from companies. However, the information is not comprehensive due to incomplete reporting.** Despite this limitation, the PRTR provides a valuable framework for identifying major polluters and trends in emissions.

The National Bureau of Statistics (NBS) collects emissions data from stationary sources and publishes annual reports. For example, in 2019, it was found that 68.54% of air emissions originated from the energy sector, while 13.61% came from industry. Such data guides policy decisions like the Low Emissions Development Program, which aims for a 27% reduction in greenhouse gas emissions by 2030. Implementing a system to collect emissions data from stationary sources could improve the decision-making process in this sector.

The upcoming Integrated Environmental Permit (IEP) system, part of the Law on Industrial Emissions (Law no. 227, 2022), will require companies to report emissions data based on Best Available Techniques (BATs). The digital form of the system is not entirely in place yet. However, the data will be crucial for decision-making around industrial pollution.

The Ministry of Environment monitors water quality through river basin management plans. **Industrial wastewater from companies that lack treatment facilities is a significant concern.** The National Water Cadastre provides data to identify areas vulnerable to pollution.

Using digital solutions, Moldova has tried to streamline bureaucracy and improve data sharing in the environmental sector. For instance, waste management data collected by the National Bureau of Statistics is shared with the Ministry of Environment to identify pollution hotspots. The Environmental Agency collaborates with the Ministry of Agriculture to share water quality data to develop river basin management plans and protect water resources. Moreover, the National Bureau of Statistics and the Ministry of Environment work together to collect emissions data from stationary sources.

However, the Ministry of Environment lacks the financial and technical capacity to maintain the digital systems without external support. Not all companies report their data to the PRTR system, resulting in incomplete data. Better integration of environmental databases across sectors is also needed to improve data sharing.

Despite these challenges, Moldova is moving in the right direction by **making its environmental bureaucracy more efficient and promoting cross-sector data sharing** through digital platforms like the PRTR and digitized permit systems.

5.8 Buildings

5.8.1 Sector definition, role of digitalization

The EU prioritises the building sector as a key sector that supports reaching Europe's green transition goals. Being one of the largest energy consumers within a country, the key objective of the *Building & Renovation* thematic area for GUMA countries is to identify the pathways to promote energy saving in the sector and reach nearly zero energy demand of buildings. In its visions and regulations, the European Commission stresses the visionary role of the public sector in setting strategic energy-saving goals as well as gathering and sharing data on public sector buildings' energy use (Directive (EU) 2023/1791, 2023). At the same time, private sector buildings (especially residential multi-apartment buildings and individual housing) play a crucial role in achieving energy-saving goals. On the European level, the key strategic goals are set in the Renovation Wave Strategy (EC, 2020) that aims to double annual energy renovation rates in the next 10 years, as well as to reduce emissions from the sector significantly. The legislative framework to boost the energy performance of buildings is established in the Energy Performance of Buildings Directive (Directive 2010/31/EU, 2010) and the Energy Efficiency Directive (Directive (EU) 2023/1791, 2023).

Digitalization measures have to ensure data availability to understand the status of energy consumption and buildings´ efficiency, including instruments such as the digital

building logbook, and public sector buildings' energy consumption databases. Much significance is given to the application of "smart buildings" and other digital solutions to better understand, manage and minimise buildings´ energy consumption.

5.8.2 Main buildings related digital challenges

Moldova's main building-related digital challenges are rooted in its building stock's ageing and inefficient nature**, the need for substantial investments to improve energy efficiency, and the integration of modern energy solutions**. Approximately 75% of Moldova's buildings were constructed before 1990 and lack modern energy performance standards. This situation contributes to Moldova's high energy consumption in the buildings sector, which accounted for 54% of the country's total final energy consumption in 2022. The outdated infrastructure significantly hampers efforts to reduce energy use and greenhouse gas emissions. Despite the potential for improvements, financial constraints pose a significant barrier. It is estimated that 11 to 22 billion EUR are required to upgrade the building stock to achieve desired energy efficiency levels. Furthermore, legislative and policy gaps, such as a lack of **a comprehensive long-term renovation strategy and specific action plans**, further complicate the transition to energy-efficient and nearly zero-energy buildings.

Keeping in mind the previously mentioned digitalization measures such as:

- Data availability to understand the energy consumption of buildings and energy efficiency
- Digital building logbook
- Public sector buildings' energy consumption databases
- Smart buildings and other digital solutions to manage & minimise energy consumption of buildings; and to enable generated energy on building level (principle of nZEBs) into the grid as "prosumers"

5.8.3 Status of building-related digitalization efforts

Moldova's approach to addressing its building-related challenges involves a combination of regulatory frameworks, financial incentives, and strategic partnerships to modernise its building stock, reduce energy consumption, and promote sustainable development.

Moldova has adopted several initiatives and policy goals to enhance buildings' energy efficiency and transition towards a greener economy. The government has embraced the objectives of the EGD, setting ambitious targets to **reduce greenhouse gas emissions from buildings by 74% by 2030 relative to 1990 levels. It aims for a 27% share of renewable energy in total energy production**. To support these targets, Moldova has introduced laws transposing EU directives on energy efficiency and energy performance of buildings. These laws include measures such as the **Energy Efficiency Obligation Scheme, which aims to renovate a significant portion of residential and**

public buildings annually. The legal framework for fair heating energy billing, introducing an energy management system for the public sector, and mobilising investments in 410 megawatts (MW) of renewable energy (biogas, photovoltaic, wind) are also on the agenda.

