Thematic Assessment on Digitalisation for Ukraine

Part of the Green Agenda for Armenia, Georgia, Moldova, and Ukraine Project

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DISCLAIMER:

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The findings, interpretations, and conclusions expressed in this report are those of the authors and do not necessarily reflect the official policy or position of Sida, SEI, or any other project partners or stakeholders.

The report is based on information available up to Summer 2024. For the latest data and analysis, please refer to the national green transition assessment report for Ukraine.

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

1.1. INTRODUCTION

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

As methods, we have used document analysis, i.e., assessments made by different international organisations such as the EU, ITU (UN), OECD, USAID, World Bank Group, etc., and governmental documents such as legal acts, strategies, and action plans related to digitalisation, also about different sectors. Secondly, a national digitalisation expert in Moldova has interviewed policymakers and non-governmental experts in Moldova to gain deeper insights on the status of the green transition: gaps, needs, and enabling conditions.

To provide an overview of the state of digitalisation in Ukraine more generally, 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 digitalisation in Ukraine, 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 R&I, Just Transition, and Transition Finance. Then, we conclude with the main takeaways.

1.2. NATIONAL DIGITALISATION GOVERNANCE AND STRATEGIES

Ukraine’s journey of digitization was a decade in the making and involved support from the global community to overhaul policy, institutional, and technological structures. By embracing change in all three areas, analogue systems were revised to be compatible with digital solutions. Today, Ukraine allows for near-seamless e-government services for citizens, businesses, and an array of government ministries. Digitalization in Ukraine has been gaining momentum in recent years, driven by various factors including government initiatives, private sector investments, and increasing digital literacy among the population.

The Ukrainian government has been actively promoting digitalization as a key driver for economic growth and innovation. Several initiatives have been launched to support the development of digital infrastructure, encourage the adoption of digital technologies, and create a conducive environment for digital entrepreneurship. Ukraine has been expanding its e-government services to improve administrative efficiency and accessibility for citizens and businesses. Online platforms such as "Diia" offer a wide range of digital services, including electronic document submission, online tax filing, and digital identification.

Ukraine's digital economy is experiencing rapid growth, driven by a thriving tech startup ecosystem, skilled IT workforce, and increasing investment in digital technologies. Key drivers include:

- Tech Startup Ecosystem- a vibrant hub for startups
- IT Outsourcing- a highly skilled IT workforce used for software development, IT services
- Emerging technologies- AI, Blockchain, and IoT
- Digital skills & education- enhancing digital literacy and skills

One key concern is cybersecurity, also the digital divide is an issue (rural, urban, age). The regulatory environment is not always favourable (collaboration between sectors is an issue). The full-scale invasion by Russian Federation has led to increased interest in digital self-defence technologies, including personal data protection and communications security. According to the EC Communication on EU enlargement, it is noted that Ukraine is between a moderate and a good level of preparation in the domain of digital transformation. It has made good progress during the reporting period. The suggestions from EC include[1]:

- Achieve full alignment with EU roaming legislation
- Ensure necessary financing to enact rules on the expansion of the Regulator's competencies (telecom and media), and for the performance of the central executive bodies.

1.3. MAIN GOVERNMENTAL STAKEHOLDERS

Regarding e-government development, in 2014, the Agency for E-governance was created. It worked with individual ministries and had some success in ensuring certain agencies could digitalize, but had no authority over their approach. In 2019, under President Zelensky, authority was migrated to the new Ministry of Digital Transformation with an enhanced profile and authority.

President Zelensky appointed Mykhailo Fedorov as Minister of Digital Transformation and as Deputy Prime Minister. The Ministry, established in 2019, had a staff of over 300 people by 2023. It is a central authority regarding Ukraine's aspirations to establish the country as a modern digital economy. The ministry coordinates digital development across the government and maintains the platform Trembita and the service delivery app Diia. It does not institute specific digital changes and services for other ministries and agencies, but it exercises oversight. The parliament supports these activities through a Committee on Digital Transformation. Ministries and other central executive bodies, local executive bodies, and local governments are also stakeholders in the digitalization process. They develop sectoral and regional informatization programs and projects. These programs and projects must be approved by the Ministry of Digital Transformation.

Other state institutions that play an important role in the digital transformation processes of Ukraine include:

- The National Commission that performs state regulation in the fields of electronic communications, radio frequency spectrum, and postal communication services;
- The Department of Cyber Police of the National Police of Ukraine;
- ► The National Cybersecurity Coordination Center of the National Security and Defence Council of Ukraine;
- The Security Service of Ukraine;
- The state enterprise "Diia";
- The state enterprise "Electronic Health", and others.

[1] EC report on Ukraine, 2023, Communication on EU Enlargement Policy https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0699

The government has instituted the position of Chief Digital Transformation Officer (CDTO). Every ministry now has a CDTO at the level of deputy minister. The key role of the CDTOs is to facilitate smooth and transparent communication between various levels of government bodies to evolve a new digital culture in the state. CDTOs are also designated at the regional and community level. As of mid-2023, 15 were in place in the 24 oblasts (regions), and the plan is to have CDTOs in each of the more than 1400 municipalities. The responsibilities of regional and community CDTOs are the integration and protection of critical infrastructure, the introduction of electronic services, increased internet coverage, and improved digital literacy. The focus is on the areas of health care, social care, education, environment, transportation, and government services.

1.4. Main strategic documents, assessment of relevance and coverage of latest developments (data, AI)

In 2018, the Cabinet of Ministers approved the Concept of Development of the Digital Economy and Society of Ukraine for 2018-2020 and approved the plan of measures for its implementation.

Key Laws that operate in the field of informatization and digital transformation:

- On electronic identification and electronic trust services
- On electronic public registers
- On digital content and digital services
- On electronic communications
- In 2023, a new law of Ukraine on the National Informatization Program entered into force.

In 2018, Cabinet Decree 357 on state electronic information resources established a single interoperable system of public registries (Trembita) to underpin seamless e-government services and prevent duplication of registries. In 2021, the Rada adopted the Law on Public Electronic Registries that regulates the functioning of registries. Regarding open data, Ukraine updated its open data strategy in June 2022. Regarding cybersecurity, Ukraine's National Security and Defence Council is implementing a national cybersecurity strategy. Other critical areas, such as emerging technologies (e.g., AI, blockchain, cloud), should receive special attention by defining nationwide strategies and policies.

1.5. Connectivity

1.5.1. Connectivity in numbers

Ukrainian households have access to the internet at a level comparable to the EU. Ukraine made great strides in building telecommunications infrastructure before the full-scale invasion by Russian Federation, though some of these have been set back by the destructiveness of Russian forces. As of February 24, 2022, 90% of Ukraine was covered by fibre-optic networks[2], meaning there was the technical ability to connect to fixed broadband internet. 89% of citizens have access to LTE (mobile communication) from at least two operators[3]. The diversification of the market with numerous large and small providers promotes competitive prices (lowest in the ITU Europe region). Ukraine still has no 5G mobile network and does not seem, for the moment, to have plans to implement the EU toolbox for 5G security.

[2] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[3] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

1.5.2. Cybersecurity

The main regulatory and legal documents shaping the policy of Ukraine in the field of cybersecurity are the Cyber Security Strategy of Ukraine and the Law "On the Basic Principles of Ensuring Cyber Security of Ukraine". In 2016, the National Coordination Centre for Cyber Security (NCCC) was established by the Decree of the President of Ukraine, a working body of the National Security and Defence Council of Ukraine. It coordinates and controls the activities regarding cybersecurity. The decree of the President of Ukraine No. 27 of January 28, 2020, strengthened the capabilities of the NCCC and changed the format of its activities, in particular, private sector specialists were involved in the work, who specialize in cyber defence[4]. The strengthened NCCC has become a "hub", a digital platform, an analytical centre for monitoring, detecting, neutralizing, forecasting potential cyber threats, and preventing them in both the public and private sectors.

The State Service for Special Communications and Information Protection of Ukraine operates the Government Computer Emergency Response Team of Ukraine - CERT-UA. Its computer emergency response team, CERT-UA, has received international accreditations and is taking steps within the overall framework of the EU-Ukraine cyber dialogue towards closer institutional cooperation with EU counterparts. Ukraine adopted regulations regarding cyber incidents as of 9 February 2023, with the objective of moving towards alignment with the requirements established at the EU level (NIS 2 framework).

1.5.3. Digital identity

Ukraine's digital identity system encompasses eID, Bank ID, and Mobile ID, forming a comprehensive ecosystem. Currently, about 70% of Ukrainian citizens are equipped with digital IDs[5]. These are utilized for storing essential documents like biometric passports, tax IDs, and driver’s licenses, and for accessing a wide array of public services. Diia, a central hub for digital identification, plays a pivotal role in this ecosystem.

Ukraine's alignment with the EU's eIDAS regulation underscores its commitment to adhering to stringent European standards for electronic identification and trust services.

1.5.4. Digital Services

In 2015, the first significant innovation was the e-procurement platform Prozorro, which increased transparency (thereby reducing corruption), intensified competition for government bids, and reduced costs[6]. It was followed three years later with e-services for citizens and businesses built on the interoperable platform Trembita that links a series of independent registries (population, business, land cadastre, etc.)[7] and enables digital public services via the personal phone app Diia[8].

Ukraine has a well-advanced e-government system, where people have easy access to public services. Digital governance has increased the efficiency and transparency of the government and facilitated government-citizen dialogue. The mobile application is used by 21 million users and is installed on more than 32 million devices[9].

[4] https://www.president.gov.ua/documents/272020-32041

[5] https://www.biometricupdate.com/202310/ukraines-digital-identity-app-growing-and-becoming-an-inspiration-for-other-countries

[6] https://prozorro.gov.ua/

[7] https://thedigital.gov.ua/news/shvidkiy-obmin-danimi-mizh-reestrami-trembita-zdiysnila-7-mlrd-tranzaktsiy-z-momentu-zapusku

[8] https://diia.gov.ua/

[9] https://thedigital.gov.ua/news/21-mln-ukraintsiv-koristuyutsya-dieyu

The overarching digital services framework does not exist. Before moving to the re-engineering of public services, it is advisable to set standards and requirements.

1.5.5. Data management

The base registers are digitized, and their connectivity is enabled and regulated by the law on registries. Digital document management is in place within most central public organizations and is supported by digital archiving.

In Ukraine, Trembita is the interoperability platform created with the financial support of the EU. The platform is centrally operated by the Ministry of Digital Transformation. Data exchange through the platform is regulated. However, only the public sector uses the platform.

Institutional and technological reforms and policies contributed to meaningful improvements in transparency and efficiency and set the stage for wider transformation. Trembita facilitated the exchange of information across hundreds of government registries.

Ukrainian open data policy supports the reuse of open data by both the public and private sectors. Ukraine has achieved a high level of transposition of the Open Data Directive[10].

1.6. SKILLS

1.6.1. Digital literacy

In 2020, less than half of the women of Ukraine were using public digital services[11]. 47% of Ukrainians who did not use public electronic services in 2022 cited a lack of skills as the main reason[12]. From 2019 to 2023, the share of Internet users in the total structure of the population increased by 8% and now amounts to 94%. The frequency of Internet use practices is directly related to the respondent's age. Among the population group of 60–70-year-olds, 71% of respondents use the Internet every day, and among the youngest adults (18–29 years old), it is 96%. As of 2023, 93% adult population of Ukraine aged 18–70 (+8% since 2019) have digital skills, 95% of people aged 10–17, and 99% people with hearing impairments have digital skills, and the same is true for the 18-59 age group (+15% in 4 years)[13].

This rapidly evolving employment landscape is creating a critical need for effective training strategies to help Ukrainians remain competitive. The updated and upgraded version of Diia.Education (https://osvita.diia.gov.ua) is supported by Google and the Eastern Europe Foundation[14]. It offers a unique range of functions that allow users to create personalized learning trajectories and tailored educational courses focusing on their specific interests and objectives.

1.6.2. Cybersecurity programmes

The training of specialists in information security began in 1997[15]. Despite the growing cyber risk in Ukraine, few cybersecurity educational programs have been available to early-career professionals and students at Ukrainian universities. To help address this challenge, CRDF (Civilian Research& Development Foundation) Global is working to integrate cybersecurity curricula at the university

[10] https://data.europa.eu/en/publications/datastories/acceleration-open-data-practices-ukraine
[11] https://ukraine.un.org/en/161405-gender-digital-divide-ukraine-causes-consequences-and-ways-overcome
[12] https://osvita.diia.gov.ua/uploads/1/8800-ua_cifrova_gramotnist_naselenna_ukraini_2023.pdf
[13] https://osvita.diia.gov.ua/uploads/1/8800-ua_cifrova_gramotnist_naselenna_ukraini_2023.pdf
[14] https://eef.org.ua/en/platforma-diya-osvita/
[15] https://zakon.rada.gov.ua/laws/show/507-97-%D0%BF#Text

level[16]. Cybersecurity at the National Technical University (NTU) in Kharkiv was established on January 11, 2022 [17]. The Department of Cybersecurity is actively cooperating in the field of education and research with leading IT companies.

1.7. LEVEL OF DIGITALISATION OF THE PRIVATE SECTOR

1.7.1. IT sector

Ukraine's digital sector has long been a source of pride for the country, which includes over 4,000 local companies and more than 100 global companies[18]. Between 2020 and 2021, the IT sector in Ukraine saw 36 percent growth, from $5 billion in exports of computational services in 2020 to $6.8 billion in early 2021[19]. In 2022, Ukraine ranked fourth worldwide in the number of certified IT professionals[20]. Despite the challenges of full-scale invasion by Russian Federation, the sector has remained resilient and has adapted to wartime. In addition to critical budget support from Ukraine's allies, the digital sector has played a crucial role in keeping Ukraine's economy afloat. The sector has remained a constant area of economic growth, with IT industry exports reaching $3.7 billion in the first six months of 2022[21].

1.7.2. Sectoral digitalisation aimed at the green transition

The accelerating pace of digitalisation in Ukraine is transforming key sectors of the country's economy and society. This section assesses the status and impact of digital technologies in biodiversity conservation, agricultural practices (farm to fork), industry & circular economy & waste management, building and renovation, climate action, and energy, identifying key gaps, needs, and enabling factors to further the green transition via digital means.

1.8. BIODIVERSITY

In Ukraine, digitalisation in biodiversity conservation is emerging with technologies like remote sensing and AI improving ecosystem monitoring and protected area management. Initiatives like "Ukraine Digital 2030" mark a governmental shift to bolster digitalisation in conservation, meaning there is political and administrative willingness. The main gap is that Ukraine lacks comprehensive biodiversity monitoring covering biological and landscape diversity. Therefore, there is a need to develop relevant databases and processes for this purpose. This has started already, as there is a working group within the Ministry of Ecology composed of different governmental, scientific, and non-governmental stakeholders. This signifies governmental willingness to advance the adoption of digital monitoring mechanisms.

Some other biodiversity challenges are limited digital infrastructure (absence of reliable internet access, especially in rural areas), which means digitalisation efforts are hindered as data cannot be reliably collected in some regions. A further issue is the lack of standardised protocols for data storage, exchange, and analysis, as this fragmentation leads to difficulties in assessing data for

[16] https://www.crdfglobal.org/news/strengthening-cybersecurity-ukraine-building-capacities-local-universities/
[17] https://www.kpi.kharkov.ua/ukr/department/kiberbezpeka/
[18] https://www.csis.org/analysis/digital-will-drive-ukraines-modernization
[19] https://www.csis.org/analysis/digital-will-drive-ukraines-modernization
[20] https://www.csis.org/analysis/digital-will-drive-ukraines-modernization
[21] https://www.csis.org/analysis/digital-will-drive-ukraines-modernization

monitoring purposes. There is also a need for further funding and expertise regarding digitalising biodiversity conservation efforts.

1.9. INDUSTRY FOR GREEN AND CIRCULAR ECONOMY & WASTE MANAGEMENT

Digitalising 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. In Ukraine, there are examples of how companies use digitalisation for circular economy, resource efficiency, and sustainability. MetInvest implements modern technologies to reduce emissions and increase energy efficiency by creating automated systems to store and process environmental information regarding sewage, waste disposal, and reclamation of sites[22]. In the agro-industrial complex, Kernel implements precision farming technologies, including the use of sensors and drones for field monitoring and resource optimization[23]. The integration of digital platforms for agricultural data management helps reduce losses and improve the efficiency of fertilizer and water use.

Therefore, large enterprises implement modern digital tools for resource monitoring and management and automated systems for controlling and optimizing production processes. There are more and more such examples, although SMEs still rarely use these approaches. To increase their number, it is necessary to boost investments in innovation and technology, develop infrastructure, such as creating a network of sensors and drones for precise monitoring of production and agricultural processes. Further, it is important to enhance data exchange systems between enterprises for better resource and waste management, organize training and educational programs to improve employee qualifications, and support startups and young professionals developing new solutions for the circular economy, including digital ones.

1.10. CLIMATE

Digitalisation of climate-related issues usually refers to possibilities in more effective and efficient GHG data collection for monitoring and reporting purposes; smart city solutions; digital modelling for effects of climate change; data analysis for informed decision making aimed at furthering sustainability.

Policies such as the Renewable Energy Directive and the Circular Economy Package indirectly influence Ukraine's adoption of digital solutions for climate action. Ukraine's "National Strategy for Economic, Social and Environmental Development" acknowledges the pivotal role of digitalization in climate action, although specific action plans or regulations focused solely on digital climate solutions are still in development. Ukraine is beginning to leverage Internet of Things (IoT) and sensor technology for environmental monitoring and smart grid development to optimize energy use. Additionally, cloud solutions are increasingly utilized by government agencies and private companies for data storage, analysis, and collaboration on climate-related projects. The concept of smart cities is gaining momentum, with pilot projects underway in major urban centres like Kyiv and Lviv[24]. These projects focus on various aspects of urban life, including smart grids, intelligent transportation systems, and waste management, all enabled by digital solutions.

Despite progress, challenges persist. For instance, while government agencies are working towards integrating climate data into decision-making processes, a centralized platform for climate data is

[22] https://metinvestholding.com/ua/ar2023/pdf/ua/26%20Response%20to%20Climate%20Chanage_UA.pdf

[23] https://stud-point.com/blog/kernel-innovatsiyi-i-suchasni-tekhnolohiyi-v-ahrarnomu-sektori/

[24] https://kyivcity.gov.ua/news/kiv_pidnyavsya_na_16_punktiv_ta_uviyshov_u_top-100_rozumnikh_mist_svitu/

yet to be established. Investment in climate resilience remains limited, with some initiatives underway but often reliant on international donor support. Similarly, resources dedicated to high-performance computing and AI for extreme weather prediction are scarce, necessitating significant investment for wider implementation. In terms of carbon accounting, Ukraine operates a national system based on manual reporting by companies. Digital platforms for emissions tracking are still in the nascent stages, highlighting an area for development. In the area of waste management, one challenge is increasing recycling rates, and digital solutions could be helpful to optimise collection routes, smart waste bins with sensors could improve trash sorting and collection efficiency, and tracking & monitoring waste can improve transparency, reporting accuracy.

1.11. Energy

Effectiveness, efficiency, and security of energy distribution have up to now been the main areas regarding the digitalisation of the energy sector. Ukraine is aligning its energy policies with EU directives such as the Renewable Energy Directive (RED) and the Energy Efficiency Directive (EED). Additionally, the country actively participates in EU-funded initiatives aimed at digitalizing the energy sector. Projects like twinning projects pair Ukrainian energy institutions with EU counterparts to facilitate knowledge exchange and capacity building in areas like smart grid development and smart metering implementation. The "Strategy for the Development of the Energy Sector of Ukraine for the Period Up to 2050" outlines specific digitalization goals and action plans. These include expanding pilot projects for smart grid technologies and developing a regulatory framework to incentivize investments in smart grid infrastructure and smart metering deployment[25]. The Ukrainian government allocates funds for digitalization initiatives in the energy sector through the national budget, but resources are often limited. Pilot projects for smart metering are underway in both the electricity and gas sectors[26]. Data management platforms are being developed to optimize grid monitoring and energy flows, with initiatives like YASNO Energy Company's project for the electricity distribution network[27].