At the government level, the Ministry of Energy (a new ministry in the government) is the responsible body for the energy sector, including buildings. Additionally, the government has established the **National Centre for Sustainable Energy to oversee the energy efficiency initiatives and manage the national information system in the field of energy efficiency.**

Moreover, **financial mechanisms have been put in place** to facilitate the renovation of buildings, including grants and concessional loans funded by international financial institutions and donor agencies. These financial aids are intended to cover a substantial portion of the renovation costs, thereby accelerating the building sector's adoption of energy-efficient technologies and practices.

For instance, **the Fund for Energy Efficiency in the Residential Sector of Moldova (FEERM) is a financing program** approved in April 2024 by the Moldovan Government. The program aims to mobilize approximately 1.4 billion MDL from 2024 to 2027 with internal and external funds. The National Centre for Sustainable Energy will oversee FEERM. The primary beneficiaries of FEERM's energy renovation projects for housing stock will be Condominium Owners' Associations. At least 50% of the renovated heated surfaces will be allocated to vulnerable households, including those in energy poverty. FEERM will cover up to **70% of the investment required for thermal renovation of buildings through grants, with tenants contributing the remaining 30%**.

In the context of setting up and operating FEERM, the National Centre for Sustainable Energy, with the support of donors, aims to streamline the application process for energy efficiency measures in buildings by digitising it. Building-related digitalization efforts in Moldova primarily focus on enhancing energy efficiency and integrating renewable energy sources through regulatory frameworks and technological adoption. To summarize, the following digital platforms are available, or initiatives are underway regarding the building-related sector:

- **Energy Vulnerability Information System (EVIS):** EVIS was created and launched to manage and monitor measures funded by the Energy Vulnerability Reduction Fund. The system encompasses two modules, “Energy Vulnerability” and “Ecovoucher”. **The "Energy Vulnerability" module is a resource for managing the compensation system for vulnerable energy users affected by rising regulated prices for natural gas, electricity, and/or thermal energy tariffs**. It assigns consumers to energy vulnerability categories using predefined criteria. The system is not fully automated. Consumers must apply, and the system evaluates

and determines their vulnerability level. The government then pays the compensation to the utility providers, resulting in a reduced invoice for consumers based on their vulnerability level. For those who do not apply, the system will automatically assign the lowest level of vulnerability, and no compensation will be provided. The **"Ecovoucher" module is a resource for administering financial aid programs to promote efficient energy consumption among vulnerable consumers.** The vulnerable population is enrolled voluntarily by using appropriate scoring methods. Overall, the system aims to prevent and address energy vulnerability within the population, improve energy accessibility for vulnerable consumers, and promote energy efficiency.

- **Energy Efficiency Calculator for Homes:** The National Center for Sustainable Energy developed an online calculator (CNED, 2024) that allows, in a simple and affordable way, to determine the options for improving energy consumption in a home. As the figure below shows, it helps the consumer choose where savings could be made via a questionnaire detailing aspects such as the size of the living space, types of floors, roofs, windows, heating source, etc. With its help, the benefits of energy efficiency measures can be identified, as well as the estimated costs for implementing these measures.