One challenge in Ukraine energy development is high reliance on fossil fuels that could be mitigated via data-driven renewable energy planning solutions, smart grid development, and peer-to-peer energy trading platforms, for example. The electricity grid is aging, therefore, investments in grid modernisation, including smart grids, could be a digital solution available in upgrading the grid. This could be maintained via sensor-based systems to monitor potential issues. Demand-response programs are another opportunity where digital platforms incentivise consumers to reduce energy demand during peak hours. What needs to be kept in mind is that Ukraine’s energy infrastructure is under constant attack, which makes modernisation efforts much more complicated.

1.12. Farm to Fork

Digital technology unlocks enormous untapped potential for Ukrainian farmers, investors, and entrepreneurs to improve the efficiency of food production and consumption. Digitalization in Ukraine "from farm to table" is developing, but there are still opportunities for improvement, in particular regarding compatibility with EU systems. For information management, farms often rely on paper-based record-keeping or basic software. Some large agribusinesses use farm management software for tasks such as yield tracking and resource planning. The government is

[25] https://zakon.rada.gov.ua/laws/show/373-2023-%D1%80#Text

[26] https://biz.liga.net/ua/all/all/novosti/derzhava-pochala-stvoriuvaty-rozumni-elektrychni-merezhi-uzhe-ie-12-pilotnykh-proiektiv

[27] https://yasno.com.ua/business/energymanagement

developing initiatives to create a centralized agricultural information system[28], but progress is slow. As for compatibility with the European Union, currently, Ukraine's interaction with EU information systems, such as TRACES (trade control system and expert system), is limited due to differences in the data structure, and there are problems in information exchange[29].

Digital solutions are increasingly used by farmers, for example GPS navigation systems for tractors and combines to improve accuracy and efficiency; yield monitors to collect data on crop performance; online marketplaces are emerging that connect farmers directly with buyers; mobile apps are being developed to give farmers access to weather data, market information and best agriculture practices. One gap is Ukraine's need for indicators, targets related to agriculture, so digital collection of data could be a way forward. The lack of green skills among the workforce is a gap, and digital and green skills education via digital means is a need. Digital skills education would also help with increasing precision farming. Awareness around healthy diets could also be raised via online campaigns.

1.13. Buildings & Renovation

The key objective is to promote energy saving in the sector and reach nearly zero energy demand of buildings. It is important to ensure data availability to understand the status of energy consumption and efficiency of buildings, including instruments such as the digital building logbook, public sector buildings' energy consumption databases. While traditional methods still dominate, a handful of innovative companies are pioneering the adoption of digital tools and embracing principles of the circular economy.

Many construction firms and renovation specialists remain entrenched in paper-based systems for project management, stifling efficiency and collaboration in an increasingly digital world. Smaller companies, in particular, grapple with limited awareness and resources to invest in digital solutions, further exacerbating the digital divide. Concerns regarding standardization and data security cast shadows over digital endeavours. However, there are opportunities. Building Information Modelling (BIM) offers a digital twin of buildings that streamlines collaboration and optimizes resource utilization throughout the lifecycle of a project. Smart building technologies could be promoted and taken up more. There are some existing examples already. UVT GROUP leverages BIM technology to optimize energy efficiency in building projects[30]. BIMTeam specializes in digital renovation planning services[31]. The government can raise awareness among construction companies and SMEs to showcase the advantages digital solutions provide.

1.14. Smart Mobility

Smart mobility entails the utilization of different ICT tools, emerging technologies, and modern solutions for the optimization of the transportation system. There are both opportunities and challenges for Ukraine regarding smart mobility. Some examples that attest to Ukraine's initiative towards smart mobility are smart public transportation solutions in Kyiv, where electronic ticketing, real-time tracking of trams & buses is in place, and there are mobile applications for route planning[32]. Lviv has a similar system, while traffic management is also centralised[33]. Intelligent

[28] https://www.dar.gov.ua/
[29] https://ecoaction.org.ua/wp-content/uploads/2024/03/analiz-stanu-sg-ua-ta-implement-es2024.pdf
[30] https://uvt-group.com/uk/poslugy/generalne-proyektuvannya-bim-menedzhment/
[31] https://bim-team.com.ua/
[32] https://portal.kyiv.digital/
[33] https://leocard.lviv.ua/

Transport Systems have been implemented in Kyiv and Lviv to manage traffic flows, reduce congestion, and improve safety[34].

There is, however, more potential in Ukraine. Some needs to get to the next stages of smart mobility include developing and implementing a transparent and automatic carbon footprint calculation system for different transportation types. Limited infrastructure regarding 5G and IoT, which is necessary for advanced smart mobility solutions, is an issue. Comprehensive regulation and policy are also missing regarding smart mobility. Among them, ensuring data security and protecting personal data are ongoing challenges to be addressed. Ensuring cybersecurity is important as cyberattacks can threaten the integrity of smart mobility systems. Lastly, there are financial constraints to deploy smart mobility infrastructure, and public awareness needs to be raised to move forward with smart mobility acceptance and solutions.

Therefore, Ukraine is moving towards adopting more smart mobility solutions, but data availability, security, and interoperability, together with 5G and IoT systems, need to be further improved to make full use of smart mobility. This requires comprehensive regulation and policy, funding, and raising public awareness regarding the sustainability of such solutions.

1.15. Zero Pollution

Under zero pollution, there are areas such as air quality & health, emission reduction, pollution prevention and control, water quality and conservation, soil protection, chemicals management, green technologies and innovation, environmental monitoring and reporting. Ukraine is working towards achieving zero pollution by utilizing digital technologies for monitoring, controlling, and managing environmental processes. The Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030", the Government approved the Low-Carbon Development Strategy of Ukraine until 2050, setting environmental standards that also encourage the use of digital technologies.

More concretely, by the Concept of Implementation of State Policy in the Field of Industrial Pollution, the Electronic Emission Permits System (E-permits) was created and operates, allowing for the issuance of electronic permits for emissions of pollutants into the atmosphere[35]. The system simplifies the permitting process. Further, the Cabinet of Ministers of Ukraine has approved the Procedure for the Introduction of Automated Systems for Emission Control of Pollutants, which obliges enterprises to install monitoring systems at their facilities[36]. Enterprises should conduct measurements, and the data on emissions from their equipment should be transmitted to the Ministry of Environmental Protection. These automated control systems are foreseen to be installed in five years, however, the full-scale invasion by Russian Federation has impact on progress. A fine example is from the Ministry of Environmental Protection responsible for the state environmental monitoring system. The system collects and analyses the quality of air, land, water, coastal water, soil, radiation, and biodiversity indicators[37]. This system provides for the exchange of information between departmental monitoring databases at the national and regional levels. Environmental data is available to the public through applications such as SaveEcoBot, EcoCity, and EcoZagroza.

Regarding challenges, some parts of the country are insufficiently covered by monitoring networks. This leads to the absence of data on the environmental conditions in some parts of the country.

[34] https://www.swarco.com/stories/smart-prio-lviv-technology-expression-resilience
[35] https://eco.gov.ua/services
[36] https://zakon.rada.gov.ua/laws/show/272-2023-%D0%BF#Text
[37] https://eco.gov.ua/pro-proyekt

Some of the monitoring equipment is outdated and does not meet modern accuracy and reliability standards. Furthermore, environmental data is not always available in real time, complicating the quick response to environmental problems. Further development of the sensor network and the integration of data from various sources will ensure more accurate and comprehensive air quality monitoring in Ukraine. In short, several databases and systems exist to monitor pollution, and there are activities in place to increase monitoring and compliance, also via digital means[38]. However, the systems need to be developed further to ensure that data is complete, accurate, and interoperable between registries.

1.16. Links to Just Transition, RDI, and Transition Finance

1.16.1. Just Transition

Ukraine's sectoral policy on digitalization has been focused on addressing potential job loss, gender inequality, and other issues affecting vulnerable groups. For example, the IT Generation initiative, launched by the Ministry of Digital Transformation, aims to retrain individuals from various sectors for IT careers[39]. The Diia.Business hubs (business.diia.gov.ua) provide resources and training for small and medium-sized enterprises (SMEs) to adapt to digitalization. The Diia.Digital Education platform (osvita.diia.gov.ua) offers free online courses to improve digital literacy across the population. Special emphasis is placed on reaching women, rural communities, and other vulnerable groups. Various NGOs and private sector initiatives focus on encouraging women to pursue careers in technology. Programs like the Women Techmakers initiative and the STEM is FEM project provide mentorship, training, and networking opportunities for women and girls [40].

It is expected that digitalization in the key sectors covered by the European Green Deal may lead to a reduction in traditional low-skilled jobs. At the same time, there will be an increased demand for specialists in jobs geared towards sustainability, which require digital skills. In short, the demand for new technological and managerial skills will grow, while traditional, less-skilled jobs may decline. The digital and IT sector will see job growth. Investments in retraining and upskilling programs will be crucial to prepare Ukraine's workforce for these new opportunities. Several regional and international funding schemes are in place across Ukraine to advance digital skills. These initiatives, supported by entities like the EU, USAID, GIZ, and the British Council, ensure comprehensive digital literacy and skill development, catering to diverse regional needs and promoting inclusive digital growth. Also, the Ministry of Digital Transformation runs multiple programs to enhance digital literacy and skills, including the Diia. Digital Education platform, which provides free online courses to all Ukrainians. Municipalities of Kharkiv, Lviv, and Kyiv also provide digital skills programs [41].

Several companies in Ukraine are actively involved in the green transition and have implemented programs to retrain their employees in digital skills, these companies include DTEK, Ukraine's largest energy company, SoftServe- a major IT company, GlobalLogic offers training programs and Metinvest is a large mining and metallurgy company with several initiatives to support green transition including via retraining to develop digital skills[42]

[38] https://mepr.gov.ua/wp-content/uploads/2024/10/Strategichnyj_plan_24.10.2024_zatverdzhenyj-Ministrom.pdf
[39] https://it-generation.gov.ua/
[40] https://stemisfem.org/golovna
[41] https://ips.ligazakon.net/document/MR231509
[42] https://emptrain.dtek.com/mod/scorm/view.php?id=188

1.16.2. Transition Finance

Ukraine has identified digitalization as a key enabler of its green transition. Some of the areas that are addressed by financing efforts are related to do with smart grid development, the development of digital platforms for collecting, analysing, and visualising environmental data. The Ministry of Energy of Ukraine allocates budget funds for the development of smart grids, while international donors, such as the European Union through the EU4Energy programme, provide grants and technical support. Projects related to environmental monitoring receive funding from the state budget, managed by the Ministry of Environmental Protection and Natural Resources of Ukraine. Additionally, the United Nations Development Programme (UNDP) and the German Society for International Cooperation (GIZ) offer grants and technical assistance to support these initiatives.

The promotion of circular economy principles through digital solutions is a significant aspect of Ukraine's green transition. The State Environmental Investment Agency (SEIA) is instrumental in managing and disbursing funds for environmental projects that include digital components. International organisations, such as the European Union and the UNDP, also contribute funding and support for these efforts. Concrete examples of funding include the establishment of the Energy Efficiency Fund by the Ukrainian government, which finances energy-saving projects in residential buildings.

Despite progress, several areas still face funding gaps. Scaling up smart grids requires substantial investment in infrastructure and technology, as current efforts are primarily limited to pilot projects. Building comprehensive environmental monitoring systems and developing data analytics capabilities also necessitates ongoing financial support. Moreover, promoting circular economy practices, particularly in industries with significant environmental impact, requires investment in digital tools and platforms. While donor support has been crucial, Ukraine needs to strengthen internal funding mechanisms to ensure the long-term sustainability of its green digitalisation efforts.

1.16.3. Research and Development

In Ukraine, scientific research and innovation are partially integrated into strategic documents and priority areas of digitalization. A few examples include The National Economic Strategy of Ukraine for the period until 2030, recognising the importance of scientific research for the development of digital technologies and innovations; The National Artificial Intelligence Development Strategy in Ukraine until 2025, which for the development and implementation of artificial intelligence. The Low-Carbon Development Strategy of Ukraine until 2050 envisages the necessity of conducting research and implementing innovations in areas such as improving the efficiency of power plants; developing nuclear energy; modernizing and digitalizing electric grids; modernizing the transport sector; developing high-efficiency cogeneration at local and regional levels; supporting the implementation of energy storage technologies; and developing hydrogen production technologies. However, the inclusion of innovation and scientific research in strategic documents is often merely declarative. Real support for innovation and scientific research is insufficient.

In Ukraine, there is a certain level of ICT skills, but further efforts are needed in all eight areas to support the digital and green transition, including upskilling and reskilling. Skills in managing energy systems and using digital tools for monitoring and optimizing energy consumption are necessary. Knowledge of environmental monitoring and data analysis is needed. Skills in renewable energy engineering, programming, and data analysis are essential. These are some examples. Regarding education programmes, there are several MA/PhD programs, research centres, and R&D projects in Ukraine that focus on supporting green transition via digital skills. National Technical

University of Ukraine provides both MA and PhD courses in renewable energy and digital technologies[43]. The university also houses several research centres dedicated to energy and environmental research. National University of Kyiv-Mohyla Academy has the Center for ecosystems, climate change and sustainable development research that also focuses on the application of ICT in environmental monitoring, data analysis, and sustainable resource management[44] . Finally, the Institute of Renewable Energy at the National Academy of Sciences of Ukraine (IRE NASU) and its research centres conduct extensive research in the field of renewable energy[45].

There are also tech hubs like UNIT. City in Kyiv and Lviv IT Cluster, which actively support digital startups and innovations, providing infrastructure and support to enterprises[46]. However, continuous investments are needed. Ukraine also has a robust IT talent pool with over 300,000 IT professionals[47]. Some social innovation approaches include Greencubator, which is a public platform that promotes energy efficiency and renewable energy projects through collaboration and innovation[48]. They organize hackathons and innovation labs. Impact Hub Odessa is an innovation hub that supports social entrepreneurs and community projects addressing local and national challenges[49] Through its programs, Impact Hub Odessa helps incubate and accelerate projects aimed at improving social and environmental conditions using innovative approaches. Regarding private actors, Ukrainian tech firms, such as SoftServe and GlobalLogic, are actively involved in developing digital solutions for energy management and environmental monitoring[50]. Also, DTEK, Ukraine's largest private energy company, is investing in wind and solar power plants, incorporating digital technologies for efficient energy management and smart grid solutions[51]. Regarding NGOs, organizations like Save Dnipro and Ecoaction are at the forefront of environmental advocacy and innovation. They engage in activities ranging from public awareness campaigns to developing digital tools for environmental protection.

All in all, there is quite a lot of focus on RI efforts regarding digitalisation. There are policies, albeit sometimes declarative, that focus on RI and digitalisation; there are higher education institutions where sustainability issues are taught, also by focusing on digitalisation. Both private and non-governmental organisations are involved in promoting sustainability via digital means. However, funding is often limited, and collaborations among different stakeholders can be improved to further efforts regarding digitalisation aimed at sustainability.

1.17. Conclusion

Ukraine's digital transformation is significant. The country's efforts in digitalization have been substantial, encompassing e-government services, cybersecurity, and digital identity systems. The establishment of the Ministry of Digital Transformation as the central coordinator of digitalisation efforts has proved effective. The government's strategic approach, including the development of Chief Digital Transformation Officers (CDTOs) across various levels of government, has been important in the process. This is evident in the implementation of the Trembita system and the Diia

[43] https://kpi.ua/kpi_faculty
[44] https://www.ukma.edu.ua/index.php/science/tsentri-ta-laboratoriji/tsentr-doslidzhen-ekosystem-zmin-klimatu-ta-staloho-rozvytku
[45] https://www.ive.org.ua/?page_id=4287&lang=en
[46] https://unit.city/ecosystem/
[47] https://itcluster.lviv.ua/projects/it-research-ukraine/
[48] https://greencubator.info/en/projects/
[49] https://impacthub.odessa.ua/about/
[50] https://www.softserveinc.com/en-us/industries/the-energy-sector/utility-consulting-and-engineering-services, https://www.globallogic.com/technology-capabilities/end-to-end-iot/
[51] https://renewables.dtek.com/en/

app, which have greatly improved the delivery of public services and streamlined administrative processes.

Ukraine's economy is supported by a startup ecosystem, a skilled IT workforce, and significant investments in emerging technologies such as AI, blockchain, and IoT. The focus on enhancing digital literacy and education further supports the growth of the digital sector, which has shown resilience even in the face of full-scale invasion by Russian Federation and cyber threats. Despite these advancements, challenges remain, including the digital divide, cybersecurity risks, and the need for regulatory improvements to foster sectoral collaboration. The country's connectivity infrastructure still lacks 5G networks, and the ongoing conflict poses a threat to the progress made.

In the realm of cybersecurity, Ukraine has made progress by establishing the National Coordination Centre for Cyber Security and the Government Computer Emergency Response Team of Ukraine (CERT-UA). These entities play a crucial role in safeguarding the nation's digital infrastructure and responding to cyber incidents. The digital identity system in Ukraine, with its eID, Bank ID, and Mobile ID, provides citizens with secure access to a wide range of services. This system aligns with European standards, reflecting Ukraine's commitment to international best practices.

Digital services like the Prozorro e-procurement platform and the Diia app have increased transparency and efficiency in government operations. Data management has also seen improvements, with digital document management and archiving becoming standard in public organizations. Digital literacy is on the rise, with significant portions of the population now possessing the necessary skills to navigate the digital landscape. This is crucial as there is further demand for a workforce adept in digital competencies.

Ukraine's commitment to green transition is rather evident in its adoption of digital technologies across various sectors, aiming to enhance sustainability and environmental management. Digitalization plays a role in biodiversity conservation, with remote sensing and AI aiding in ecosystem monitoring. However, the country faces challenges such as incomplete biodiversity monitoring and limited digital infrastructure, particularly in rural areas. There is a need for comprehensive databases, standardized protocols, and increased funding to support these conservation efforts.

In the industrial sector, companies like MetInvest and Kernel are utilizing digital technologies for circular economy practices, such as precision farming and automated environmental information systems. These innovations contribute to resource efficiency and sustainability, but the uptake remains low. To encourage broader adoption, investments in new technologies, infrastructure development, and digital skills training are essential.

Climate action in Ukraine is being shaped by digital solutions that facilitate GHG data collection, smart city initiatives, and cloud-based collaboration on climate projects. Despite these advancements, the country still requires a centralized platform for climate data integration, increased investment in climate resilience, and the development of digital platforms for emissions tracking. The energy sector's digitalization focuses on enhancing the effectiveness, efficiency, and security of energy distribution. Ukraine aligns its policies with EU directives and participates in EU-funded initiatives to promote smart grid technologies and smart metering. Challenges include a high reliance on fossil fuels, an aging electricity grid, and the need for modernization amidst ongoing infrastructure attacks.

Agricultural digitization, or "farm to fork," is progressing with the use of GPS systems, yield monitors, and mobile apps to improve farming efficiency. However, compatibility with EU systems and the development of a centralized agricultural information system are areas needing improvement. In the realm of building and renovation, digital tools like Building Information

Modelling (BIM) are being adopted to promote energy efficiency and support the circular economy. The construction industry faces hurdles in transitioning from paper-based systems to digital solutions, with a need for increased awareness and investment in digital technologies. Smart mobility in Ukraine is advancing with ITS, electronic ticketing, and real-time tracking systems in urban areas. Future developments require enhanced 5G and IoT infrastructure, comprehensive regulations, and increased public awareness to fully realize the potential of smart transportation solutions. Lastly, the zero-pollution initiative leverages digital technologies for environmental monitoring and management. Electronic emission permits and automated control systems are being implemented, although gaps in monitoring coverage and outdated equipment present challenges. Further development of sensor networks and data integration is necessary to achieve comprehensive and real-time environmental monitoring.