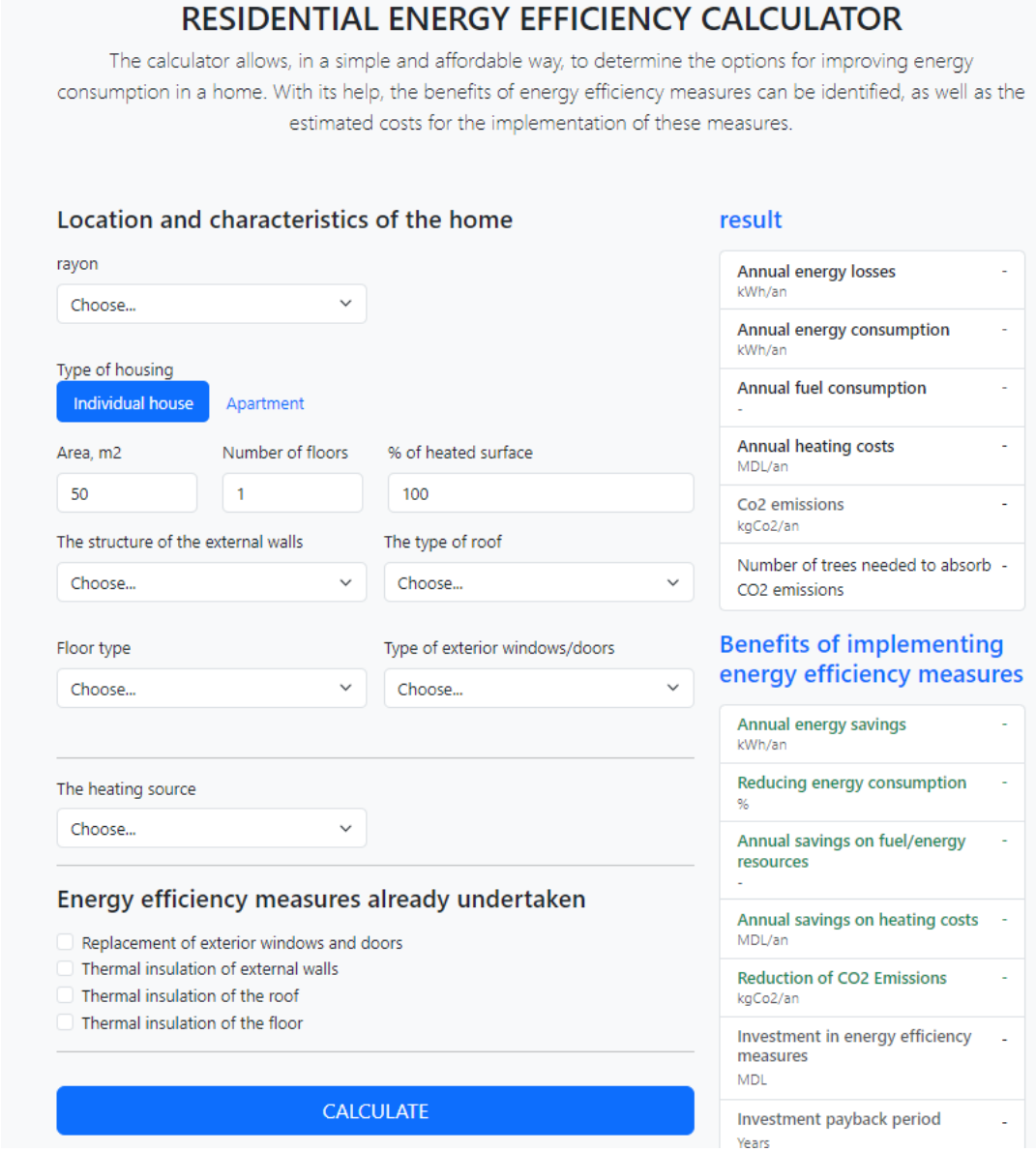

Figure 8. Residential energy efficiency calculator

1. **Energy Management Information System (EMIS):** An energy consumption monitoring system called EMIS is being tested in Chisinau, inspired by the Croatian model. It was developed with the assistance of UNDP Moldova under the Sustainable Green Cities Project (GreenCityLab, 2021). EMIS enables ongoing remote water, electricity, and thermal energy monitoring. **This intelligent system triggers alerts for excessive energy use and facilitates swift responses to breakdowns or instances of fraudulent consumption.** Initially, EMIS was implemented in a select few social institutions in Chisinau.

2. **National Information System in the field of Energy Efficiency:** The national information system in the field of energy efficiency is an integrated information system, which includes the following subsystems:
    a. The national information subsystem on building energy efficiency was created and managed according to the provisions of Law No. 128/2014 on building energy performance.
    b. The energy savings monitoring and verification information subsystem (SIMVE).
    c. The energy management information subsystem (SIME).
    d. The "Electronic Register of Energy Auditors" information subsystem.
    e. The "Electronic Energy Audit Register" informational subsystem.
3. **Energy Efficiency Fund Application Platform:** The National Centre for Sustainable Energy aims to create a digital platform to streamline the funding application process for energy efficiency measures in buildings.
4. **Energy Performance Certification:** Moldova has established a regulatory framework for the energy performance certification of buildings (Law no.282, 2023). This involves assessing and rating buildings' energy efficiency, which is a form of digitalization that requires data collection, analysis, and management to optimize energy use.

While Moldova has made good progress in greening its buildings sector through digitalization and regulatory measures, the following main gaps still impede its full potential.

- **Funding Constraints**: Significant financial barriers exist, with an estimated need of 11 to 22 billion EUR to upgrade the building stock to desired energy efficiency levels.
- **Ageing Building Stock**: Approximately 75% of Moldova's buildings were constructed before 1990 and lack modern energy performance standards, leading to high energy consumption.
- **Legislative and Policy Gaps**: There is a lack of a comprehensive long-term renovation strategy and specific action plans, complicating the transition to energy-efficient and nearly zero-energy buildings.
- **Integration of Modern Energy Solutions**: The need for substantial investments to integrate modern energy solutions and smart building technologies is critical for achieving energy efficiency goals.

In conclusion, Moldova has made progress in greening its buildings sector through digitalization, implementing platforms like the EVIS and EMIS to enhance energy efficiency and monitor consumption. Regulations and financial mechanisms support these initiatives and align with the EGD's objectives. Despite challenges like an ageing building stock and financial constraints, Moldova's approach, combining regulatory

measures, financial incentives, and digital solutions, positions it well to achieve its ambitious targets for reducing greenhouse gas emissions and increasing renewable energy use.

6 Assessment of other cross-cutting areas

6.1 Research and innovation

6.1.1 Background and scope of the area under scrutiny

Research and Development (R&D) refers to creative and systematic work undertaken to increase knowledge, including knowledge of humankind, culture and society, and to devise new applications, systems, services, processes or products of available knowledge.

Innovation refers to using new ideas and knowledge from research and practical experience to implement new technology, management processes, products or services to the market or society. An innovation is a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process).

Over the last decade, the EU´s R&I policy has been redesigned to ensure that public funding results in support, enables, and drives the green transition while ensuring that the EU remains competitive. The diffusion of R&I results across economic sectors and EU borders, and their transformation into innovative and marketable products and services is of key importance for realizing the EGD and developing an economy that works for people.

Eurostat (Eurostat, 2025) defines environmental goods and services as products manufactured or services rendered for the main purpose of:

- preventing or minimising pollution, degradation or depletion of natural resources.
- repairing air, water, waste, noise, biodiversity and landscape damage.
- reducing, eliminating, treating and managing pollution, degradation and natural resource depletion.

27. carrying out other activities such as measurement and monitoring, control, R&D, education, training, ICT related to environmental protection or resource management.

Digitalization plays a significant part in research, development and innovation, making it more just and equally available, as well as facilitating, speeding up and standardizing many processes, contributing to achieving the goal of climate neutrality. Leveraging digital tools and developing helpful technologies, including monitoring, can enhance inclusion and support innovation, moving towards green transition goals.

6.1.2 Mapping the role of digitalization in relation to R&D

Moldova's strategic documents, particularly **the Digital Transformation Strategy 2023-2030, reflect a strong commitment to integrating Research and Innovation (R&I) in the digitalization process**. There is a clear link between digitalization and R&I in the context of the green transition, with a focus on sustainable development, green technologies, and collaborative efforts to drive innovation. This holistic approach positions Moldova as a digital and green transformation leader, contributing to economic growth and environmental sustainability.

Moldova is making strides in integrating ICT skills into its workforce, which is essential for supporting both digital and green transitions. However, notable challenges include a significant skills mismatch and a need for more effective reskilling and adult training programs. Enhancing these initiatives, particularly in critical sectors like renewable energy and food processing, will be vital for Moldova's successful transition to a green and digital economy.

Several Moldova MA/PhD programs, research centres, and R&D projects work to support the green transition via digital skills. For example:

MA/PhD Programs:

Technical University of Moldova:

- MA Program in Renewable Energy: This program integrates digital skills and technologies to effectively develop and manage renewable energy systems.
- PhD Program in Sustainable Agriculture and Digital Farming: Combines agricultural practices with digital technologies, focusing on precision farming and digital monitoring of crops.

Moldova State University:

28. MA in Environmental Management: Aims to equip students with digital solutions for environmental management.

- PhD in Sustainable Development and Digital Innovations: Focuses on developing new digital tools and methodologies to support sustainable development goals.

Research Centres:

Moldova State University Research Centre for Digital Innovations in Sustainability: Conducts research on leveraging digital technologies to promote sustainability, exploring applications in energy efficiency, waste management, and smart agriculture.

National Centre for Sustainable Energy (CNED): Dedicated to advancing sustainable energy solutions, integrating digital technologies to optimize energy production and distribution.

Centre for Excellence in Construction: Specializes in energy efficiency and sustainable building practices, developing smart building technologies to monitor and reduce energy consumption.

R&D Projects:

SINERGIE Project: This project focuses on developing eco-innovative solutions for energy efficiency in buildings and integrating renewable energy into smart grids.

Renewable Energy and Biomass Project: Aims to increase the use of renewable energy sources such as biogas and small-scale solar projects in Moldova, including training and capacity-building components.

Moldova's digitalization sector has a solid foundation to support the green transition, thanks to robust growth in the ICT sector, supportive infrastructure like Moldova IT Park, and comprehensive educational initiatives. However, challenges such as low participation in vocational training, skills shortages in key sectors, and limited private sector innovation capacity must be addressed to leverage this potential fully. **Enhancing firms' absorptive capacity, improving practical relevance in training programs, and fostering stronger industry-academia collaboration** will ensure that Moldova's digitalization sector can effectively support the green transition.

The proportion of innovative enterprises (NBS, Glossary, 2023) among the total number of enterprises was 11.4% in 2021-2022, a slight decrease from 12.6% in 2019-2020. The manufacturing industry had the highest share of innovative enterprises, accounting for 46.2%. Despite some advancements, notable challenges include low participation in continuous vocational training and skills shortages in sectors like renewable energy. Basic training programs often lack practical relevance, highlighting the need for targeted and practical training initiatives.

Social innovation processes in Moldova are increasingly supported by digitalization, which enhances community engagement, facilitates data-driven decision-making, and democratizes access to information and resources. Community engagement in renewable energy projects, digital platforms for environmental monitoring, and educational programs integrating digital skills with sustainability education highlight the synergy between digitalization and social innovation. These initiatives are crucial for fostering a sustainable and inclusive green transition in Moldova.