In terms of just transition, digitalization policies are addressing job displacement and promoting inclusivity. Training programs and initiatives like IT Generation and Diia.Business hubs are equipping citizens with the skills needed for the digital age. Research and development in Ukraine are integrating digital technologies into various sectors, with higher education institutions and tech hubs promoting innovation. Private companies and NGOs are also contributing to the digitalization of energy management and environmental monitoring.

In conclusion, Ukraine's digital transformation journey is marked by various achievements, especially regarding general digitalisation efforts in connectivity, digital services, and eID. There are ongoing challenges to improve these systems and make them even more convenient. The greening of the sectors can be helped by digital means, namely, comprehensive data collection and management for monitoring and compliance in all the sectors. Digitalisation can also help with efficiency and effectiveness gains in energy, buildings, waste management, farm-to-fork, and smart mobility sectors, first and foremost.

Table 1: Summary Table

Main elements	Enabling conditions	Key gaps	Needs
National digitalisation governance and strategies	Several initiatives have been launched to support the development of digital infrastructure, encourage the adoption of digital technologies, and create a conducive environment for digital entrepreneurship. In 2018, the Cabinet of Ministers approved the Concept of Development of the Digital Economy and Society of Ukraine for 2018-2020 and approved the plan of measures for its implementation.		

	Ukraine has been expanding its e-government services to improve administrative efficiency and accessibility for citizens and businesses. Online platforms such as "Diia" offer a wide range of digital services, including electronic document submission, online tax filing, and digital identification. Ukraine's digital economy is experiencing rapid growth, driven by a thriving tech startup ecosystem, skilled IT workforce, and increasing investment in digital technologies.		
Connectivity, digital infrastructure	Ukrainian households have reached access to the internet on the EU comparable level. The sociological survey by the Kyiv International Institute of Sociology on behalf of the UNDP shows that the number of Ukrainians who use the Internet daily increased from 72% to 80% in 2023. National-level initiatives to address digital inclusiveness through strategic programmes are in place. Ukraine’s telecom sector, despite being a prime target of Putin’s war, has proved resilient. Telecommunications, postal services, and broadcasts have been adapted to war conditions, and basic services have been	Approximately 11% of households have no internet access at all. Access to the internet and the quality of data transmission have decreased due to Russia’s destruction of digital infrastructure and attacks on energy facilities. As of August 2023, a quarter of internet networks and more than 4000 mobile base stations had been destroyed or damaged. As of February 2023, the estimated loss to the Ukrainian telecommunications sector was more than	Implementing 5G should particularly focus on cybersecurity. To introduce 5G in Ukraine, it is necessary to free up radio frequencies that are used in the 5G network. Implementing robust legislative amendments and maintaining an agile cybersecurity strategy will be crucial in fortifying Ukraine’s digital resilience in the face of evolving cyber challenges.

	maintained. As of February 24, 2022, 90% of Ukraine was covered by fibre-optic networks, meaning there was the technical ability to connect to fixed broadband internet. 89% of citizens have access to LTE (mobile communication) from at least two operators. As of December 2023, a mere 22 months after the war with Russia began, usage of Diia has increased 27% to 19.8 million users. 51% of Ukrainians said that they used Diia at least once during 2023. The main regulatory and legal documents shaping the policy of Ukraine in the field of cyber security are the Cyber Security Strategy of Ukraine, approved by the Decree of the President of Ukraine dated March 15, 2016, No. 96/201666 and the Law of Ukraine "On the Basic Principles of Ensuring Cyber Security of Ukraine" No. 2163-VIII67. Ukraine's National Security and Defence Council is implementing a national cybersecurity strategy.	$2.2 billion. The damage has been concentrated in the three oblasts, with Kyiv accounting for 37% of the damage, Kharkiv 19%, and Donetsk 17%. Ukraine still has no 5G mobile network and does not seem, for the moment, to have plans to implement the EU toolbox for 5G security. The risks of implementing 5G technology in Ukraine are exacerbated by potential Russian attacks on telecommunications infrastructure.	
Digital identity	eGovernment Strategy 2016-2020 aimed to streamline public services and enhance citizen engagement through digital channels, with a core focus on improving transparency and efficiency	70% of the population is equipped with an eID, so there is room for improvement	Uptake can be further increased Increase the uptake of eID solutions in the private sector

	within government bureaucracies. Built with robust security features and leveraging biometric authentication, Diia instilled trust in users, crucial for widespread acceptance. The ongoing conflict highlighted Diia's true potential, as it became a vital tool for displaced Ukrainians to access essential services remotely. Public-private partnerships have also played a critical role in fostering innovation and ensuring the system remains adaptable. Ukraine's digital identity system encompasses eID, Bank ID, and Mobile ID, forming a comprehensive ecosystem. Recently, Ukraine achieved a milestone by becoming the first country where a digital ID is universally valid within its borders and the fourth in Europe to introduce a digital driving license. Currently, about 70% of Ukrainian citizens are equipped with digital IDs.	Private company service provision related to eID can be further improved	
Digital services	Ukraine has **a well-functioning e-government system**, where people have **easy access** to public services. Digital governance has increased the efficiency and transparency of the government and facilitated government-citizen dialogue. The mobile application is used by 17.3 million users	The overarching digital services framework does not exist. Uptake of Diia is 51% of the population, so there is room for improvement.	Before moving to the re-engineering of public services, it is advisable to set standards and requirements. Uptake of Diia can be encouraged.

	and is installed on more than 32 million devices.		
Data management	The **base registers are digitized**, and their connectivity is enabled and regulated by the law on registries. Digital document management is in place within most central public organizations and is supported by digital archiving. In Ukraine, **Trembita** is the interoperability platform created with the financial support of the EU. The platform is centrally operated by the Ministry of Digital Transformation. Data exchange through the platform is regulated. Ukrainian **open data policy supports the reuse of open data** by both the public and private sectors. Ukraine has achieved a high level of transposition of the Open Data Directive.	Only the public sector uses the Trembita platform. Though Ukraine scores well in open data, the use of open data can be better.	Find ways to support Trembita's usage in the private and non-profit sectors. Use of open data can be further encouraged, related skills should be focused on
Skills	Efforts are underway to enhance digital literacy and skills development among the Ukrainian population to ensure that they can fully participate in the digital economy. The updated and upgraded version of **Diia.Education** is supported by Google and the Eastern Europe Foundation. It **offers a unique range of functions that allow users to create personalized learning trajectories** and tailored educational courses focusing on their specific interests and objectives.	In 2020, less than half of the women of Ukraine were using public digital services. 47% of Ukrainians who did not use public electronic services in 2022 cited a **lack of skills** as the main reason. Despite the growing cyber risk in Ukraine, **few cybersecurity educational programs** have been available to early-	This rapidly evolving employment landscape is creating a critical need for effective training strategies to help Ukrainians remain competitive. Different, more vulnerable groups should be targeted with **digital skills education**. **Cybersecurity education** needs to be improved.

	The training of specialists in information security began in 1995.	career professionals and students at Ukrainian universities.	
State of digitalisation of the private sector and overview of the IT sector	Ukraine's digital sector has long been a source of pride for the country, which includes over 4,000 local companies and more than 100 global companies. Ukraine has emerged as a vibrant hub for tech startups, particularly in the fields of software development, IT services, and cybersecurity. Cities like Kyiv, Lviv, and Kharkiv are home to numerous tech companies and startup incubators. Ukraine is known for its highly skilled IT workforce and has become a popular destination for outsourcing software development and IT services. The country's competitive labour costs, coupled with its strong engineering talent, have attracted clients from around the world. Ukrainian startups and tech companies are actively engaged in developing emerging technologies such as artificial intelligence (AI), blockchain, and Internet of Things (IoT). These technologies have the potential to drive innovation across various sectors, including finance, healthcare, and agriculture. In Ukraine, there is a steady increase in interest in ERP	The level of ERP system implementation varies significantly depending on the industry. They are most common in large manufacturing enterprises, logistics companies, and the financial sector. They are less used in small and medium-sized businesses, especially in the service sector. This disparity is due to the greater financial capabilities and the need for comprehensive business process automation in larger enterprises. People who do not use online shopping indicated a preference for personal shopping and product familiarization (69.4%) and a lack of necessary skills (12.9%). The IT sector faces challenges such as wartime disruptions, brain drain, infrastructure vulnerabilities, regulatory hurdles, and global competition.	**Supporting the uptake of ERP systems** in the private sector, especially in small and medium-sized businesses. **Developing digital skills** to also support the usage of e-commerce, thus preventing a lack of skills from acting as a barrier to e-commerce solutions. **Continued government support through tax incentives**, **infrastructure investment, and education programs** is essential. International partnerships can provide valuable resources and market access, while investing in IT education and training can nurture the next generation of tech professionals. **Strengthening cybersecurity measures and fostering a culture of innovation** through incubators, accelerators, and

	systems and their implementation.		research initiatives are also crucial.

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 European Green Deal (EGD). The main objective is delivered through four specific objectives (Table 2). 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 resources required to implement them.

The first project year focuses on the preparation of Country Green Transition Gap Assessment (CGTA) reports for each of the GUMA countries, which will serve as an input for the later development of countries' green transition roadmaps and project proposals as well as activities that could be implemented the under "technical assistance" (TA) and "capacity building" component 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 the capacity of key stakeholders to further support the green transition in respective countries**	• Output 4: TA and capacity building • Output 5: Communications 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[52]. 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[53]. Digitalisation 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 to optimise resource use, enhance energy efficiency, or facilitate the integration of renewable energy sources into smart grids. Digitalisation can also empower industries to streamline production processes, minimise waste, and reduce emissions.

On the other hand, it is important to ensure that digital technologies do not consume more energy than they save[54]. This is precisely the reason why the 'twin transformations' must be implemented hand in hand: harnessing the opportunities of digital innovation for climate change mitigation and adaption, while at the same time limiting the carbon footprint of the IT sector.

Achievement of a digital green transformation promises substantial benefits for the economy, environment, as well as society, enhancing productivity and improving safety, reducing environmental impacts of current production and consumption, and paving the way for a sustainable future. Unlocking systemic change will require collaborative, ambitious commitments and near-term action across all levels of society, from leadership and government, the private sector, as well as individuals.

Several EU policies have strong links to digitalisation, 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[55], the Green Deal Industrial Plan for the Net-Zero Age[56], Biodiversity Strategy for 2030,[57] and Zero Pollution Action Plan[58]), numerous other important legislations, strategies, and initiatives seek to maximise synergies between the green and digital transitions.

- The **Digital Decade Decision**[59] sets the overall aim of ensuring that digital infrastructure and technologies, including their supply chains, become more sustainable, resilient, and energy- and resource-efficient, with a view to minimising their negative environmental and social impact. The document also includes references to the sustainability of infrastructures targets, 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**[60] also recognizes the potential of digital and data technologies as "enablers" for the attainment of the EU´s priority objectives for climate neutrality and circular economy.
- The EU **Action Plan on the Digitalisation of the Energy System**[61] defines the ICT sector as a principal factor for growing investments in renewables and energy efficiency along the value

[52] https://digital-strategy.ec.europa.eu/en/policies/green-digital
[53] Ibid.
[54] EIT Digital presents report on Digital Technologies and the Green Economy | EIT (europa.eu)
[55] Circular economy action plan (europa.eu)
[56] COM_2023_62_2_EN_ACT_A Green Deal Industrial Plan for the Net-Zero Age.pdf (europa.eu)
[57] Biodiversity strategy for 2030 (europa.eu)
[58] Zero pollution action plan (europa.eu)
[59] Europe's Digital Decade: digital targets for 2030 (europa.eu)
[60] Commission welcomes political agreement on the 8th Environment Action Programme (europa.eu)
[61] EUR-Lex - 52022DC0552 - EN - EUR-Lex (europa.eu)

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[62]. The latter will help to drive and coordinate investments in the digitalisation of the electricity infrastructure.

- The **Commission´s Sustainable and Smart Mobility Strategy**[63] is aimed at making European mobility and transport systems greener. Through digitalisation and automation, European logistics chains and 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**[64] encourages and assists Member States to use 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**[65] have strengthened the capacities of European SME´s to adapt to climate neutrality challenges, while also reaping the benefits of digitalisation as well as reducing the regulatory burden that SMEs face and improving opportunities to access finance.
- The **Europe Fit for the Digital Age Strategy**[66], 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**[67], 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"[68].

All legislative acts, strategies/roadmaps, and initiatives above either explicitly or implicitly envision digital transformation as a vital ally 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 upon the report is the national and international digital society community, from startups and investors to regulators, forming the basis for the digital states. For the government officials, authorities, and development institutions, the report will provide information on the investment gap in horizontal and key thematic areas, as well as recommendations to address it. For donors, the area will provide an understanding of which horizontal and key thematic areas are most in need of assistance, as well as how to better synchronize funding efforts between donors.

[62] Commission welcomes cooperation between ENTSO-E and EU DSO Entity on the digital electricity grid twin (europa.eu)
[63] Sustainable and Smart Mobility Strategy (europa.eu)
[64] Guidance to MS for updated NECPs 2021-2030 (europa.eu)
[65] EUR-Lex - 52020DC0103 - EN - EUR-Lex (europa.eu)
[66] A Europe fit for the digital age (europa.eu)
[67] Right to repair: Making repair easier for consumers (europa.eu)
[68] Call_for_Green_Digital_Transition_EU.PDF (economie.gouv.fr)

2.3. REPORT STRUCTURE

The report is structured in five chapters (excluding the executive summary as the first chapter). After the introduction, the third chapter covers general digitalisation issues in the country. The fourth chapter addresses Ukraine's key digitalisation-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 digitalisation has to offer with sectoral requirements in climate actions, clean energy, buildings and renovations, 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 digitalisation issues related to cross-cutting areas: just transition to a green economy, transition financing, as well as research and innovation.

3. OVERVIEW AND TRENDS

3.1. SCOPE

Assessment of progress along the digital transformation maturity curve is a complex task at the 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[69] that focuses on four main pillars: digital skills, digital infrastructure, digitalisation of businesses, and digitalisation of public services. There is, yet no agreed-upon methodology for assessing the maturity of the green digital transition. This report will explore the digitalisation initiatives in GUMA countries that act as enablers of the green transition and discuss gaps where the support of digitalisation 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 could 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.

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

A basic level of digitalisation is a precondition for all other developments, as general digital society building blocks are needed to advance digitalisation in other sectors. The general digitalisation assessment is divided into seven parts. We describe the relevance of each and the link to the green transition in more detail below.

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

[69] https://digital-strategy.ec.europa.eu/en/library/2023-report-state-digital-decade

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 that is exchanged is secure and safe, and thus it serves as a second important pillar for connectivity. In this section, we assess internet coverage (broadband, mobile networks) 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 in terms of ease of access and ownership of hardware. The existence of digital skills is also in focus.

Digital identity, which includes digital signatures and eIDAS compliance assessment. Digital identity is needed for secure access to e-government services. Having trustworthy authentication and verification functionalities is a must for countries aiming at digitalising 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 make use of e-services more. The eIDAS framework is an EU framework setting 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 the ones 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, convenience goals, they save time and paper for all involved parties relevant also in different green sectors regarding its communication with the government (permits, data reporting, applications etc.).

Data management including information on data registries, data 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 standards for data and data processing need to be in place, this includes personal data processing rules to safeguard privacy and sensitive personal information. Therefore, in this part, we assess how far the country has come to digitalise services for citizens, businesses. We look at the number and character of services that are digitalised, how much these services are used by the population, identify centralised standards for data collection and management and investigate how open data provision is set up. This chapter has specific relevance to sectoral digitalisation as data is often collected regarding different green sectors to monitor for compliance and reporting purposes. Open data can be used by different stakeholders to build services, applications to further the green transition of the sectors. Therefore, the availability and maturity of open data portals is 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 but also cyber security education: Digital skills are needed both for providing and using online services. If a country prioritises uptake of digital services for efficiency and convenience reasons, citizens should be able to use the services. Another aspect is data literacy among the population which is important for services being built using (open) data, for example, as citizens need 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 segments of the population to assess the readiness of people 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 cyber security skills education (the programs and initiatives in place in the country).

The state of **digitalisation of the private sector**: Private sector, especially the ICT sector, has an important impact on digital service provision in the country. The more active role it takes in digitalising services, 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, also those relevant for the green transition. So, to map the general level of digitalisation of the private sector, we look at the uptake of enterprise resource planning (ERP) software by small and medium size enterprises (SMEs), e-commerce activity and use of AI, Blockchain and other new technologies.

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

The scope of Chapter 5 is broad. We cover digitalisation efforts in eight sectors: biodiversity, climate, energy, farm to fork, circular economy & waste management, buildings & 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 digitalisation of the sector in the country covering the existing capabilities and outlining further needs based on the benchmark and the gap assessment.

Digitalisation level **of businesses** for 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 around digital green transformation and adoption of new technologies in value chains across the thematic areas. The role of start-up community and adoption of their greentech/cleantech solutions is included in the assessment.

In Chapter 6 we demonstrate links between digitalisation and domains such as research & development & innovation; just transition and transition finance. All these aspects are interlinked to ensure that GUMA countries move in the direction of the Green Transition. Digitalisation is a significant part of the countries' RDI developments which need funding. Also, green transition needs to be conducted in a just and fair way so no one and no region suffers from these developments and digitalisation can be one mechanism to ensure this.

3.2. PROFILE AND STATISTICS

3.2.1. EU cooperation with Ukraine in digitalisation

Ukraine has seen developments in digitalisation over the last decade or so. Existing digital initiatives and further work regarding digital transformation can help Ukraine transform its economy into a greener and a 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.

As indicated in the Strategy on Shaping Europe's digital future, the digital transformation can enable growth and drive sustainable development for both the EU and partner countries. The EU is therefore investing in the digital transformation of Ukraine. A Joint Staff working document

"Recovery, resilience and reform: post-2020 Eastern Partnership priorities"[70] 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 the EU regulation and standards, alignment with EU and international data protection standards

To make a meaningful difference to individuals and businesses in the Eastern Partnership region, and to maximize the impact and visibility of digital transformation efforts, the Economic Investment Plan proposes specific country flagship initiatives for digital development in each partner country. The Ukrainian flagship agenda primarily focuses on accelerating digital transformation through the modernization of public IT infrastructure.[71]

As per Koriavets et al. (2023), the responses of the Eastern Partnership countries to the support tools proposed by the EU in the field of digital transformation vary from country to country and from sector to sector. The report points out that Ukraine shows the greatest activity in this context, especially when it comes to cybersecurity, e-Governance / public e-services, electronic communications, e-Trust, and electronic identification spheres. Ukraine has the highest indicator regarding adopted laws and normative acts in terms of implementing the EU digital agenda. In response to Ukraine's requests, the EU engages the country's institutions in various joint projects (experimental project on mutual recognition of electronic trust services; participation of Ukraine in the European Union program "Digital Europe"; financial support of Ukrainian cybersecurity infrastructure, etc). Granting the EU candidate status to Ukraine plays a significant role in this.[72]

The EU4Digital Facility has, since 2019, been focusing on increasing the digital capacities of each country. The first phase, from 2019-2022, focused on strengthening coordination and a common approach in 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.[73] 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.[74]

3.2.2. Statistics

The 4 countries in focus of GUMA project are being added to monitor digital transformation via the Digital Economy and Society Index (DESI), as is the practice with the EU member states. However, for now, the methodologies are being aligned with no tangible assessments of GUMA countries yet.