Both the private and third sectors in Moldova are engaged in the green and digital transition, with the ICT sector leading in digital innovation and NGOs playing a crucial role in promoting sustainable practices. While the private sector shows promise, particularly in digitalization, it faces challenges that must be addressed to harness its innovation potential for green technologies fully. With its strong advocacy and community engagement capabilities, the third sector complements these efforts, driving social innovation and policy changes necessary for a sustainable transition. For example, NGOs like Eco-TIRAS (Eco-Tiras, 2024) and EcoContact (EcoContact, 2024) are leveraging digital innovations to enhance their environmental and sustainability efforts.

6.2 Social impact and just transition

6.2.1 Background and scope of the area under scrutiny

Just transition and social impact assessment constitute a cross-cutting thematic field in green transition. **Social sustainability means that the transition to a low-carbon economy should not come at the expense of social wellbeing**. It's crucial to ensure that communities have access to fulfil their basic needs like housing, healthcare, and education and that the changes do not disproportionately impact vulnerable populations. This thematic area helps ensure that the societal transitions to climate neutrality and a green economy via digitalization will be economically viable and environmentally sustainable, socially equitable, and fair. This aligns with the EGD's emphasis on a holistic approach that leaves nobody behind. Just transition principles emphasize fairness for workers and communities affected most by the transition. This thematic area contributes by assessing and addressing social impacts on these groups, helping to ensure that job opportunities, retraining, and support mechanisms are in place for a smooth transition.

Evaluating just transition processes in different country contexts can involve the following areas related to the digital green transition:

- The impact of the green and digital transition on jobs
- measures to ensure and improve equal access to basic services (also e-services)
- examining gender-specific, age and location-related impacts (regarding digital skills and access)
- Socio-cultural acceptance involves assessing public awareness, understanding, and acceptance of a green and digital transition towards more sustainability to ensure that the transition will be just
- Community engagement and participation involve evaluating the level and quality of community engagement and partnerships for nudging the just transition agenda, also regarding its digital dimension

Digitalization can facilitate equitable access to information, education, and services, particularly in marginalized communities. **Leveraging digital tools can enhance capacity building, promote inclusion, and ensure that the benefits of digitalization reach all segments of society.**

6.2.2 Mapping the role of digitalization in relation to green and just transition

Digitalization policy in Moldova's transition to a green economy addresses potential job losses and supports vulnerable groups, including women. It recognizes that moving to a green economy can disrupt traditional jobs, especially in sectors like energy and industry. To mitigate this, the policy focuses on **reskilling and upskilling workers, helping them transition to new opportunities in emerging sectors.** Specific programs include professional training for the unemployed, subsidies for young people, women farmers, and returning migrants to start new businesses, and special support for women-owned enterprises. Additionally, energy vouchers are provided to low-income families to help reduce energy costs. These measures aim to ensure a fair and inclusive transition, offering support and opportunities to those most affected by economic changes.

The digitalization policy in Moldova addresses job changes across various sectors as the country transitions to a green economy. The move towards a greener economy will significantly impact employment structures, particularly in carbon-intensive sectors like energy and industry, resulting in job losses. However, job growth is anticipated in emerging sectors such as renewable energy, energy efficiency, and circular economy industries. Programs supporting the digitalization of SMEs, enhancing energy efficiency, and promoting sustainable agricultural practices are designed to foster job creation in green and digital sectors while ensuring a smooth transition for workers from traditional industries.

Moldova's policy framework for the green transition includes estimates of potential job creation in the digital and IT sectors. **The digital transformation program for SMEs ensures that at least 70% of supported enterprises successfully implement digitization projects each year, generating significant employment opportunities** in the digital and IT sectors (ODA, 2023). The Digital Innovation and Technology Start-up Support Program (ODA, 2025) also fosters technological innovations by businesses, further contributing to job creation in the IT sector. These initiatives are part of a broader strategy to enhance Moldova's digital infrastructure and support digital skills development, driving job growth in the IT sector as the country transitions to a greener economy.

Several **digital literacy programs** support skills development among vulnerable groups in Moldova. Tekwill, with the support of donor institutions, has implemented national programs on IT skills and IT careers, specifically targeting women to enhance their digital literacy and career opportunities in the IT sector. The e-Government

Agency's development of e-government services and online platforms also supports digital literacy by making digital tools more accessible to the public. Additionally, six tech hubs have been created with donor support **to support tech education and career reorientation**. The National Bank of Moldova's information initiative, which focused on financial education, indirectly supports digital literacy by enhancing the understanding and use of digital financial tools. GIZ-supported initiatives include digital and tech skill training sessions organized in over 200 schools in Moldova. The Digital Transformation Strategy, part of the National Development Strategy "European Moldova 2030," emphasizes the importance of digitalization across all sectors, including education, supporting the integration of digital technologies and skills development to ensure an inclusive digital transformation.

Several companies and organizations in Moldova have programs that support retraining employees to enhance their digital skills and ensure they remain competitive in the job market. Some of these programs are related to the green transition. The dual education system, supported by project initiatives, involves around 280 companies and public institutions providing up to 1200 apprenticeship places yearly. This system focuses on practical training in partnership with businesses, ensuring that the skills taught align with market needs. The Organization for Entrepreneurship Development (ODA) implements various programs, including training for aspiring and current entrepreneurs in regulatory measures, financing, and greening. These training sessions, reviewed and updated annually, include courses targeting IT skills development and embracing IT careers. There are also specific greening programs for SMEs to support businesses implementing greener processes and technologies. The National Employment Agency offers professional training programs for the unemployed, including digital skills development. The Energy Vulnerability Reduction Fund supports initiatives that reduce energy consumption and increase energy efficiency, with training sessions on related topics contributing to developing green skills among workers.

Several funding schemes and programs within Moldova, supported by international beneficiaries, advance digital skills across different regions. The Digital Innovation and Technology Start-up Support Program aims to support technological innovation by businesses, including funding for digital start-ups and technological advancements. The Digital Transformation Programme for SMEs supports small and medium-sized enterprises in implementing digitization projects, enhancing their digital capabilities and competitiveness. ODA implements various programs targeting different groups, including start-ups, growing businesses, youth, women, and rural businesses, often including training in regulatory measures, financing, greening, and IT skills development. Moldova benefits from significant international support from organizations such as the EU, UNDP, GIZ, USAID, and others, funding various programs to enhance digital skills, support technological innovations, and ensure inclusive digital transformation. Specific programs supporting the green

and digital transitions include funding for energy efficiency projects, green technologies, and sustainable practices, incorporating digital skills training and technological adoption. The National Employment Agency offers professional training programs for the unemployed, including digital skills development to enhance employability and competitiveness.

In Moldova, several national and municipal initiatives address the need for a green and digital transition in a just way. The National Strategy on Smart Mobility (2023-2030) aims to develop a sustainable and accessible transport system with minimal environmental impact. It focuses on improving infrastructure, enhancing passenger and freight transport management, and integrating with international transport networks, emphasizing environmentally friendly transport models and digital advancements. Chisinau's Intelligent Transport and Mobility Strategy advances urban transport and mobility through collaboration with UN Moldova and the EU's "Move it like Lublin" initiative, focusing on traffic management, public transport improvements, parking solutions, and promoting active mobility like cycling and alternative transport options. The Programme for the Promotion of the Green Economy (2018-2020) supported green economic principles, facilitating advancements like the creation and coordination of green economy topics within an interministerial coordination group and supporting SMEs through green efficiency and technology funding programmes. The Green City Lab, supported by donors and universities, includes training and information sessions on greening, waste management, agriculture, digitalization, and tech skills. The Energy Vulnerability Reduction Fund aims to support socially vulnerable people by providing financial assistance for energy costs and implementing eco-energetic vouchers, also supporting energy efficiency and greening programs for SMEs. The Digital Transformation Programme for SMEs supports small and medium-sized enterprises in implementing digitization projects, enhancing their digital capabilities and competitiveness.

6.3 Transition finance

6.3.1 Background and scope of the area under scrutiny

Transition finance is defined as financial activities conditional on entities achieving contextually relevant environmental and socially sustainable criteria within a limited time frame. In other words, transition finance in the current context aims to improve organisations' environmental footprint. In contrast to green finance, transition finance recognizes the importance of addressing social issues along with environmental issues (Schumacher, 2023). Further, transition finance is about financing private investments to reduce today's high greenhouse gas emissions or other environmental impacts and transition to a climate-neutral and sustainable economy (EC, 2023).

Sustainable finance is key to delivering the policy objectives under the ESG and the EU's international commitments to climate and sustainability objectives. Sustainable finance channels private investment to deliver policy objectives, leveraging it from the whole economy through the new setting of countries' financial systems as a complement to public money. The EU strongly supports the transition to a low-carbon, more resource-efficient, and sustainable economy and has been at the forefront of efforts to build a financial system that supports sustainable growth (EC, 2023).

Digitalization can provide a means for a green transition. There have been examples from the previous chapters, but to summarize, digitalization can help build smart grids and develop precision agriculture and digital monitoring systems so that funding measures can prioritise these goals. Furthermore, transition finance can cover preconditions for a green and digital transition, for example, there can be funding to build broadband connections in the country, to increase digital skills, and to develop e-services. Investing in data governance can also lead countries towards data-driven decision-making regarding emissions and energy consumption, for example. Finally, transition funding can prioritize green innovation and green tech start-ups, so the national funding schemes might contain these principles when designing funding programmes and allocating funds.

6.3.2 Mapping the role of digitalization in relation to transition finance

Moldova has made significant strides in its digitalization efforts, supported by a combination of internal and external funding sources. However, ensuring long-term sustainability requires enhancing internal funding capabilities, developing public-private partnerships, and maximizing the use of international funds. Addressing these funding gaps will be crucial for maintaining momentum and achieving the strategic objectives outlined in the country's digital roadmaps.

Digitalization is central to Moldova's strategy for enhancing governance, public services, and overall economic competitiveness. Key focus areas include e-government, digital infrastructure, and digital skills enhancement. Transition finance is integral to these efforts, supporting financial activities that align with environmental and social sustainability criteria.

Relevant Policy Documents, Strategies, Laws & Regulations Related to Financing Digitalization Initiatives in Moldova

1. *National Development Strategy "European Moldova 2030"* (Law no.315, 2022) - outlines Moldova's development priorities, focusing on economic growth, environmental sustainability, and social inclusion. The strategy emphasizes the integration of digital technologies to enhance various sectors, including public administration, education, and healthcare.