[70] https://www.eeas.europa.eu/sites/default/files/swd_2021_186_f1_joint_staff_working_paper_en_v2_p1_1356457_0.pdf
[71] Koriavets et al. (2023) Resilient Digital Transformation in the Eastern Partnership Region EaP_Digitalization_ (prismua.org)
[72] Koriavets et al. (2023) Resilient Digital Transformation in the Eastern Partnership Region EaP_Digitalization_ (prismua.org)
[73] https://eufordigital.eu/digital-connectivity-a-pathway-to-transformation-in-the-eastern-partnership/
[74] https://eufordigital.eu/discover-eu/the-eu4digital-initiative/

Still, to provide a picture of where GUMA countries stand about digital transformation, we mainly use the UN's E-government Development [75] and the OECD 2022 assessment on service delivery and [76] It needs to be kept in mind 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 Ukraine, 66% of households have internet at home[77], 89% of the population is covered with mobile networks, and 93% of households own a computer or smartphone[78]. Ukraine still has no 5G mobile network and does not seem, for the moment, to have plans to implement the EU toolbox for 5G security. In recent years, more services have been digitalised with a focus on e-services available via mobile devices. Ukrainian households have reached access to the internet on the EU comparable level. The sociological survey by the Kyiv International Institute of Sociology on behalf of the UNDP shows that the number of Ukrainians who use the Internet daily increased from 72% to 80% in 2023.[79] The Ukrainian journey of digital transformation has led to an impressive 15.5 million users of the Diia app. As of December 2023, usage of Diia had increased 27% to 19.8 million users.[80] In EGDI, Ukraine ranks highest among the GUMA countries in 2022 and is placed 46th globally.[81]

4. DIGITALISATION TO SUPPORT TRANSITION

4.1. NATIONAL DIGITALISATION GOVERNANCE AND STRATEGIES

Ukraine's journey of digitization was a decade in the making and involved support from the global community to overhaul policy, institutional, and technological structures. Today, Ukraine allows for near-seamless e-government services for citizens, businesses, and an array of government ministries.[82] Digitalization in Ukraine has been gaining momentum in recent years, driven by various factors including government initiatives, private sector investments, and increasing digital literacy among the population.

More specifically**, the Ukrainian government has been actively promoting digitalization as a key driver of economic growth and innovation**. Several initiatives have been launched to support the development of digital infrastructure, encourage the adoption of digital technologies, and create a conducive environment for digital entrepreneurship.

Ukraine's digital economy is experiencing rapid growth, driven by a thriving tech startup ecosystem, skilled IT workforce, and increasing investment in digital technologies. The key elements are the following:

[75] https://publicadministration.un.org/egovkb/en-us/About/Overview/-E-Government-Development-Index

[76] Thijs, N., I. Mackie and M. Krievins (2022), "Service design and delivery in the European Neighbourhood Policy East region: A comparative report on designing and delivering administrative services in Armenia, Azerbaijan, Georgia, Moldova and Ukraine", SIGMA Papers, No. 64, OECD Publishing, Paris, https://doi.org/10.1787/c6debcce-en.

[77] https://ukrstat.gov.ua/druk/publicat/kat_u/2022/zb/07/zb_dd_internet_21.pdf

[78] Research on the digital skills of Ukrainians. The third wave: https://osvita.diia.gov.ua/uploads/1/8800-ua_cifrova_gramotnist_naselenna_ukraini_2023.pdf

[79] Analytical report: Opinions and views of the population of ukraine regarding government electronic services.

[80] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

[81] Thijs, N., I. Mackie and M. Krievins (2022), "Service design and delivery in the European Neighbourhood Policy East region: A comparative report on designing and delivering administrative services in Armenia, Azerbaijan, Georgia, Moldova and Ukraine", SIGMA Papers, No. 64, OECD Publishing, Paris, https://doi.org/10.1787/c6debcce-en.

[82] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war. https://policycommons.net/artifacts/11321694/ukraine/12207852/

- **Tech Startup Ecosystem**: Ukraine has emerged as a vibrant hub for tech startups, particularly in the fields of software development, IT services, and cybersecurity.
- **IT Outsourcing**: Ukraine is known for its skilled IT workforce and has become a popular destination for outsourcing software development and IT services.
- **Emerging Technologies**: Ukrainian startups and tech companies are actively engaged in developing emerging technologies such as artificial intelligence (**AI**), **blockchain**, and Internet of Things (**IoT**). These technologies have the potential to drive innovation across various sectors, including finance, healthcare, and agriculture.
- **Digital Skills and Education**: Efforts are underway to enhance digital literacy and skills development among the Ukrainian population to ensure that they can fully participate in the digital economy. There are various programs and initiatives aimed at improving digital literacy and skills training, particularly among youth and underserved communities.
- **Regulatory Environment**: **Streamlining regulations and creating a favourable regulatory environment for digital innovation remains a challenge**. Addressing regulatory barriers and promoting collaboration between government, industry, and academia are essential for fostering digital entrepreneurship and innovation.

Although the war creates numerous challenges for connectivity, cybersecurity, and digitalization processes, Ukraine continues to develop a digital economy and society. According to the EC Communication on EU enlargement, it is noted that Ukraine is between a moderate and a good level of preparation in the domain of digital transformation. It has made good progress during the reporting period.[83] The three main tasks for 2024, according to the EC, are:

- achieve full alignment with EU **roaming** legislation;
- ensure the necessary financing and human resources for **enacting the legal rules on expansion of the Regulator's competencies** (both telecommunications and media regulator) and for the performance of the central executive bodies around electronic communications;
- further **align with the EU Directive on the security of network and information systems** (NIS).

4.1.1. Main government stakeholders

E-government development started more rapidly in **2014** as an independent **Agency for E-governance** was established. It worked with individual ministries and had some success in ensuring that certain agencies could digitalize services but had no authority over their approach. **In 2019**, under President Zelensky, this authority was **migrated to the new Ministry of Digital Transformation with enhanced profile and authority**.[84]

President Zelensky appointed Mykhailo Fedorov as Minister of Digital Transformation and as Deputy Prime Minister. The Ministry, established in 2019, had a staff of over 300 people in 2023. It is in the centre of Ukraine's aspirations to establish the country as a modern digital economy. **The ministry coordinates digital development across the government and maintains the Trembita platform and the Diia service delivery app.** It does not institute specific digital changes and services for other ministries and agencies, but it exercises oversight to ensure they follow basic government digital transformation principles. The parliament supports these activities through a Committee on Digital Transformation.[85]

[83] EC report on Ukraine, 2023, Communication on EU Enlargement Policy https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023SC0699

[84] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

[85] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

Ministries and other central executive bodies, local executive bodies, and local governments are also stakeholders in digitalization processes. They develop sectoral and regional digitalisation programs and projects. These programs and projects must be approved by the Ministry of Digital Transformation according to the Law on the National Informatization Program.

The State Service for Special Communications and Information Protection performs an auxiliary function in the protection of state information resources in cyberspace.

Other state institutions that play an important role in the digital transformation processes of Ukraine include:

- The National Commission that performs state regulation in the fields of electronic communications, radio frequency spectrum, and postal communication services;
- The Department of Cyber Police of the National Police of Ukraine;
- ► The National Cybersecurity Coordination Center of the National Security and Defence Council of Ukraine;
- The Security Service of Ukraine;
- The state enterprise "Diia";
- The state enterprise "Electronic Health", and others.

Figure 1 below displays the structure of authorities responsible for digitalisation efforts.

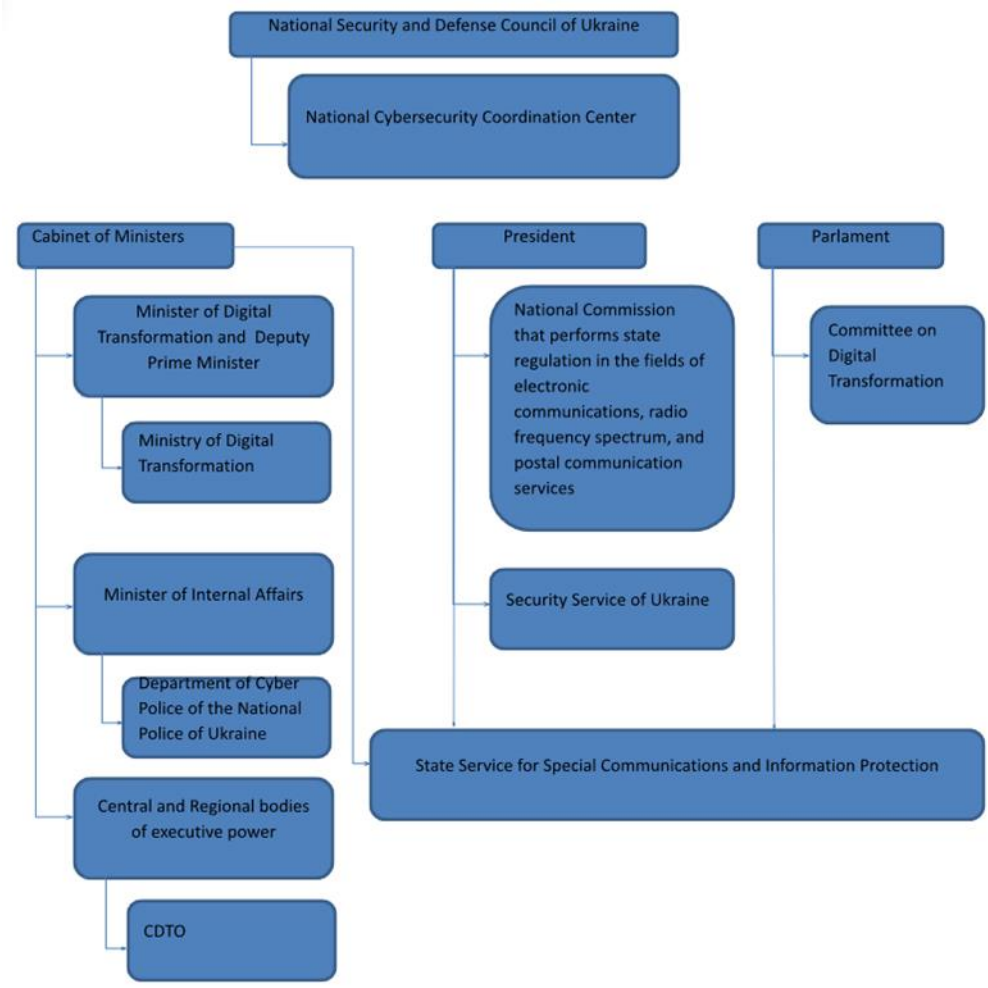

Figure 1. The structure of the authorities responsible for digitalisation efforts

4.1.2. Central Coordination vs Sectoral Responsibilities

The government has instituted the position of Chief Digital Transformation Officer (CDTO). **Every ministry now has a CDTO at the level of deputy minister**. The key role of the CDTOs is to facilitate smooth and transparent communication between various levels of government bodies to evolve a new digital culture in the state. The responsibilities of the position include updating digital technology, introducing innovations, and ensuring that citizens receive services electronically. CDTOs are also designated at the regional and community level. As of mid-2023, 15 were in place in the 24 oblasts (regions), and the plan is to have CDTOs in each of the more than 1400 municipalities. **The responsibilities of regional and community CDTOs are the integration and protection of critical infrastructure, the introduction of electronic services, increased internet coverage, and improved digital literacy.** The focus is on the areas of health care, social care, education, environment, transportation, and government services.[86]

All programs and projects implemented within the framework of the National Informatization Program are coordinated by the Ministry of Digital Transformation as the General State Customer of the National Informatization Program.

4.1.3. Main strategic documents

In 2018, the Cabinet of Ministers approved the **Concept of Development of the Digital Economy and Society of Ukraine for 2018-2020** and approved the plan of measures for its implementation.

Key Laws that operate in the field of informatization and digital transformation:

- On electronic identification and electronic trust services
- On electronic public registers
- On digital content and digital services
- On electronic communications

In 2023, a new law of Ukraine on the National Informatization Program entered into force.

In 2014, the Verkhovna Rada (parliament) enacted a law on asset declaration imposing an e-declaration requirement on all government employees to declare their assets. In 2016, the Rada enacted the Law on Public Procurement, the purpose of which is to ensure effective and transparent procedures for public procurement, create a competitive environment, and reduce corruption risks. The law was amended in 2018 and again in 2019 to make public procurement more efficient and to align the legislation with European directives. **In 2018, Cabinet Decree 357 on state electronic information resources established a single interoperable system of public registries** (Trembita) to underpin seamless e-government services and prevent duplication of registries. In 2021, the Rada adopted the Law on Public Electronic Registries that regulates the functioning of registries.[87]

Regarding connectivity Ukraine has The Law on electronic communications and the Law on the national commission for the state regulation of electronic communications, radio frequency spectrum and provision of postal services ('the Law on regulator'). These two core laws are

[86] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[87] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

approximated with Directive (EU) 2018/1972, which establishes the European Electronic Communications Code.[88]

Regarding open data, Ukraine updated its open data strategy in June 2022.[89]

In 2021, the Rada enacted the Law on Public Electronic Registries (more below under data registries sub-section).

Regarding cybersecurity, Ukraine's National Security and Defence Council is implementing a national cybersecurity strategy.[90]

Other critical areas, such as emerging technologies (e.g., AI, blockchain, cloud), should receive special attention by defining nationwide strategies and policies. There is no single overarching national strategy document specifically focused on emerging technologies like data, AI, blockchain, and cloud technologies in Ukraine. However, there are indications that these areas are receiving attention, albeit potentially needing further development. There are some enablers:

- Focus on Digitalization: Ukraine's Ministry of Digital Transformation leads the charge in digitizing government services. This inherently involves aspects of data and cloud technologies.
- "Army of Drones" Initiative: This wartime effort highlights Ukraine's embrace of technology for national defence, potentially including AI for data analysis and drone control[91].

To ensure comprehensive development in these areas, it is crucial to define nationwide strategies and policies specifically tailored to emerging technologies. This will help to harness their full potential, address any associated risks, and ensure that Ukraine remains competitive and secure in the digital age. [92]

In December 2023, the Cabinet of Ministers adopted a resolution approving the provisions on the **Unified Information System of the National Informatization Program**, which will make it possible to implement digital technologies faster, create, modernize and develop information and information and communication systems, informatization tools, as well as increase cyber protection of critical information infrastructure.

Ukraine's digital transformation has been a decade-long journey, driven by comprehensive government initiatives, private sector investments, and international support. There has been progress in digitalizing government services, as evidenced by the development of platforms like Diia and the establishment of the Ministry of Digital Transformation. Key strategic documents and laws, such as the Concept of Development of the Digital Economy and Society of Ukraine and the Law on Public Electronic Registries, have laid a strong foundation for continued progress. Despite challenges posed by the ongoing conflict, including cyber threats and infrastructure damage, Ukraine remains committed to enhancing its digital infrastructure and services. **To sustain and accelerate this progress, it is essential to develop robust national strategies for emerging technologies, ensure cybersecurity, and bridge the digital divide**. Continuous improvement and alignment with European standards will be critical for Ukraine to fully realize its potential as a modern digital economy.

[88] EC report on Ukraine, 2023, Communication on EU Enlargement Policy
[89] EC report on Ukraine, 2023, Communication on EU Enlargement Policy
[90] EC report on Ukraine, 2023, Communication on EU Enlargement Policy
[91] https://u24.gov.ua/uk/dronation
[92] EU4Digital: supporting digital economy and society in the Eastern Partnership eGovernance report - Ukraine

4.2. CONNECTIVITY, DIGITAL INFRASTRUCTURE

4.2.1. Connectivity in numbers

Ukrainian households have reached access to the internet on the EU comparable level. The sociological survey by the Kyiv International Institute of Sociology on behalf of the UNDP shows that **the number of Ukrainians who use the Internet daily increased from 72% to 80% in 2023**[93]. Approximately 11% of households have no internet access at all[94]. As more investments are made in rebuilding roads, laying fibre, and reaching those not served will be a critical part of reconstruction. National-level initiatives to address digital inclusiveness through strategic programmes are in place.[95]

Ukraine's telecom sector, despite being a prime target of Putin's war, has proved resilient. Telecommunications, postal services, and broadcasts have adapted to war conditions, and basic services are maintained. Ukraine progressed in building telecommunications infrastructure before the war, though some of these have been set back by the Russian invasion. **As of February 24, 2022, 90% of Ukraine was covered by fibre-optic networks**, meaning there was the technical ability to connect to fixed broadband internet. 89% of citizens have access to LTE (mobile communication) from at least two operators[96]. The diversification of the market with numerous large and small providers promotes competitive prices (lowest in the ITU Europe region) and resilience[97]. Access to the internet and the quality of data transmission have decreased due to Russia's destruction of digital infrastructure and attacks on energy facilities. As of August 2023, a quarter of internet networks and more than 4000 mobile base stations had been destroyed or damaged[98]. As of February 2023, the estimated loss to the Ukrainian telecommunications sector was more than $2.2 billion[99]. The damage has been concentrated in three oblasts, with Kyiv accounting for 37% of the damage, Kharkiv 19%, and Donetsk 17%[100].

The Ukrainian journey of digital transformation has led to a substantial number (15.5 million) of users of the Diia app. As of December 2023, a mere 22 months after the full-scale invasion by Russian Federation began, use of Diia has increased 27% to 19.8 million users[101]. 51% of Ukrainians said that they used Diia at least once during 2023.

4.2.2. Current shortcomings and activities in place to reach goals

Ukraine still has no 5G mobile network and does not seem, for the moment, to have plans to implement the EU toolbox for 5G security.[14] The transmission capacities of 5G offer extensive opportunities, such as managing transportation in real-time, conducting detailed weather research, and coordinating thousands of AI-driven vehicles. However, the expansion of internet capabilities also increases various economic sectors' dependence on its functionality, especially critical infrastructure enterprises. The risks of implementing 5G technology in Ukraine are exacerbated by potential Russian attacks on telecommunications infrastructure. Additionally,

[93] Analytical report: Opinions and views of the population of ukraine regarding government electronic services.
[94] https://www.undp.org/uk/ukraine/press-releases/ukrayintsi-staly-chastishe-korystuvatysya-internetom-80-onlayn-shchodnya-sotsopytuvannya
[95] EU4Digital: supporting digital economy and society in the Eastern Partnership eGovernance report - Ukraine
[96] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[97] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[98] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[99] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[100] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[101] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

some tasks related to freeing up the radio spectrum for 5G networks cannot be carried out during a state of war, as it is used by the military.

The introduction of 5G technology will provide new opportunities for both civilian and military uses, but increasing network bandwidth without improving monitoring capabilities will significantly heighten the vulnerability of Ukrainian infrastructure to cyberattacks. Therefore, implementing 5G should particularly focus on cybersecurity. **To introduce 5G in Ukraine, it is necessary to free up radio frequencies that are used in the 5G network**. Currently, these frequencies are occupied by television, which could operate in lower ranges. After this, auctions for the use of these radio frequencies and the certification of equipment providers for infrastructure development need to be conducted. The first steps in this direction have already been taken. On February 28, 2023, the Supreme Court of Ukraine denied LLC "Ukrainian Modern Technologies" the extension of the license to use the radio frequency resource in the 3400...3600 MHz bands for broadband radio access[102]. This decision allows new auctions to be held on frequencies used for the 5G internet network.