29. *Digital Transformation Strategy of the Republic of Moldova (2023-2030)* (GD no.650, 2023) - provides a roadmap for the country's digital development, focusing on building digital infrastructure, enhancing e-government services, and promoting digital literacy. The strategy details specific initiatives and projects to achieve comprehensive digitalization by 2030.*Nationally Determined Contribution (NDC)* (ClimateWatch, 2020) - Aligns Moldova's development planning with climate adaptation measures and sustainable practices, including digitalization efforts that support these goals. A low-emission national development program was developed by experts from the EU4Climate project, funded by the EU and implemented by UNDP, to translate Moldova's commitments under the Paris Climate Agreement into national development policies. These were expressed in the updated NDC, submitted by Moldova in 2020 to the UNFCCC. According to its NDC, Moldova will unconditionally reduce greenhouse gas emissions (GHG) by 70% compared to 1990 to 2030, and by 88% if it has access to technical and financial assistance.
30. *Nationally Determined Contribution (NDC)* (ClimateWatch, 2020) - Aligns Moldova's development planning with climate adaptation measures and sustainable practices, including digitalization efforts that support these goals. A low-emission national development program was developed by experts from the EU4Climate project, funded by the EU and implemented by UNDP, to translate Moldova's commitments under the Paris Climate Agreement into national development policies. These were expressed in the updated NDC, submitted by Moldova in 2020 to the UNFCCC. According to its NDC, Moldova will unconditionally reduce greenhouse gas emissions by 70% compared to 1990 to 2030, and by 88% if it has access to technical and financial assistance.*Low Emission Development Program (LEDP)* (GD no. 659, 2023) - The EU and UNDP have supported the Government of Moldova to develop its first-ever Low Emissions Development Program (LEDP). The Program, which entered into force on 1 January 2024, systematizes policies and sectoral action plans that aim to achieve emission reduction objectives of greenhouse gases exposed in the updated Nationally Determined Contribution (NDC) reported in March 2020 to the UN Framework Convention on Climate Change, UNFCCC. The program provides a roadmap for achieving emissions reduction targets, highlighting the role of digital solutions in monitoring and reducing greenhouse gas emissions. The program emphasizes digital infrastructure as a key component in achieving environmental targets.
31. *Low Emission Development Program (LEDP)* (GD no. 659, 2023) - The EU and UNDP have supported the Government of Moldova to develop its first-ever

Low Emissions Development Program (LEDP). The Program, which entered into force on 1 January 2024, systematizes policies and sectoral action plans that aim to achieve emission reduction objectives of greenhouse gases exposed in the updated Nationally Determined Contribution (NDC) reported in March 2020 to the UN Framework Convention on Climate Change, UNFCCC. The program provides a roadmap for achieving emissions reduction targets, highlighting the role of digital solutions in monitoring and reducing greenhouse gas emissions. The program emphasizes digital infrastructure as a key component in achieving environmental targets.
National Climate Change Adaptation Program (NCCAP) (GD no.624, 2023) - The Government of Moldova approved the National Climate Change Adaptation Program until 2030 and its Action Plan on 30 August 2023. The Program was developed with the support of the UNDP Moldova project “Advancing Moldova’s national climate change adaptation planning”, funded by the Green Climate Fund. The Program Outlines strategies to increase climate resilience, incorporating digital tools for data collection and analysis to support decision-making. It focuses on the role of digital solutions in enhancing resilience across various sectors.

32. *National Climate Change Adaptation Program (NCCAP)* (GD no.624, 2023) - The Government of Moldova approved the National Climate Change Adaptation Program until 2030 and its Action Plan on 30 August 2023. The Program was developed with the support of the UNDP Moldova project “Advancing Moldova’s national climate change adaptation planning”, funded by the Green Climate Fund. The Program Outlines strategies to increase climate resilience, incorporating digital tools for data collection and analysis to support decision-making. It focuses on the role of digital solutions in enhancing resilience across various sectors.

33. *EU4Digital Initiative* (EU4Digital, 2024) - The EU program aimed at extending the benefits of the Digital Single Market to Eastern Partnership countries, including Moldova. The initiative supports Moldova's digital economy, ICT innovation, and digital skills development.*Law on information society services* (Law no.284, 2004) - The Law on Electronic Commerce was amended. It renamed the "Law on Information Society Services" to adjust the legal framework related to electronic commerce (e-commerce) in accordance with the best practices in the EU. At the same time, the purpose of the normative act is to eliminate constraints that hinder the development of e-commerce in Moldova and to provide greater protection of consumer rights. The law regulates electronic commerce activities, providing a legal framework for digital business operations. The law defines standards for digital transactions, consumer protection, and data privacy in e-commerce.