However, **the issue of cybersecurity for future fifth-generation mobile internet networks needs to be addressed first.** Additionally, amendments to the Law of Ukraine on Electronic Communications and the Law "On the Basic Principles of Cybersecurity of Ukraine" are required. Currently, **bill** No. 8087 is being prepared for the second reading, which aims **to implement the requirements of the "European Union Directive on Network and Information Security (NIS2)**" into Ukrainian legislation. It is also advisable to start consultations and implementation of the "EU 5G Cybersecurity Toolkit." Since it does not impose very strict time constraints on achieving the EU's strategic and technical goals, a roadmap prepared in advance for implementing these norms and goals into Ukrainian legislation could significantly facilitate the process of developing the fifth-generation mobile internet network in Ukraine.

4.2.3. Cybersecurity

The main regulatory and legal documents shaping the policy of Ukraine in the field of cyber security are the **Cyber Security Strategy of Ukraine**, approved by the Decree of the President of Ukraine dated March 15, 2016 No. 96/201666 and the Law of Ukraine **"On the Basic Principles of Ensuring Cyber Security of Ukraine"** No. 2163-VIII67. These documents determine the main subjects of decision-making in the field of cybersecurity.

In 2016, to coordinate and control the activities of security and defence sector entities that provide cyber security in the relevant areas, the **National Coordination Center for Cyber Security** (NCCC) was established by the Decree of the President of Ukraine. It is a working body of the National Security and Defence Council of Ukraine.

The decree of the President of Ukraine No. 27 of January 28, 2020, strengthened the capabilities of the NCCC and changed the format of its activities, in particular, private sector specialists were involved in the work, who specialize in cyber defence. The strengthened NCCC has become a "hub", a digital platform, an analytical centre for monitoring, detecting, neutralizing, forecasting potential cyber threats, and preventing them in the future in both the public and private sectors[103]. The creation and maintenance of a single database for the exchange of information about cyber incidents will allow coordinating the activities of all cybersecurity subjects, not only in individual sectors, but also at the level of the entire state.

[102] Reveiw of the Supreme Court's case law on resolving economic disputes under martial law https://court.gov.ua/storage/portal/supreme/voenstan_KGS.pdf
[103] https://www.rnbo.gov.ua/ua/Diialnist/7086.html

Ukraine's National Security and Defence Council is implementing a national cybersecurity strategy. The State Service for Special Communications and Information Protection of Ukraine operates the Government Computer Emergency Response Team of Ukraine - CERT-UA. Its computer emergency response team, CERT-UA, has received international accreditations[104] and is taking steps within the overall framework of the EU-Ukraine cyber dialogue towards closer institutional cooperation with EU counterparts, including the European Union Agency for Cybersecurity and CERT-EU. Ukraine adopted regulations regarding cyber incidents as of 9 February 2023 **to move towards alignment with the requirements established at the EU level by the framework for a high common level of cybersecurity across the EU (NIS 2 framework**[105]).

In conclusion, Ukraine has shown resilience and progress in digital infrastructure despite the ongoing full-scale invasion by Russian Federation. It has maintained basic telecommunications and advanced its digital transformation through widespread internet use and adoption of the Diia app. However, the war has severely damaged the telecom sector, requiring major repairs, especially in hard-hit areas. Rebuilding efforts must prioritize 5G expansion and stronger cybersecurity. Achieving this will require strategic planning, regulatory reforms, and collaboration with private sector experts. The creation of a centralized cyber incident database and alignment with EU cybersecurity standards have enhanced Ukraine's cyber defence. Continued focus on proactive threat detection, legislative updates, and a responsive cybersecurity strategy will be key to strengthening digital resilience.

4.3. DIGITAL IDENTITY

As of 2024, Ukraine exhibits a sophisticated **digital identity landscape, integrating both state-developed solutions and private sector offerings**. The country has a robust digital identification framework and **aligns with European standards**, enhancing interoperability on an international scale.

The groundwork was laid well, driven by proactive government initiatives such as the "eGovernment Strategy 2016-2020." This strategy aimed to streamline public services and enhance citizen engagement through digital channels, with a core focus on improving transparency and efficiency within government authorities. Digital identity solutions became a key tool in this endeavour, facilitating secure online access to services. Ukrainians, known for their tech-savvy reputation, readily embraced these digital solutions, providing valuable user feedback that helped refine the system.

The introduction of the Diia app in 2019 proved to be a turning point. Diia offered a user-friendly platform for citizens to access various government services, from obtaining official documents to filing taxes, significantly boosting the adoption of digital services. **Built with robust security features and leveraging biometric authentication, Diia instilled trust in users, crucial for widespread acceptance. The ongoing full-scale invasion by Russian Federation highlighted Diia's true potential, as it became a vital tool for displaced Ukrainians to access essential services remotely. Public-private partnerships have also played a critical role** in fostering innovation and ensuring the system remains adjustable. By adhering to European digital identity

[104] https://www.first.org/members/teams/cert-ua
[105] EC report on Ukraine, 2023, Communication on EU Enlargement Policy

regulations, Ukraine facilitates data exchange and regional cooperation, showcasing the digital identity as an example of successful digital transformation.

4.3.1. State-developed solutions and private sector offerings

Ukraine's digital identity system encompasses eID, Bank ID, and Mobile ID, forming a comprehensive ecosystem. Recently, Ukraine achieved a milestone by becoming the first country where a digital ID is universally valid within its borders and the fourth in Europe to introduce a digital driving license. **Currently, about 70% of Ukrainian citizens are equipped with digital IDs**. These are utilized for storing essential documents like biometric passports, tax IDs, and driver's licenses, and for accessing a wide array of public services.

Diia, a central hub for digital identification, plays a key role in this ecosystem. It provides secure storage and easy access to digital versions of passports, driver's licenses, and tax IDs, among other documents. **Diia's functionality extends beyond storage; it allows for the electronic sharing of documents with authorized entities, facilitating various processes that require document verification. The platform has achieved a high adoption rate, with over 50% of Ukrainians having an account**[106]. It enables users to interact with government services online, significantly reducing bureaucratic hurdles and streamlining interactions like business registrations, benefits applications, and even wartime communications.

4.3.2. Uptake of Public Sector Solutions by the Private Sector

The integration of public sector digital solutions into the private sector has been substantial. **Businesses now routinely utilize the Diia platform for verifications and registrations**, promoting a more efficient, paperless, and transparent operational environment. For example, PrivatBank uses Diia. Sign to verify the identity of clients and securely electronically sign documents. This simplifies the process of opening accounts and obtaining loans, as well as enhances trust between the bank and its clients.[107] Nova Poshta offered its clients the ability to track parcels using Diia. Sign, sign electronic waybills, and receive delivery notifications in the Diia app. This saves time and paper and makes the delivery process more transparent.[108]

Individual entrepreneurs can register their business using the Diia.Entrepreneurship platform in just a few minutes, without the need to visit government offices. This makes the registration process more convenient and accessible and stimulates the development of small and medium-sized enterprises.[109] Limited Liability Companies (LLCs) can also register online using Diia.Entrepreneurship. This saves time and money and makes the registration process more transparent. Entrepreneurs can then obtain extracts from the Unified State Register, submit reports to the tax service, register for licenses and permits, and access other government services online via the Diia platform. This saves time and resources and makes interactions with the government more convenient.

[106] https://www.undp.org/uk/ukraine/press-releases/ukrayintsi-staly-chastishe-korystuvatysya-internetom-80-onlayn-shchodnya-sotsopytuvannya
[107] https://en.privatbank.ua/privat24
[108] https://novaposhtaglobal.ua/en/
[109] https://business.diia.gov.ua/

4.3.3. eIDAS compliance

Ukraine's **alignment with the EU's eIDAS regulation** underscores its commitment to adhering to European standards for electronic identification and trust services. The cooperative work plan adopted with the EU in January 2021[110] set the stage for significant legislative and technical advancements. By the end of 2022, Ukraine had legally recognized, on an experimental basis, qualified electronic signatures from EU member states. Furthermore, **it became the first non-EU country included in the EU's trusted list of third countries**, a critical step that facilitates the validation of electronic signatures and seals within the EU.

In December 2022, the Ukrainian parliament passed legislation to ensure the mutual recognition of qualified electronic trust services between Ukraine and the EU[111]. This law mandates a conformity assessment for qualified trust service providers, based on a model mirroring that of the EU. Such developments not only enhance the security and reliability of digital transactions but also pave the way for seamless business and administrative interactions between Ukraine and EU countries.

In conclusion, **Ukraine's digital identity landscape as of 2024 exemplifies an integration of state-developed solutions and private sector offerings, aligning with European standards**. The groundwork for this system was laid through proactive government initiatives such as the "eGovernment Strategy 2016-2020," which aimed to streamline public services and enhance citizen engagement via digital channels. **The introduction of the Diia app in 2019 marked a significant turning point, providing a user-friendly platform for accessing various government services** securely, which proved invaluable during the ongoing conflict. Public-private partnerships have further fostered innovation, ensuring adaptability and high adoption rates, with over 70% of Ukrainians now using digital IDs[112]. These IDs, stored and managed through Diia, facilitate interactions with both public and private sector services, significantly reducing bureaucratic hurdles. The integration of digital identity solutions into the private sector has promoted a more efficient and transparent operational environment. Ukraine's adherence to the EU's eIDAS regulation underscores its commitment to European digital identity standards, enhancing the security and reliability of digital transactions and fostering seamless interactions between Ukraine and EU countries.

4.4. DIGITAL SERVICES

4.4.1. Overall maturity of public and private sector services

Initial efforts to digitize government started in 2012 with assistance from the Organization for Security and Cooperation in Europe (OSCE) and the eGovernment Academy (eGA) of Estonia[113]. After the November 2013-February 2014 Maidan Uprising in Ukraine, which led to the ousting of Russia-leaning President Yanukovych, the government of Petro Poroshenko developed action plans and the underlying architecture for e-government services. **The first significant innovation was in 2015 with the e-procurement platform Prozorro,** which increased transparency (thereby reducing corruption), intensified competition for government bids, and reduced costs. **It was followed three years later with e-services for citizens and businesses built on the**

[110] https://thedigital.gov.ua/storage/uploads/files/news_post/2021/1/lyudmila-rabchinska-ukraina-ta-es-spivpratsyuvatimut-zadlya-vzaemnogo-viznannya-elektronnikh-dovirchikh-poslug/20_12_08_EU_UA_Joint_Working_Plan_on_mutual_recognition_of_trust.pdf
[111] https://zakon.rada.gov.ua/laws/show/2801-20#Text
[112] https://ukraine.ua/invest-trade/digitalization/
[113] https://ega.ee/ukraine-egovernance-democracy-are-two-sides-coin/

interoperable platform Trembita that links a series of independent registries (population, business, cadastre, etc.) and enables digital public services via the personal phone app Diia.

Ukraine has an advanced e-government system, where people have easy access to public services. The government launched its vision for electronic public service design and delivery, known as 'The State in a Smartphone', in 2019. It resulted in the rapid development of electronic services and has proven its resilience and adaptability throughout the war. Digital governance has increased the efficiency and transparency of the government and facilitated government-citizen dialogue. The unified web portal for electronic services, **Portal Diia, enables access to the most popular electronic public services (120 in total). Electronic public services are also available in the Diia mobile application** (25 services) as well as on other web resources of public authorities. The mobile application is used by 17.3 million users and is installed on more than 32 million devices.[114] Further, Diia can be integrated into various payment systems, enabling users to pay for government and private services and fees. Digital creation, signing, storage, and sharing of documents; Diia allows the transfer of copies of documents.

The war catalysed extensive advancements, including cloud-based data storage, low-code development tools, improved cryptography standards, and European acceptance of Ukrainian digital credentials. The Ukrainian journey of digital transformation has led to 15.5 million users of the Diia app accessing numerous benefits and capabilities described above. As of December 2023, a mere 22 months after the war with Russia began, usage of Diia has increased 27% to 19.8 million users[115]. To view what Diia services are offered, please refer to Annex 1, copied from p.17 in Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of full-scale invasion by Russian Federation.

4.4.2. Current shortcomings and activities in place to reach goals

The overarching digital services framework does not exist. Before moving to the re-engineering of public services, it is advisable to set standards and requirements for a unified national approach for the development, delivery, management, and improvement of digital public services across different agencies[116].

In conclusion, Ukraine's digital services landscape has evolved significantly since its initial digitization efforts began in 2012 with assistance from international partners. The post-Maidan Uprising government accelerated digital transformation with key innovations like the e-procurement platform Prozorro in 2015, which enhanced transparency and competition, and the interoperable platform Trembita in 2018, facilitating digital public services via the Diia app. The launch of the 'State in a Smartphone' initiative in 2019 further propelled the development and resilience of electronic services, even amid the ongoing conflict. The Diia platform, with over 21 million users and installation on more than 32 million devices[117], offers comprehensive digital services, including document management and payment integration. The full-scale invasion by Russian Federation has spurred advancements in cloud-based data storage, low-code development tools, improved cryptography standards, and European recognition of Ukrainian digital credentials. Despite these achievements, a unified national framework for digital services is still lacking. **Setting standards and requirements for a cohesive approach to developing, delivering, managing, and improving digital public services across agencies is crucial for further progress**. The impressive growth of the user base of the "Diya" system, driven by the growth in the number of

[114] EC report on Ukraine, 2023, Communication on EU Enlargement Policy
[115] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war
[116] EU4Digital: supporting digital economy and society in the Eastern Partnership eGovernance report - Ukraine
[117] https://thedigital.gov.ua/news/21-mln-ukraintsiv-koristuyutsya-dieyu

online services, which reached 130 by December 2024[118] underscores the system's importance and potential. Continued focus on standardization and strategic planning will ensure Ukraine's digital services can meet current and future needs effectively.

4.5. DATA MANAGEMENT

4.5.1. Registries, data composition

The base registers are digitized, and their connectivity is enabled and regulated by the law on registries. As the law on registers was introduced recently[119], the new legislation should receive the necessary support to enforce it by ensuring that the capacity in agencies is sufficient for the implementation. **Digital document management is in place within most central public organizations and is supported by digital archiving.**

The government has adopted a resolution on the use of a Platform for the rapid creation and management of state registries. **Teams from the Ministry of Digital Transformation and the State Special Communications are working on an innovative solution — a Platform for the deployment and support of state electronic registries.** Thanks to this tool, ministries and government agencies will quickly and conveniently create and manage public registries.

The basis for a digital state is electronic registries with quality data and rapid exchange between different government bodies. Currently, Ukraine has over 450 state registries, 80% of which are technologically outdated and vulnerable to cyberattacks.[120] The deployment Registries Platform will become a basis for digital transformation. All data will be orderly stored in registries, which will accelerate the launch of online services and digitalization in general. On the Registries Platform, it is possible not only to create new registers but also to technically overhaul and gradually transfer outdated registries. All changes are recorded and occur only through business processes, preventing unauthorized data modifications. Additionally, developing registries on the Platform does not require large teams or high-level specialists. **The platform has already been tested and will soon be launched for many government bodies.** Furthermore, Ukraine will be able to share its experience in implementing the Platform with other countries that are actively undergoing digitalization.

While Ukraine is making progress with digital registers in eGovernment, it's likely still under development. Here's a breakdown to assess the state.

Enabling conditions:

- The dedicated platform for creating and managing registers signifies a commitment to digitalization, indicating a move away from paper-based systems towards increased efficiency and transparency.

Potential challenges:

- New systems can take time to fully implement and integrate seamlessly, and robust data security and privacy measures are essential to protect citizen information.
- Widespread adoption by government agencies and citizens might take time, necessitating a gradual and persistent approach to implementation.

Needs for further development:

[118] https://digitalstate.gov.ua/projects/govtech/diia

[119] https://zakon.rada.gov.ua/laws/show/1907-20

[120] https://www.kmu.gov.ua/news/mintsyfry-platforma-dlia-rozghortannia-reiestriv-stane-osnovoiu-dlia-tsyfrovoi-transformatsii

- It's likely there are still registers that have not been digitized, and public awareness campaigns might be needed to educate citizens on how to access and use the new eGovernment services.
- Continuous improvement of the platform's functionality and user experience is important to ensure it meets the evolving needs of its users.

Overall, while it's a positive step, it's likely an ongoing process. To ensure success, there should be a focus on providing adequate support and resources for implementation, addressing potential challenges, and continuously improving the system.

4.5.2. Data exchange through services

In Ukraine, Trembita is the interoperability platform created with the financial support of the EU. The platform is centrally operated by the Ministry of Digital Transformation. Data exchange through the platform is regulated. However, **only the public sector uses the platform**. Harmonization with international cryptography standards will provide benefits such as (1) interoperability with other products/vendors conforming to the standards, (2) adequate protection of sensitive government data, and (3) saved costs on additional developments and technology audits. **EU4Digital has suggested enabling and coordinating the usage of the interoperability platform in the private sector**[121]. It is recommended to consider expanding the use of the interoperability platform in the private sector to further facilitate data exchange. **Expanding data exchange with the private sector would facilitate better cooperation and wider digitalization of government services**.

Launched in 2020, Ukraine's e-government services through the Diia application—built on the Trembita interoperable data exchange system—are characterized by low construction and maintenance costs, high resistance to corruption, and improved, faster services for citizens with mobile phone and computer access. These services align with international and open contracting data standards, as well as statistical and risk-management tools and innovation.[122] Ukraine is now sharing aspects of the Diia application with other governments, including Estonia.[123]

Trembita is an interoperable, decentralized platform launched in 2018. While modelled on Estonia's X-Road solution, it differs in adapting global best practices to Ukraine's needs (such as the Diia app and Diia e-services) and using cryptography standards conforming to Ukrainian regulation (as opposed to X-Road, which conforms to European and American cryptography standards). Due to the need to conform to different standards, licensed technology from the Estonia-based company Cybernetica uses its Unified Exchange Platform. Like X-Road, key elements of Trembita's security are that[124]:

- Officials do not have direct access to the individual's data.
- Data is encrypted during transmission and storage.
- Data entered or modified is signed with a digital signature and registered.
- Logs and backups can be placed in separate secure storage.

Collectively, these institutional and technological reforms and policies contributed to meaningful improvements in transparency and efficiency and set the stage for wider transformation. **Trembita facilitated the exchange of information across hundreds of government registries**.

[121] https://eufordigital.eu/countries/ukraine/
[122] World Bank, "YOUKraine: Because Prozorro," slide 14
[123] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.
[124] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

In 2021, the Rada enacted the Law on Public Electronic Registries. Significant changes required under the law included: a prohibition of data duplication (an individual inputs personal data only once); a stipulation mandating that any new registries should be included in the Registry of Registries; common requirements for the development and functionality of registries; a requirement that data exchange between government registries must be through Trembita; and a right of citizens to be informed when their data is accessed. **As of 2023, there were more than 450 public electronic registries hosted by more than seventy government bodies, the largest number being the Ministries of Economy (38) and Justice (33)**[125].

Legislative measures were also put in place to recognize the data privacy rights of citizens[126]. The Ukrainian Law on Public Electronic Registries and the EU's General Data Protection Regulation (GDPR) share several key principles but also exhibit significant differences. Both frameworks emphasize data minimization, transparency, accountability, and standardization. **The Ukrainian law limits the collection of personal data to what is strictly necessary, prohibiting data duplication**, while the GDPR imposes similar restrictions. Both laws ensure citizens' rights to access and control their data, with the Ukrainian law guaranteeing the right to be informed when data is accessed, paralleling the GDPR's right of access. Additionally, both frameworks promote consistent standards for data management, with the Ukrainian law establishing common requirements for registries and the GDPR outlining principles for data processing across the EU.

However, there are notable differences between the two. The GDPR applies to all organizations processing the personal data of EU residents, regardless of location, while the Ukrainian law is specifically focused on public electronic registries. The GDPR is enforced by national data protection authorities with significant powers, whereas the enforcement mechanisms for the Ukrainian law are less clear. Additionally, the GDPR has stricter requirements for notifying authorities and data subjects about data breaches.

To align more closely with the comprehensive standards of the GDPR, the Ukrainian Law on Public Electronic Registries could benefit from several enhancements. Clearer and more robust enforcement mechanisms are necessary to ensure compliance. Granting citizens additional rights, such as the right to rectification and erasure of their data, would strengthen the law. Moreover, including more specific requirements for data security measures to protect against unauthorized access or breaches is crucial. Overall, while the Ukrainian law is a positive step towards protecting data privacy rights and promoting data governance, there is room for significant improvement.

For example, Diia works on the principle of “data in transition.” It stores only depersonalized data, which is required for operation needs, and does not store any personally identifiable information (PII) of users but displays information from various state registers and information systems. Users can access personal documents such as identification documents, driver’s license, passport, social security number, and student ID.

While Diia, the app, puts digital identity in the hands of citizens, Diia.Engine operates behind the scenes, forming the backbone of data management for Ukraine's digital state. Here's how this platform contributes:

- **Streamlined Register Creation:** Before Diia.Engine, government agencies struggled to create and manage digital registers. The platform offers a user-friendly interface with pre-built tools,

[125] https://www.kmu.gov.ua/news/mintsyfry-platforma-dlia-rozghortannia-reiestriv-stane-osnovoiu-dlia-tsyfrovoi-transformatsii
[126] Ingram, G., & Vora, P. (2024). Ukraine: Digital resilience in a time of war.

allowing agencies to develop new registers or update existing ones efficiently. This eliminates the need for complex coding or extensive IT resources.

- **Enhanced Data Exchange:** One of the biggest hurdles with traditional registers was their isolation. Data was not easily exchanged between different systems, hindering the development of comprehensive digital services. **Diia.Engine fosters interoperability**. Registers built using the platform can communicate seamlessly, allowing data to flow securely between government agencies. This facilitates the creation of integrated services that leverage information from multiple sources.
- **Cost-Effectiveness:** Developing and maintaining custom digital registers can be expensive. Diia.Engine offers a standardized approach, reducing the need for custom coding and specialized IT teams. This translates to significant cost savings for government agencies.
- **Scalability and Security:** The platform is designed to be scalable, accommodating the growing number and complexity of digital registers. Additionally, Diia.Engine prioritizes robust security measures to safeguard sensitive citizen data. This ensures the integrity and trustworthiness of the information stored within the registers.

In summary, **Diia.Engine acts as a game-changer for data management in Ukraine's digital transformation**. By simplifying register creation, enabling data exchange, and offering a cost-effective and secure solution, the platform paves the way for a more efficient and interconnected digital state. This allows the Ukrainian government to deliver a wider range of digital services to its citizens, streamlining bureaucracy and fostering a more digital future.

4.5.3. Open Data, Personal data protection

Public data, i.e., data collected by government agencies during their functioning, should be constantly and freely accessible. Access to public information in the form of open data leads to increased transparency and efficiency in public administration, reduces corruption, and promotes democratic processes. Access to more comprehensive information improves the quality of decisions made by both organizations and individuals and expands opportunities for residents to participate in the social and political life of cities. Ukraine has a developed civil society that is interested in the disclosure of more public data[127].

Ukrainian open data policy supports the reuse of open data by both the public and private sectors. Ukraine has achieved a high level of transposition of the Open Data Directive. The Ministry of Digital Transformation drafted a new open data strategy in June 2022. According to the EU Open Data Maturity Report 2022, Ukraine ranks second (after France) in the overall index and is also the best performer among the candidate countries[128]. As Ukraine is in the process of updating the legislation on data protection and privacy, there will be a need to harmonize the approach with the General Data Protection Regulation (GDPR) and the Council of Europe Convention 108 (COE) requirements.

In Ukraine, the issue of **personal data protection is regulated by several legislative acts**, the main one being the Law of Ukraine "On Personal Data Protection," which came into force in 2011. This Law establishes the general principles and legal foundations for the protection of personal data in Ukraine, defines the rights of personal data subjects, and the obligations of personal data controllers.

Some key provisions of the Law include:

[127] https://www.usaid.gov/uk/ukraine/civil-society-governance

[128] Open data maturity report 2022: https://www.capgemini.com/us-en/insights/research-library/open-data-maturity-report-2022/

- Consent to process personal data: The processing of personal data is possible only with the consent of the personal data subject. The consent must be free, expressed in written form, or in a form that allows a conclusion to be made about the consent.
- Right to access one's data: A personal data subject has the right to know what personal data is being processed, for what purpose, in what way, and to whom this data is provided.
- Right to correct one's personal data: A personal data subject has the right to demand from the personal data controller the correction of their personal data if it is inaccurate or incomplete.
- Right to block one's personal data: A personal data subject has the right to demand from the personal data controller the blocking of their personal data in cases stipulated by the Law.
- Right to delete one's personal data: A personal data subject has the right to demand from the personal data controller the destruction of their personal data in cases stipulated by the Law.
- Protection of special category personal data: The processing of personal data concerning racial or ethnic origin, political, religious, or philosophical beliefs, trade union membership, as well as health, sexual life, or biometric data, is only possible with the personal data subject's written consent.

It is important to note that on May 25, 2018, the General Data Protection Regulation (GDPR) came into force in the European Union. **Ukraine aims to align its data protection legislation with the GDPR**, and on October 25, 2022, the Draft Law "On Personal Data Protection" No. 8153 was registered in the Verkhovna Rada of Ukraine, which provides for the reform of the personal data protection sphere in Ukraine and bringing Ukrainian personal data protection legislation in line with European standards.

4.5.4. Data analysis and application in policy planning

The Ministry of Digital Transformation's priorities for the near and medium term are centred around emerging technologies, including artificial intelligence (AI), augmented reality, and machine learning (ML). One notable project in this realm is **BI Government**, **a collaboration between the Ministry of Digital Transformation and the State Statistics Service**. This initiative aims to **optimize decision-making** at the state level, harnessing the power of data-driven insights.[129]

At the same time, considering the implementation of state electronic registers and information systems, more and more government bodies rely on data analysis from these systems when developing policies. For example, **the Ministry of Economy actively uses data from the Prozorro electronic procurement system when drafting regulatory acts governing the field of public procurement**.

Overall, Ukraine's data management system has seen significant advancements with the **digitalization of base registers** and the **establishment of a robust legal framework**. The introduction of the Platform for the rapid creation and management of state registries, supported by the Ministry of Digital Transformation and the State Special Communications, marks a pivotal step in accelerating the deployment and modernization of state electronic registries. **Despite over 450 state registries, 80% remain technologically outdated, posing cybersecurity risks[130]**. The new platform, designed for easy creation and management of registries, aims to address these issues, enhance interoperability, and ensure secure data handling.

[129] Gridin, K. & Kurochka, N. (2023). OPINION: How Ukraine Is Becoming the World's Number One Digital Government, Kyiv Post Oct 23, 2023: https://www.kyivpost.com/opinion/23136

[130] https://www.kmu.gov.ua/news/mintsyfry-platforma-dlia-rozghortannia-reiestriv-stane-osnovoiu-dlia-tsyfrovoi-transformatsii

Furthermore, **Trembita, Ukraine's interoperability platform, facilitates secure data exchange across government bodies and is poised for potential expansion into the private sector**. This platform, built on international cryptography standards, enhances efficiency, transparency, and data protection. However, challenges remain, including **the need for comprehensive standards for developing, delivering, and managing digital services across agencies**, as well as ensuring data security and privacy measures. Public awareness and gradual adoption are crucial for the successful implementation of these digital systems. Ukraine's commitment to aligning with the EU's GDPR underscores its dedication to data protection, transparency, and citizen rights. By leveraging platforms like Diia.Engine, which simplifies register creation and enhances data exchange, Ukraine is paving the way for a more efficient and interconnected digital state. Continued focus on addressing current shortcomings, **standardizing processes, and enhancing user experience will be essential** for sustaining and advancing Ukraine's digital transformation.

4.6. Skills

4.6.1. Overall, digital literacy, interventions to increase

In 2020, less than half of the women of Ukraine were using public digital services[131]. 47% of Ukrainians who did not use public electronic services in 2022 cited a lack of skills as the main reason. **From 2019 to 2023, the share of Internet users in the total structure of the population increased by 8% and now amounts to 94%.** The frequency of Internet use practices is directly related to the respondent's age. Among the category of 60–70-year-olds, 71% of respondents use the Internet every day, and among the youngest adults (18–29 years old), it is 96%. As of 2023, the following shares of population groups have digital skills: 93% adult population of Ukraine aged 18–70 (+8% since 2019), 95% people aged 10–17, 99% people with hearing impairments, 18-59 years old (+15% in 4 years)[132].

This rapidly evolving employment landscape is creating a critical need for effective training strategies to help Ukrainians remain competitive. The updated and upgraded version of **Diia.Education** is supported by Google and the Eastern Europe Foundation. It offers a unique range of functions that allow users to create personalized learning trajectories and tailored educational courses focusing on their specific interests and objectives. Users can also take career-oriented tests along with standardized national digital literacy tests. There are more than 50 different job-specific educational series to choose from, covering jobs ranging from SMM specialist to baker[133]. Additional training tools focus on digital literacy, entrepreneurship, creativity, and more. Crucially, the upgraded platform now also features a job search function. Diia.Education has become a popular tool for Ukrainian schools. According to the Ministry of Education and Science, as of May 2024, the app is used by over 5 million students, parents, and teachers[134].

The Ministry of Digital Transformation, together with partners, has completed its "Development of Digital Education Hubs Libraries' Capabilities" project, which it started in October 2022. As part of the project, representatives of the Ukrainian Library Association conducted a weeklong online training course for trainers of librarians working in the regional training centres in each region. After their studies, the trainers held further sessions for the librarians who are acting as the

131 https://ukraine.un.org/en/161405-gender-digital-divide-ukraine-causes-consequences-and-ways-overcome
132 https://osvita.diia.gov.ua/uploads/1/8800-ua_cifrova_gramotnist_naselenna_ukraini_2023.pdf
133 https://osvita.diia.gov.ua/
134 https://digitalstate.gov.ua/news/govtech/ukraine-accelerates-e-literacy-through-public-infrastructure

coordinators of the Hubs in 12 regions of the country[135]. The coordinators, in turn, teach citizens digital skills.

4.6.2. Data literacy

In 2019-2023, the study of digital skills of Ukrainians was conducted within the framework of the EGAP programme with the support of the Eastern Europe Foundation and the Innovabridge Foundation in partnership with the Ministry of Digital Transformation of Ukraine. The level of digital skills of the population has a trend of steady growth. It manifested in the reduction of the share of adults with no digital skills and the increase of the population with the level of basic skills and above. As of 2023, the following shares of population groups have digital skills: 93% adult population of Ukraine aged 18–70 (+8% since 2019), 95% of teenagers aged 10–171, 99% of people with hearing impairments, 18 59 years old (+15% in 4 years). Digital skills for individuals below the basic level have improved by over 12 % over the past 4 years[136].

The greatest development has occurred in informational and communication skills, as well as in digital content creation skills. Digital content creation skills increased by 6.7% over the period from 2019 to 2021[137]. The ability to create and edit content is quite widespread. About 52.2% of the population have basic and above-basic skills in this area[138]. Ukrainians actively use software for text processing, creating presentations, working with data (Excel), editing photos, videos, and audio, as well as coding in programming languages[139].

Open data is also widely used for various purposes, such as downloading software, music, video files, games, etc. About 77.6% of the population use the Internet to watch videos, 71.0% to search for information about goods and services, and 45.4% to make calls, including video calls[140]. Internet banking and online shopping are becoming increasingly popular. In 2021, 43.4% of the population ordered goods online, and 39.8% used internet banking[141]. At the same time, Internet security issues are becoming more relevant. 45.7% of the population have encountered security-related problems on the Internet, such as phishing and redirection to fake websites (pharming).

Thus, Ukraine demonstrates significant progress in the use of digital technologies, open data, and digital content creation. However, electronic security issues require more attention as the number of fraud cases and other cyber threats increases.

4.6.3. Cybersecurity programmes

The training of specialists in information security began in 1997. As of 2023, there are **over 60 higher education institutions in Ukraine that offer programs for training specialists in cybersecurity and information protection**; however, **the quality of their training is not always adequate**. The Department of Cybersecurity at the National Technical University (NTU) in Kharkiv was established in 2022. The Department of Cybersecurity is actively cooperating in the field of education and research with leading IT companies (Distributed Lab, Cypher, Microcrypt Technologies)[142]. Despite the growing cyber risk in Ukraine, **few cybersecurity educational**

135 https://www.undp.org/uk/ukraine/press-releases/khaby-tsyfrovoyi-osvity-ponad-3-tysyachi-bibliotek-prodovzhuyut-navchaty-ukrayintsiv-tsyfroviy-hramotnosti
136 https://osvita.diia.gov.ua/uploads/1/8801-en_cifrova_gramotnist_naselenna_ukraini_2023.pdf
137 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
138 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
139 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
140 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
141 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
142 https://www.kpi.kharkov.ua/ukr/department/kiberbezpeka/

programs have been available to early-career professionals and students at Ukrainian universities. To help address this challenge, **CRDF** (Civilian Research& Development Foundation) **Global is working to integrate cybersecurity curricula at the university level to achieve two complementary goals**: strengthen Ukraine's ability to defend itself from foreign hackers and open competitive in-country career pathways for aspiring cybersecurity professionals[143]. With support from the U.S. Department of State, CRDF Global recently hosted a virtual training for Ukrainian university representatives to develop and implement modern cybersecurity academic curricula at eight leading universities across the country. The training is one of three planned curriculum development workshops, and it is designed to improve the universities' abilities to teach students practical skills and prepare them for competitive jobs in IT and cybersecurity[144]. Training the future workforce is critical to building long-term, sustainable local capacity in cybersecurity.

Further, in December 2023, USAID announced the delivery of much-needed equipment donated by Cisco to support education in Ukraine and help prepare the next generation of Ukrainian cybersecurity experts[145]. USAID worked with Cisco and the Ministry of Education and Science of Ukraine to identify immediate equipment and training needs. As part of its Country Digital Acceleration program, Cisco is equipping five instructional labs at Ukrainian universities with state-of-the-art Cisco telecommunications equipment to support the training of a new cadre of cybersecurity experts. To further support the development of Ukraine's digital workforce, almost 200 educational institutions have partnered with Cisco to provide digital skills training to 36,000 learners over the past academic year through the Cisco Networking Academy[146].

In conclusion, Ukraine has made progress in enhancing digital literacy, with comprehensive interventions aimed at increasing digital skills and access. **By 2023, 93% of adults aged 18-70 and 95% of teenagers possessed digital skills[147], reflecting marked improvement**. The Diia.Education platform, supported by Google and the East Europe Foundation, offers personalized learning, career tests, and job-specific courses, now used by over 5 million students, parents, and teachers. The Ministry of Digital Transformation's Digital Education Hubs project further extends training across 12 regions. Data literacy has also improved, with a notable increase in basic skills. Cybersecurity training is advancing, with over 60 institutions offering programs, though quality varies. Initiatives like CRDF Global's curriculum integration, supported by the U.S. Department of State, aim to enhance practical skills and prepare students for competitive IT and cybersecurity jobs[148]. Additionally, USAID and Cisco are equipping universities with advanced telecommunications equipment to train future cybersecurity experts. These efforts highlight Ukraine's commitment to building a digitally literate and cyber-secure society, essential for its ongoing digital transformation and resilience.

143 https://www.crdfglobal.org/what-we-do/cybersecurity/

144 https://www.crdfglobal.org/news/strengthening-cybersecurity-ukraine-building-capacities-local-universities/

145 https://reliefweb.int/report/ukraine/usaid-and-cisco-partner-support-education-and-cybersecurity-ukraine https://reliefweb.int/report/ukraine/usaid-and-cisco-partner-support-education-and-cybersecurity-ukraine

146 https://reliefweb.int/report/ukraine/usaid-and-cisco-partner-support-education-and-cybersecurity-ukraine

147 https://osvita.diia.gov.ua/uploads/1/8800-ua_cifrova_gramotnist_naselenna_ukraini_2023.pdf

148 https://www.crdfglobal.org/news/strengthening-cybersecurity-ukraine-building-capacities-local-universities/

4.7. STATE OF DIGITALISATION OF THE PRIVATE SECTOR AND OVERVIEW OF THE IT SECTOR

4.7.1. IT sector

Ukraine's digital sector has long been a source of pride for the country, which includes over 4,000 local companies and more than 100 global companies [149]. Before the full-scale invasion by Russian Federation, major companies such as Samsung, Microsoft, Boeing, Google, and Ericsson had established subsidiaries in the country. Ukrainian entrepreneurs launched start-ups with global reach, including Grammarly and GitLab. Between 2020 and 2021, the IT sector in Ukraine saw 36 percent growth, from $5 billion in exports of computational services in 2020 to $6.8 billion in early 2021[150].

The prewar achievements of the IT sector in Ukraine are notable. Ukraine-based IT outsourcing companies commonly have specialized skills in cloud, AI, and big data. In 2023, Ukraine ranks third in Europe for open data[151] and is among the first countries to roll out digital COVID-19 certificates recognized by the European Union. Prior to the full-scale invasion by Russian Federation, Ukraine ranked fourth worldwide in the number of certified IT professionals[152]. Despite challenges, the sector has remained resilient and has adapted to wartime. In addition to critical budget support from Ukraine's allies, the digital sector has played a crucial role in keeping Ukraine's economy afloat. The sector has remained a steadfast area of economic growth, with IT industry exports reaching $3.7 billion in the first six months of 2022, a 23 percent increase from that same time in 2021[153].

4.7.2. Use of ERPs by SMEs

In Ukraine, there is a steady **increase in interest in ERP systems** and their implementation. This is evidenced by the growing number of implementation requests, the emergence of new providers, and the expansion of functionalities in existing systems. At the same time, t**he level of ERP system implementation varies significantly depending on the industry**. They are most common in large manufacturing enterprises, logistics companies, and the financial sector [154]. They are less used in small and medium-sized businesses, especially in the service sector. This disparity is due to the greater financial capabilities and the need for comprehensive business process automation in larger enterprises.

In large cities such as Kyiv, Kharkiv, Lviv, and Dnipro, the level of ERP system implementation is higher than in smaller towns and rural areas. Popular ERP systems in Ukraine include:

- BAS ERP;
- SAP;
- Galaktika ERP;
- SyteLine;
- Parus ERP;
- Oracle E-Business Suite;
- Microsoft Dynamics AX;

149 https://ukraine.ua/invest-trade/it-ukraine/
150 https://www.csis.org/analysis/digital-will-drive-ukraines-modernization
151 https://data.europa.eu/sites/default/files/country-factsheet_ukraine_2024.pdf
152 https://www.csis.org/analysis/rebuilding-and-modernizing-ukraines-ict-infrastructure-will-be-essential-attract-private
153 https://dia.dp.gov.ua/en/ukraines-it-industry-brought-in-3-2-billion-in-the-first-five-months-of-the-war/
154 https://www.statista.com/outlook/tmo/software/enterprise-software/enterprise-resource-planning-software/ukraine

- DeloPro.

Some experts estimate the level of ERP system implementation in Ukraine to be between 20% and 30% of all enterprises. However, this figure can be significantly higher in some industries and lower in others.

Overall, the state of ERP system implementation in Ukraine can be described as positive but with certain challenges. Ukrainian enterprises are increasingly recognizing the advantages of ERP systems and are investing in their implementation.

4.7.3. Level of use of e-commerce in companies

In Ukraine, the **Law "On Electronic Commerce"** No. 675-VIII, adopted on September 3, 2015, has been successfully implemented, establishing general rules and specific features for conducting electronic commerce in Ukraine.