34. *Law on information society services* (Law no.284, 2004) - The Law on Electronic Commerce was amended. It renamed the "Law on Information Society Services" to adjust the legal framework related to electronic commerce (e-commerce) in accordance with the best practices in the EU. At the same time, the purpose of the normative act is to eliminate constraints that hinder the development of e-commerce in Moldova and to provide greater protection of consumer rights. The law regulates electronic commerce activities, providing a legal framework for digital business operations. The law defines standards for digital transactions, consumer protection, and data privacy in e-commerce.*Law on Public Procurement* (Law no.131, 2015) - Includes provisions for green and sustainable public procurement, encouraging the integration of digital solutions in public projects. The law mandates consideration of environmental and digital criteria in public tenders. Per the law, the contracting authority must accept the equivalent certificates issued by the bodies established in the EU member states. If the economic operator does not hold an environmental certificate as requested by the contracting authority, the latter has the obligation to accept any other certifications presented by the respective economic operator, insofar as they confirm the provision of an appropriate level of environmental protection.

35. *Law on Public Procurement* (Law no.131, 2015) - Includes provisions for green and sustainable public procurement, encouraging the integration of digital solutions in public projects. The law mandates consideration of environmental and digital criteria in public tenders. Per the law, the contracting authority must accept the equivalent certificates issued by the bodies established in the EU member states. If the economic operator does not hold an environmental certificate as requested by the contracting authority, the latter has the obligation to accept any other certifications presented by the respective economic operator, insofar as they confirm the provision of an appropriate level of environmental protection.

Current funding sources and mechanisms

Internal Funding

State Budget Allocations: Managed by the Ministry of Finance, the Ministry of Economy and Infrastructure, and the E-Governance Agency.

E-Government projects: E-Governance infrastructure (including MPass, MSign, MPay, MNotify, MDelivery, MConnect, MCloud) (e-Gov, 2024), aimed at streamlining public services and ensuring secure data management, are funded by the national budget.

Connectivity Projects: Broadband expansion projects, especially in rural areas, receive partial funding from state allocations to enhance digital inclusion.

External Funding

EU Funding:

EU4Digital Programme: Supports digital economy and society initiatives, including e-trade, ICT innovation, and digital skills.

European Investment Bank (EIB): Provides loans for large-scale digital infrastructure projects.

European Structural and Investment Funds (ESIF): Allocates funds to enhance digital capabilities across member states and associated countries.

World Bank: Finances projects aimed at enhancing digital services in public administration.

UNDP: Supports various digital transformation initiatives.

USAID: Provides grants for developing digital infrastructure and e-services.

Assessment of funding gaps and sustainability

Despite progress, Moldova faces significant funding gaps and sustainability challenges in its digital transformation efforts. Many of the achievements in this sector are largely due to external funding and international assistance. This reliance indicates a lack of long-term sustainability, underscoring the need to prioritize internal financial resources for this sector.

State budget allocations are often insufficient to cover comprehensive digitalization needs, and there is a lack of specialized funding schemes specifically tailored for digital projects.

A lack of funds also leads to a lack of interest from skilled IT professionals, creating a shortage of public sector IT resources.

Recommendations for addressing funding gaps

To ensure sustainable digital development, the government must implement strategies that attract private investments and enhance the capacity for self-financing digitalization projects. This approach will reduce dependence on external funding and ensure the continuity of digital initiatives.

Enhancing Internal Capabilities

Increasing state budget allocations for digital transformation projects is crucial for Moldova's digitalization efforts. This involves prioritizing digital initiatives in the national budget, targeting funds toward specific projects such as upgrading public sector IT systems and expanding broadband coverage, and establishing robust monitoring mechanisms. Additionally, creating a dedicated national fund for digitalization would provide a continuous and reliable source of financing. This fund could be sourced from state budget allocations, public-private partnerships, and international grants and loans, prioritizing high-impact projects such as national broadband initiatives and smart city developments.

Developing Public-Private Partnerships (PPPs)

Encouraging government and private sector collaboration can accelerate digital transformation by leveraging private sector resources and expertise. Developing a clear policy framework to facilitate PPPs, engaging with private sector stakeholders, and providing training for public officials to manage PPP projects effectively are essential steps. An example of a successful PPP is partnering with telecom companies to expand broadband infrastructure, particularly in underserved rural areas. This involves co-investing in broadband networks, offering regulatory and financial incentives, and utilizing existing infrastructure to reduce costs and speed up deployment.

Leveraging EU and International Funds

Moldova can enhance its digital transformation by fully utilizing EU funding opportunities, such as the Digital Europe Programme and ESIF. Aligning national digital projects with EU funding criteria, enhancing the capacity of public institutions to manage EU-funded projects, and fostering partnerships with EU member states and organizations are key strategies. Additionally, loans from institutions like the EIB can provide substantial financing for large-scale digital infrastructure projects. Developing long-term repayment plans, implementing risk management strategies, and building institutional capacity to manage these loans effectively are crucial for sustainable financing.

Creating Incentives for Local Investments

To stimulate local investment in digitalization, the government can offer tax incentives and subsidies for businesses investing in digital infrastructure and services. Tax breaks, direct subsidies, and innovation grants can encourage local investment. Additionally, local banks can play a crucial role by providing favourable loan terms for digital projects. Developing specialized loan programs, implementing risk-sharing mechanisms, and training bank officials on the specificities of digital projects can enhance support for digital initiatives.

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