According to the European Business Association, **the e-commerce market in Ukraine grew and developed steadily until February 2022, showing an annual growth rate of 20-30% since 2018**[155]. In 2021, its volume amounted to $3,506.98 million; however, in 2022, against the backdrop of the full-scale invasion by Russian Federation, volumes decreased nearly 12 times, to $295.85 million[156]. Nevertheless, in the spring of 2023, the volume of e-commerce in Ukraine returned to pre-war levels and continued its positive dynamics. According to Statista forecasts, in 2024, e-commerce in Ukraine will reach 2021 levels.[157]

Ukraine is one of the most digitized countries in the e-commerce sector. The Direct-to-Consumer model, where suppliers sell their products directly to consumers without intermediaries, is widely used. **Private entrepreneurs and micro-businesses dominate among sellers.** E-commerce is also actively utilized through social networks, where convenient shopping can be done via mobile applications, paying through Apple Pay, Google Pay, mobile banking, etc.

The popularity of e-commerce among the population is growing every year. In 2021, 66.2% of the population ordered goods and services online[158]. E-commerce was mainly engaged by young people aged 18-29, primarily buying clothing and home goods. People who do not use online shopping indicated a preference for personal shopping and product familiarization (69.4%) and a lack of necessary skills (12.9%).[159]

In short, after a significant decline in 2022, the e-commerce market is recovering, maintaining a trend towards digitalization and increasing popularity among the population, especially the youth.

4.7.4. Level of use of AI, big data, block chain, and other new technologies

Ukrainian IT professionals are actively involved in AI research and development. They create **AI-powered solutions for healthcare, finance, agriculture, and more**. For example, some companies are using AI to develop diagnostic tools for early disease detection or to optimize crop yields. With its vast pool of talented cybersecurity experts, the country is home to numerous

155 https://eba.com.ua/en/research/doslidzhennya-ta-analityka/
156 https://elit-web.ua/ua/blog/kak-izmenilsja-rynok-ecommerce-v-ukraine-v-2022-godu
157 https://elit-web.ua/ua/blog/kak-izmenilsja-rynok-ecommerce-v-ukraine-v-2022-godu
158 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf
159 https://osvita.diia.gov.ua/uploads/0/2623-research_eng_2021.pdf

companies specializing in threat detection, incident response, and data protection. These firms play a crucial role in safeguarding businesses and individuals from cyberattacks.

Ukraine's fintech sector is experiencing rapid growth. Local startups are developing innovative financial products and services, such as mobile payment apps, online lending platforms, and blockchain-based solutions. These technologies are transforming the way people manage their finances, making them more accessible and convenient.

Ukrainian companies are also making significant progress in the SaaS (Software as a Service) space. They are developing cloud-based software solutions for businesses of all sizes, helping them streamline operations, improve efficiency, and boost productivity. These SaaS products are gaining traction both domestically and internationally.

The digital sector has played a crucial role in keeping Ukraine's economy afloat. The sector has remained an area of economic growth, with IT industry exports reaching $3.7 billion in the first six months of 2022, a 23 percent increase from that same time in 2021[160]. Ukraine's IT sector is strong, showcasing significant resilience and growth even amid challenging circumstances. The sector's achievements in AI, cybersecurity, fintech, game development, and SaaS demonstrate Ukraine's digital potential. However, **the sector faces challenges such as wartime disruptions, brain drain, infrastructure vulnerabilities, regulatory hurdles, and global competition**.

To overcome these challenges, continued government support through tax incentives, infrastructure investment, and education programs is essential. International partnerships can provide valuable resources and market access, while investing in IT education and training can nurture the next generation of tech professionals. Strengthening cybersecurity measures and fostering a culture of innovation through incubators, accelerators, and research initiatives are also crucial. Despite these hurdles, Ukraine's IT sector has the potential to drive economic growth, innovation, and job creation, solidifying its position as a global leader in technology.

5. SECTORAL ASSESSMENT

5.1. BIODIVERSITY

5.1.1. Sector definition, role of digitalisation

"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 must be done and making sure that actions within green transitions do not negate their outputs by adversely affecting biodiversity.

The thematic area will focus on the subthemes of nature conservation (mainly on in situ measures) that are central to the topic. Nature restoration is increasingly needed in the efforts to safeguard

[160] https://dia.dp.gov.ua/en/ukraines-it-industry-brought-in-3-2-billion-in-the-first-five-months-of-the-war/

biodiversity and ecological processes and is one of the key targets of the green transition and is covered by the biodiversity thematic area as well.

One of the focal strategies on biodiversity on the European level, the EU Biodiversity Strategy 2030[161], does not address digital transformation in the sector, but lists the digital functionalities that support reaching sectoral aims:

- In combination with the EU Forest Strategy, ensuring data availability 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 the context of 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, e.g., 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 a main digital enabler related to reaching biodiversity goals. This includes, for instance, the EU's Copernicus programme using 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.[162]

5.1.2. Main biodiversity-related challenges in Ukraine

This table lists the main thematic shortcomings. The second column illustrates how these challenges can be significantly improved via digitalisation (e.g., IoT, information systems, AI, blockchain). The third column depicts the regulatory framework relevant for addressing the gap.

Table 3: Main biodiversity-related shortcomings

Ukraine		
Main biodiversity-related gaps in the country.	How can digitalisation support to overcome this gap?	Is applicable European regulation or other framework in place that should be followed in the country (e.g., harmonised data structure)?
Limited monitoring and data collection: There are gaps in scientific knowledge on the status of many species and habitats in Ukraine. This lack of data makes it	**Improved monitoring and data collection**: Digital tools can be used to collect data on biodiversity more efficiently and effectively. For example, **camera traps, acoustic monitoring devices, and**	While there isn't a directly applicable European regulation for biodiversity data structure in Ukraine currently, there are a couple of points to consider:

161 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52020DC0380
162 Hedberg, Šipka, 2020. Improving biodiversity: How can digitalisation help? Discussion paper, Sustainable Prosperity for Europe Programme. European Policy Centre. Available at: https://www.epc.eu/en/publications/Improving-biodiversity-How-can-digitalisation-help~38bd64

difficult to prioritize conservation efforts and track progress**. The ongoing conflict has further hampered monitoring efforts in some areas.**	**remote sensing can be used to track wildlife populations** and habitat changes. This data can be used to create detailed maps of biodiversity and identify areas of greatest conservation need.	1. EU Approximation: Ukraine is actively working towards aligning its legislation with the EU acquis (body of EU law). This includes environmental regulations. While there isn't a specific regulation on data structure for biodiversity, some broader EU frameworks like the **EU Biodiversity Strategy** might **influence future Ukrainian legislation in this area.**
Habitat fragmentation: Habitat loss and fragmentation are major threats **to biodiversity in Ukraine. This is caused by factors such as agriculture, infrastructure development, and deforestation. Fragmented habitats can isolate populations of plants and animals, making them more vulnerable to extinction.**	Enhanced habitat management: **Digital tools can be used to model habitat suitability and predict the impacts of climate change and other stressors** on biodiversity. This information can be used to develop more effective conservation strategies, such as the creation of protected areas or wildlife corridors.	2. International Standards: Ukraine might not be legally bound by EU regulations, but it can still adopt international standards for biodiversity data. The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS)[163] is an example. This international agreement promotes a harmonized approach to sharing information on biodiversity, which could influence Ukrainian data structures.
Invasive species**: The introduction of invasive species is another major threat to Ukrainian biodiversity. Invasive species can outcompete native species for resources and disrupt ecosystems. Climate change is also expected to increase the threat of invasive species in Ukraine.**	Public engagement and awareness: Digital platforms can be used **to raise public awareness about biodiversity** and the importance of conservation. Social media, educational websites, and citizen science apps can all be used to engage the public in conservation efforts. Improved law enforcement: Digital tools can be used to **monitor illegal activities that threaten biodiversity, such as deforestation and poaching**. For example, satellite imagery can be used to track changes in forest cover, and drones can be used to patrol protected areas.	3. Future Developments: As Ukraine progresses towards EU membership, it's likely that closer alignment with EU regulations on biodiversity, potentially including data structures, will be required. In summary, **there isn't a mandatory European regulation on data structure for biodiversity in Ukraine currently**. However, international standards and Ukraine's move towards EU alignment encourage

163 https://www.cbd.int/access-benefit-sharing

	adopting harmonized approaches for biodiversity data.

5.1.3. Status of digitalisation in biodiversity

In the realm of biodiversity conservation, Ukraine finds itself at a critical point, where the prospects of digitalization are apparent, yet shadowed by the challenges of war. This requires a nuanced response. In recent years, Ukraine has increasingly acknowledged the transformative potential of digital technologies in environmental protection. Embodied in initiatives such as "Ukraine Digital 2030," the government's commitment to transitioning towards digital technologies underscores a strategic shift towards utilizing innovation, including for biodiversity conservation. These programs serve as blueprints, outlining a pathway towards integrating cutting-edge digital tools into environmental monitoring and protection.

For instance, the Ministry of Ecology is actively implementing modern approaches to state environmental monitoring, recognizing it as a key reform of today necessary for Ukraine's accession to the EU. Monitoring of biological and landscape diversity is an integral part of this reform. **Currently, Ukraine lacks comprehensive biodiversity monitoring covering all these components. To address this, a working group has been established** within the Ministry of Ecology, comprising representatives from executive authorities, scientific, and civil society organizations. Based on the best international practices, the experts of this working group will develop directions and mechanisms for more comprehensive monitoring. Additionally, **relevant biodiversity databases will be established** to facilitate prompt responses to any changes and develop scientifically grounded recommendations for management decisions.

In collaboration with the Ministry of Environment and Climate Change of Finland, the Ministry of Ecology of Ukraine has launched the implementation of the ISI project "Support for Ukraine in Environmental Damage Assessment and Development of Surface Water and Biodiversity Quality Monitoring."[164] **Within this project, technical assistance is planned to strengthen environmental monitoring of water and biodiversity in Ukraine from 2024 to 2027 by EU requirements, as well as to assist Ukraine in developing roadmaps for water and biodiversity monitoring** for strategic planning and implementation of EU directives.

Furthermore, amidst this landscape of aspirations, tangible progress is already discernible through existing projects leveraging digital solutions. **These initiatives serve as examples of the practical application of digital technologies in biodiversity conservation, ranging from the use of camera traps for wildlife observation to the creation of online databases facilitating the management of protected areas**. They not only signal the feasibility of digitalization but also highlight its potential to transform traditional conservation practices. For instance, the Nobelsky National Park of Ukraine, in collaboration with Poland's Narwia National Park, will implement the project "Creation of Monitoring Systems for Conservation of Protected Areas of Ukraine and Poland," with a total value of 1.753 million euros[165]. The project includes the establishment of a monitoring centre with a laboratory for biodiversity research, the creation of a joint database for biodiversity monitoring, joint research expeditions, exchange of experience between partners, development of recommendations for measures to conserve the biodiversity of international water

[164] https://www.kmu.gov.ua/news/ukraina-posyliuie-spivpratsiu-z-finliandiieiu-dlia-rozbudovy-natsionalnoi-systemy-monitorynhu-vody-ta-bioriznomanittia

[165] https://mepr.gov.ua/nobelskyj-natspark-ukrayiny-ta-polskyj-narvyanskyj-natspark-otrymaly-1-753-mln-yevro-na-stvorennya-monitoryngovoyi-systemy-dlya-zberezhennya-pryrody/

and swampy territories, development of joint monitoring programs for individual species of flora and fauna, and educational activities to explain the significance and importance of biodiversity.

Yet, there are challenges. Foremost among them is the widespread spectre of **limited infrastructure**, which poses a serious obstacle to effective digitalization. **The absence of widespread and reliable internet access, especially in remote rural areas, presents a significant barrier that hinders the seamless integration of digital tools into conservation efforts**. Combined with the disruptions caused by the ongoing war, connectivity is particularly crucial to address.

Additionally, the effectiveness of digitalization depends on robust data management, a sphere fraught with complexity and ambiguity in Ukraine. **Despite the existence of data collection initiatives, the lack of standardized protocols for data storage, exchange, and analysis is an evident deficiency. This fragmentation impedes the synthesis of diverse datasets**, hindering attempts to derive practical insights necessary for informed decisions regarding biodiversity conservation.

Simultaneously, **there is a growing need for funding and expertise**, creating an obstacle for the sustainability of digitalization efforts. Implementing and maintaining complex digital infrastructure require continuous financial investment and specialized know-how, resources often lacking in Ukraine's environmental landscape. In the **absence of proper funding and expertise, the scalability and long-term viability of digitalization initiatives remain unstable, jeopardizing their transformative potential.**

In summary, while the digitization of biodiversity efforts in Ukraine signifies a shift, it is not without its challenges. **Overcoming the barriers associated with limited infrastructure, fragmented data management practices, resource constraints, and ongoing conflict is essential to realizing the full potential of digital technologies in biodiversity conservation**.

5.2. FARM TO FORK

5.2.1. Sector definition, role of digitalisation

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 F2F briefing document here which includes key F2F 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 Ukraine

This table lists the main thematic shortcomings. The second column illustrates how these challenges can be significantly improved via digitalisation (e.g., IoT, information systems, AI, blockchain). The third column depicts the regulatory framework relevant for addressing the gap.

Table 4: Main 'farm to fork' thematic shortcomings

Ukraine		
Main gaps in the country related to the 'Farm to fork' strategy.	How can digitalisation support to overcome this gap?	Is applicable European regulation or other framework in place that should be followed in the country (e.g., harmonised data structure)?
Issues such as food waste, seed security and diversity, and sustainable fish and seafood production **have not seen substantial regulatory attention and require additional legislative effort, with the** need for indicators, targets, and the collection of key data sets**. Most grant programs, for example, do not focus on sustainability, but productivity and better data collection are needed.**	**Better data collection**. Use big data analytics to process and analyse large volumes of data from multiple sources to identify trends, predict outcomes, and optimize resource use. This can inform policymakers about the effectiveness of existing regulations and the need for new ones.	For Ukraine, aligning with European regulations and frameworks can be crucial for advancing its 'Farm to Fork' strategy and ensuring its agricultural and food systems meet high standards of sustainability, efficiency, and safety. **EU Green Deal and Farm to Fork Strategy:** The European Green Deal aims to make Europe the world's first climate-neutral continent by 2050, and the Farm to Fork Strategy is a key part of this initiative. It focuses on creating a fair, healthy, and environmentally friendly food system. While Ukraine is not an EU member, aligning with these strategies can help Ukraine integrate into European markets and improve its food system. It provides guidelines for sustainability, food safety,
A significant part of the existing workforce (both unskilled and skilled workers) will most likely need to be retrained to obtain the skills that will be required to support the green transition **of the F2F sector. Despite the existence of an**	**Digital skills education** within the sector, public awareness raising, also via digital means. Develop and expand online training platforms offering courses on new agrifood technologies, sustainable practices, and climate-resilient agriculture. This can make it easier for workers to access training and update their skills.	

extensive network of educational institutions with agricultural specialisation and multiple educational programs for agrifood and climate-related specialties, many of them need to be updated to provide knowledge and skills that are relevant to the labour market.		and supply chain transparency that can be adapted locally. **EU Standardization for Food Safety**: Standards such as those set by the European Food Safety Authority (EFSA) and various European committees for food safety and hygiene can guide Ukraine in developing compatible safety regulations. **EU Common Agricultural Policy (CAP):** The CAP supports EU farmers and promotes sustainable agricultural practices across member states. It includes measures for rural development, environmental management, and food security. Relevance: Ukraine can use CAP principles as a reference for developing its agricultural policies and practices, particularly in areas like rural development and environmental sustainability.
Precision farming agriculture – use of technologies and information systems **that reduce emissions on the farm and through food manufacturing and retail**	Implementing precision farming technologies can reduce emissions and increase efficiency: **Farm management systems:** Using management systems that reduce resource costs and improve productivity. **Monitoring systems:** Employing monitoring systems for crop and livestock management, ensuring optimal resource use.	

5.2.3. Status of digitalisation in 'farm to fork'

Digitalization in Ukraine "from farm to fork" is developing, but there are still **opportunities for improvement, regarding compatibility with EU systems**. For information management, farms often rely on paper-based record-keeping or basic software. Some large agribusinesses use farm management software for tasks such as yield tracking and resource planning.

The government is developing initiatives to create a centralized agricultural information system, but progress is slow. The Ministry of Agrarian Policy is implementing the State Agrarian Register (DAR) an automated electronic system created for the purpose of effective and transparent attraction and distribution of all types of support for Ukrainian farmers[166].

As for compatibility with the European Union, currently, Ukraine's interaction with EU information systems, such as TRACES (trade control system and expert system), is limited due to **differences in the data structure, and there are problems in information exchange**. At the

[166] https://www.dar.gov.ua/

same time, Ukraine is working on harmonizing its systems with EU standards, but this is an ongoing process.

As for the use of digital solutions in agriculture, such solutions are increasingly used by farmers, namely:

- **GPS navigation systems for tractors and combines to improve accuracy and efficiency.** In large agricultural enterprises and among wealthy farmers, the use of GPS systems is quite widespread. This allows them to optimize operations, reduce fuel costs, and increase yields through precise application of fertilizers and seeds. For small farmers, the implementation of such technologies can be limited due to high initial costs and the need for personnel training.

- **Yield monitors to collect data on crop performance in real-time and identify areas that need adjustment**. While large farms have readily adopted yield monitors, small and medium-sized farmers face more significant challenges. High initial costs, coupled with the need for technical training and ongoing maintenance, limit widespread adoption among smaller farms. However, there is growing interest and gradual uptake as the benefits become more apparent, and technology becomes more affordable.

- **Technology of variable rates of application of fertilizers and pesticides** based on the specific needs of different areas of the field.

- **Online marketplaces** are emerging that connect farmers directly with buyers, increasing transparency and potentially increasing profits. For example, **Tradomatic** (tradomatic.io) or **Agromarket** (agro-market.net). These are platforms where agricultural traders can determine the best prices, monitor market trends, and search for potential buyers in one place, and farmers can sell their products.

- **Mobile apps** are being developed to give farmers **access to weather data, market information, and best agricultural practices.** Farmers in Ukraine are increasingly using applications such as **FieldBee** (www.fieldbee.com) - software that provides GPS navigation, field management, record keeping, and other functions.

Digitization in Ukraine's agricultural sector, from farm to fork, is progressing, yet there is room for improvement, particularly in terms of compatibility with EU systems. **While large agribusinesses employ advanced farm management software for yield tracking and resource planning, smaller farms often rely on paper-based records or basic software**. The sector shows promise with significant adoption of digital tools among large agribusinesses. However, small and medium-sized farms lag due to financial and technical barriers.

As Ukraine looks to digitalize its agricultural sector, several crucial steps lie ahead. First, **improving internet connectivity in rural areas is essential** to ensure farmers can access digital tools. **Training programs** need to be rolled out to boost digital literacy among farmers, helping them understand and use modern agricultural technologies effectively. **Financial support** in the form of subsidies or incentives will encourage small and medium-sized farms to adopt these digital solutions. **Harmonizing data structures and systems with EU standards** is also a priority to enable seamless information exchange. Lastly, the development of a **centralized agricultural information system must be accelerated** to streamline data management and decision-making processes. These steps are vital for fostering a more efficient, productive, and connected agricultural sector in Ukraine.

5.3. Industry for Clean and Circular Economy

5.3.1. Sector definition, role of digitalisation

This thematic area covers two main subareas:

- ► Manufacturing industry (and main subsectors, including mining industry if relevant)
  - Circular economy/waste management sector
  - The focus is aligned around the EGD-relevant 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 GHG 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 using renewable energy sources.

In addition, the assessment investigates the transition from a traditional, linear economic model toward a circular economy that not only creates less pollution but also makes industry processes more efficient and cost-effective. The focus is not only on the assessment of circular economy and resource efficiency developments in the industry but also on the waste management system in the wider term (including also 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[167]. Regarding the twin transition of digital and green transformations, the European Commission has proposed the following interventions[168]:

- ► 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, and affordable decarbonised energy through accelerated investments into renewables and grids, and address barriers

In industries digitalisation, the following have been identified as critical areas of reform and investments[169]:

- Connectivity, to reach the goals of the Gigabit Society Strategy (Towards a Gigabit Society)
- Development and deployment of advanced digital technologies, such as AI, blockchain, cloud and 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.

167 A New Industrial Strategy for Europe (2020), https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0102
168 https://single-market-economy.ec.europa.eu/industry/strategy_en
169 Annual Single Market Report 2021 accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. {COM(2021) 350 final} - {SWD(2021) 352 final} - {SWD(2021) 353 final}

- Digitalisation of businesses, by accelerating the sustainable take-up of digital solutions and a cyber-resilient digital transformation across all sectors.
- E-government, to modernise the public administration, increase its efficiency and infrastructure security and resilience, and stimulate the online interaction between administrations and citizens, and businesses.

5.3.2. Main industry and circular economy-related challenges in Ukraine

This table lists the main thematic shortcomings. The second column illustrates how these challenges can be significantly improved via digitalisation (e.g. IoT, information systems, AI, blockchain). The third column depicts regulatory framework relevant for addressing the gap.

Table 5: Main industry and circular economy-related thematic shortcomings

Ukraine		
The main gaps in the country are related to the industry's green transition and circular economy.	How can digitalisation support to overcome this gap?	Is applicable European regulation or other framework in place that should be followed in the country (e.g., harmonised data structure)?
Limited investment in renewable energy sources **and infrastructure: Ukraine still relies heavily on fossil fuels for energy generation. Increased** investment in solar, wind**, and other renewable energy sources, along with** improvements in transmission grids, **is essential for reducing carbon emissions and fostering a greener industry.**	**Smart grids**: Digital tools can **optimize energy distribution** from renewable sources, balancing supply and demand more effectively. **Data analysis**: Digital platforms can collect and analyse data on energy consumption patterns, **helping industries identify areas for energy efficiency improvements** and optimize renewable energy use. **Predictive maintenance**: Sensors and IoT (Internet of Things) technologies can monitor the health of renewable energy infrastructure, enabling preventative maintenance and reducing downtime.	There are applicable European regulations and frameworks that Ukraine should follow to advance its digitalization efforts, particularly regarding achieving a circular economy and interoperability with the EU Single Market. Regulations: EU Regulation 1169/2011 on the indication of the origin of food: This ensures transparency in food labelling throughout the EU, which can be beneficial for Ukrainian producers seeking to export to the European market. EU Directive 2008/98/EC on waste: This sets out a framework for waste management across the EU, promoting waste reduction, reuse, and recycling. Following these guidelines will be crucial for Ukraine in developing its circular economy.
Insufficient waste management systems and infrastructure: Waste collection and	**Waste tracking and monitoring**: Digital systems can track waste generation, movement, and processing, improving transparency and	

sorting systems are underdeveloped **in many parts of Ukraine. Upgrading waste management infrastructure, including** building efficient recycling plants and composting facilities**, is crucial for diverting waste from landfills and implementing a circular economy.**	efficiency in waste management. **Smart bins**: Sensor-enabled bins can optimize collection routes, reduce fuel consumption for waste collection vehicles, and encourage proper waste sorting by citizens. **Matching platforms**: Digital platforms can **connect waste generators with recycling facilities**, promoting efficient waste diversion and creating new circular economy opportunities.	EU Circular Economy Package: This comprehensive package of directives aims to make Europe's economy more sustainable by promoting resource efficiency and reducing waste. Aligning with these directives will be essential for Ukraine's long-term economic and environmental goals. Data Harmonization: alignment with UN/CEFACT standards. Implementing these United Nations Centre for Trade Facilitation and Electronic Business **data standards for agricultural information exchange** can significantly improve interoperability with EU information systems like TRACES (Trade Control and Expert System). EU regulations on data formats and semantics: Following EU regulations on data formats and semantics for specific sectors (e.g., waste management) is another crucial step towards seamless information exchange with the EU.
Lack of widespread adoption of sustainable practices and technologies across industries: While some Ukrainian industries are embracing eco-friendly practices, it is not yet commonplace. Incentives, education, and knowledge-sharing programs are needed to encourage wider adoption of sustainable technologies **and production processes throughout Ukrainian industries.**	**Precision agriculture**: Digital tools can help farmers optimize resource use (water, fertilizers, pesticides), reducing environmental impact and promoting sustainable practices. **Supply chain transparency**: Blockchain technology can track the origin and journey of materials throughout the supply chain, enabling consumers to make informed choices about sustainable products. **Digital marketplaces for recycled materials**: Online platforms can connect businesses seeking recycled materials with suppliers, promoting the use of recycled content and closing the loop in the circular economy.	

5.3.3. Status of digitalisation in industry, application of circular economy

The examples below illustrate how Ukrainian enterprises use digitalization to implement circular economy principles, enhancing efficiency, reducing costs, and improving environmental sustainability. **Metinvest** implements programs aimed at ensuring environmental safety at all its

production facilities and develops targeted measures for their optimization. These programs cover the implementation of modern technological **equipment for reducing emissions, increasing energy efficiency, installing sewage treatment systems, waste disposal and reclamation** of sites for their placement, **creating automated systems for storing and processing environmental information**, developing strategies for reducing the impact of enterprises on air quality, water and land resources and biodiversity, as well as climate change impact assessment[170].

In the agro-industrial complex, **Kernel** implements **precision farming technologies**, including the use of **sensors and drones for field monitoring and resource optimization**. The integration of digital platforms for agricultural data management helps **reduce losses and improve the efficiency of fertilizer and water use**, contributing to sustainable development. Kernel is constantly looking for ways to improve the balance between economic feasibility, technical feasibility, and environmental impact. The company implements advanced practices in resource conservation and minimization of the impact on the environment, using resource-efficient technologies in its daily activities[171].

One of the examples of the implementation of the circular economy in Ukraine is the development of the waste management and recycling system. **PJSC "Kyiv Cardboard and Paper Mill"** has implemented and is improving an integrated management system for quality, ecology, product safety, energy efficiency, health protection, and occupational safety by the requirements of international standards [172]. The enterprise **processes wastepaper and obtains high-quality, environmentally friendly cardboard paper products**, preventing the pollution of the environment with paper waste.

As we can see, there are examples in Ukraine of enterprises using circular economy approaches and reducing their environmental impact. For this purpose, they also employ digital solutions. **Large enterprises implement modern digital platforms for resource monitoring and management and automated systems for controlling and optimizing production processes.** However, there are still relatively **few** such **examples**. To increase their number, it is necessary to boost investments in innovation and technologies, develop infrastructure - such as creating a network of sensors and drones for precise monitoring of production and agricultural processes, enhance data exchange systems between enterprises for better resource and waste management, organize training and educational programs to improve employee qualifications, and support startups and young professionals developing new solutions for the circular economy, including digital ones.

5.4. CLIMATE

5.4.1. Sector definition, role of digitalisation

In order to reach the goals of the European Green Deal and the UN's SDGs, there is a need to define science–based methods to estimate the reduction and avoidance of greenhouse gas (GHG) emissions by specific ICT solutions in different sectors, and to support a green digital transformation of sectors such as energy, transport, agriculture, and construction. This will accelerate their sustainability and circular transitions while contributing, ng to an innovative, inclusive, and resilient society.[173] Under the EU's green digital transformation there are several

[170] https://metinvestholding.com/ua/responsibility/ecology
[171] https://www.kernel.ua/ua/sustainable-development/cop29/
[172] https://www.papir.kiev.ua/development/nashi-pidhodi-do-stalogo-rozvitku/
[173] https://digital-strategy.ec.europa.eu/en/policies/european-green-digital-coalition

action areas,[174] some examples (excluding the ones mentioned already in other areas such as biodiversity, circular economy, energy, and smart mobility):

► Help cities become greener and more digital;
- Lead on energy-efficient artificial intelligence solutions;
- Digital modelling of the Earth system (DestinE) to model the effects of climate change
- Promote eco-designed products and accessible digital public services;
- Contribute to the use of a climate-neutral, sustainable, and energy-efficient European cloud and blockchain infrastructure;
- Propose permits for deployment of networks and data centres that comply with the highest environmental sustainability standards;
- Making green public procurement the default option overall;
- Develop low-power hardware technologies;
- Use of EU funding programmes and private equity to support European green tech start-ups and SMEs
- The EU pledged in its ministerial declaration in 2021[175] regarding the green and digital transition to:
- Accelerate the development and deployment of digital technologies, such as Very High Capacity Networks allowing to build 5G and 6G networks, fibre optics, High performance computing (HPC), Quantum computing and Quantum Communication, Internet of Things (IoT), Blockchain technologies, Cloud solutions, , Artificial intelligence (AI) and big data, as key solutions to ensure the impact of climate adaptation and mitigation policies, decrease pollution, optimise energy and resource efficiency, develop a circular economy, promote precision farming and helping to combat the loss of biodiversity;
- Lead on the usage of quality data, data analysis models, and energy-efficient Artificial Intelligence-based solutions for sustainable decision-making;
- Apply secure digital technologies and solutions to improve resource efficiency and allocation, encourage industrial symbiosis and asset sharing, eco-design of products, promote durability, repair (including software updates), reuse, and recycling;
- To develop a digital product passport for tracking and tracing products and materials, to increase information flows along value chains, facilitate value retention processes, new and sustainable business models, and to improve consumer empowerment and sustainable choices through information and awareness;

5.4.2. Main climate-related challenges in Ukraine

This table lists the main thematic shortcomings. The second column illustrates whether these can be significantly supported through digitalisation (e.g. IoT, information systems, AI, blockchain). The third column depicts regulatory framework relevant for addressing the gap.

Table 6: Main climate-related thematic shortcomings

Ukraine		
Main gaps in the country related to climate action	How can digitalisation support to overcome this gap?	Is applicable European regulation or another framework in place that should be followed in the country?

[174] https://digital-strategy.ec.europa.eu/en/news/eu-countries-commit-leading-green-digital-transformation
[175] https://ec.europa.eu/digital-single-market/news-redirect/705315

Inadequate policies to incentivize climate-friendly behaviour: **The Ukrainian government could do more to encourage businesses and individuals to adopt climate-friendly practices. For example, the government could provide subsidies for renewable energy or electric vehicles. It could also implement carbon pricing schemes, which would make it more expensive to pollute**	**1. Improved Monitoring and Transparency:** **Data collection and analysis:** Digital tools can be used to collect and analyse real-time data on energy consumption, emission sources, and environmental conditions. This data can help policymakers identify areas where the most significant improvements are needed and track progress over time. **Satellite imagery and remote sensing:** These technologies can be used to monitor deforestation, track changes in land use, and identify areas most vulnerable to climate change impacts. **Public access to information:** Digital platforms can be used to make environmental data and information easily accessible to the public. This transparency can empower citizens to hold polluters accountable and support climate-friendly policies.	There are several applicable European regulations and frameworks that Ukraine should consider when implementing digitalization efforts to support climate action. These can help ensure their solutions are interoperable with the EU Single Market and contribute to a more sustainable future. Here's a breakdown of some relevant regulations: **1. Emissions Trading Scheme Directive (EU ETS)** Establishes the framework for the EU ETS, including rules for allocating allowances, monitoring emissions, and trading allowances. **2. European Green Deal** **Data and Interoperability:** **UN/CEFACT standards:** Implementing these United Nations Centre for Trade Facilitation and Electronic Business data standards can significantly improve data exchange and interoperability between Ukrainian digital solutions and EU systems. **EU regulations on data formats and semantics:** Following EU regulations on data formats and semantics, particularly for relevant sectors like energy and waste, is another crucial step towards seamless information exchange with the European Union.

5.4.3. Status of digitalisation in tackling climate change

In Ukraine, the intersection of digitalization and climate change is emerging as a focal point in Ukraine's efforts towards sustainability. While progress has been made, there remains room for

growth and improvement. Ukraine's engagement with EU climate policies serves as a guiding force, despite not being an EU member. **Policies such as the Renewable Energy Directive and the Circular Economy Package indirectly influence Ukraine's adoption of digital solutions for climate action**, aligning the country with the best European practices and paving the way for potential future integration.

At the national level, Ukraine's "**National economic strategy for the period until 2030 " acknowledges the role of digitalization in climate action.** Among the goals of the Strategy are the **achievement of climate neutrality no later than 2060, the decarbonization of the economy** (increasing energy efficiency, the development of renewable energy sources, the development of a circular economy and **synchronization with the "European Green Deal" initiative) and the creation of an effective digital service state.** Although specific action plans or regulations focused solely on digital climate solutions are still in development, the recognition of digitalization's importance sets a foundation for future initiatives.

In terms of digital technologies, **Ukraine is beginning to leverage Internet of Things (IoT) and sensor technology for environmental monitoring and smart grid development** to optimize energy use. Additionally, **cloud solutions are increasingly utilized by government agencies and private companies for data storage, analysis, and collaboration on climate-related projects.** While applications of AI and Machine Learning (ML) in climate action are currently limited, ongoing research explores their potential in weather forecasting, energy demand prediction, and optimizing renewable energy production.

The concept of smart cities is gaining momentum with pilot projects underway in major urban centres like Kyiv and Lviv. These projects focus on various aspects of urban life, including **smart grids, intelligent transportation systems, and waste management, all enabled by digital solution**s.

Despite progress, challenges persist. For instance, while **government agencies are working towards integrating climate data into decision-making processes, a centralized platform has yet to be established**. Similarly, initiatives like **real-time energy monitoring in factories are emerging** but require further investment and infrastructure development for widespread adoption.

Investment in green and digital technologies is growing, both from the government and the private sector. State-owned enterprises like **ENERGOATOM** are exploring digital solutions for **optimizing power plant operations**[176], while major industrial players like **METINVEST** are **investing in renewable energy** sources to reduce carbon emissions[177].

However, **investment in climate resilience remains limited**, with some initiatives underway but often reliant on international donor support. Similarly, resources dedicated to high-performance computing and AI for extreme weather prediction are scarce, necessitating significant investment for wider implementation. In terms of carbon accounting, **Ukraine operates a national system based on manual reporting by companies. Digital platforms for emissions tracking are still in the nascent stages**, highlighting an area for development.

Overall, Ukraine's trajectory towards utilizing **digitalization for climate action is promising but uneven**. At the level of the Strategy, Ukraine seeks to implement digital climate solutions, but limited investments, especially during the war, prevent their rapid implementation. Specific action plans and **regulatory frameworks targeting digital climate solutions need to be developed** to provide a clear framework and incentives for their implementation. It would be **desirable to invest**

[176] https://saee.gov.ua/news/derzenergoefektivnosti-ta-energoatom-praciuvatimut-nad-vprovadzenniam-sistem-energomenedzmentu-na-objektax-kompaniyi
[177] https://metinvestholding.com/ua/ar2023/pdf/ua/26%20Response%20to%20Climate%20Chanage_UA.pdf

in the development of a centralized platform for the integration of climate data to enable informed decision-making and collaboration between stakeholders, and to develop and **implement digital platforms for real-time emissions tracking**, which would improve the accuracy and efficiency of emissions accounting. Collaboration between the government and the private sector to leverage resources and expertise in digital and green technologies will drive innovation and large-scale adoption. Continued policy development, increased investment, and enhanced public-private collaboration are essential to accelerate progress and achieve the climate goals in the years ahead.

5.5. ENERGY

The objective of the energy thematic area is to get an understanding of 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 European Green Deal (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.

5.5.1. Sector definition, role of digitalisation

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. Effectiveness and efficiency of electricity distribution have up to now been the main area regarding the digitalisation 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

The main documents in the EU emphasising digitalisation of energy are the European Green Deal and the EU's Digital Strategy. The EU has been supporting the digitalisation 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.[178]

Other actions such as establishing a Smart Energy Expert Group, which brings together experts from the energy and digital sectors to advise on the implementation of the action plan, and funding energy digitalisation projects under the Horizon 2020 programme.[179]

[178] https://energy.ec.europa.eu/topics/energy-systems-integration/digitalisation-energy-system_en#eu-action-plan-for-digitalising-energy
[179] https://www.iea.org/energy-system/decarbonisation-enablers/digitalisation

5.5.2. Main energy-related challenges in Ukraine

This table lists the main thematic shortcomings. The second column illustrates whether these can be significantly supported through digitalisation (e.g. IoT, information systems, AI, blockchain). The third column depicts regulatory framework relevant for addressing the gap.

Table 7: Main energy-related thematic shortcomings

Ukraine		
The main gaps in the country are related to the energy sector.	How can digitalisation support to overcome this gap?	Is applicable European regulation or other framework in place that should be followed in the country (e.g., harmonised data structure)?
High Reliance on Fossil Fuels**: Ukraine still heavily relies on fossil fuels, particularly coal, for energy generation. This dependence contributes significantly to greenhouse gas emissions and hinders progress towards a cleaner energy mix. Increased i**nvestment in renewable energy sources **(solar, wind, etc.) is crucial for reducing emissions and achieving climate goals.**	High Reliance on Fossil Fuels: **Data-driven renewable energy planning**: Digital tools can analyse energy consumption patterns and identify areas with high renewable energy potential. **This data can inform strategic planning and investment** decisions for wind, solar, and other renewable energy projects. **Smart grid integration**: Digital technologies like smart meters and advanced distribution management systems can **optimize grid operations and facilitate the integration of renewable energy** sources with variable output (e.g., solar, wind). **Peer-to-peer energy trading platforms**: Blockchain technology can enable secure peer-to-peer energy trading, allowing individuals with solar panels to sell excess electricity back to the grid, encouraging distributed renewable energy generation.	There are several applicable European regulations and frameworks that Ukraine can consider when implementing digital solutions to address gaps in its energy sector. Aligning with these will ensure interoperability with the EU Single Market and contribute to a more sustainable energy future. Here's a breakdown of some key regulations: **Energy Sector Regulations:** Renewable Energy Directive (RED) (2018/2001/EU): Sets binding targets for EU member states to increase their share of renewable energy in the energy mix. Following these principles can guide Ukraine in developing its renewable energy sector and facilitate potential future trade of renewable energy with the EU. Energy Efficiency Directive (EED) (2012/27/EU): Sets energy efficiency targets and outlines measures for member states to improve energy efficiency in buildings, industry, and other sectors. Aligning with this directive can help Ukraine achieve its energy efficiency goals and contribute to a more integrated European energy market. **Data and Interoperability:** UN/CEFACT standards: Implementing these United Nations Centre for Trade

Energy Efficiency Challenges**: Many buildings in Ukraine, both residential and commercial, lack proper insulation and energy-efficient technologies. This leads to high energy consumption, wasted resources, and missed opportunities for emissions reduction.** Upgrading building codes, promoting energy audits, and incentivizing energy-efficient renovations **are essential steps to address this gap.**	**Smart building technologies: Sensor-based systems can monitor energy consumption** in buildings and identify areas for improvement. This data can inform targeted renovations and retrofitting with energy-efficient technologies (e.g., smart thermostats, LED lighting). **Digital building management systems**: These systems can **automate building functions** like heating, ventilation, and lighting based on real-time occupancy and weather data, optimizing energy use and reducing waste. **Energy efficiency mobile apps**: Apps can provide homeowners and businesses with personalized energy usage data and tips for **reducing consumption, promoting behavioural changes** towards energy savings.	Facilitation and Electronic Business data standards for the energy sector can significantly improve data exchange and interoperability between Ukrainian digital solutions and EU energy information systems. This is crucial for potential future energy market integration. EU regulations on data formats and semantics for the energy sector: While not a member state, Ukraine can benefit from following EU regulations on data formats and semantics for specific energy-related data (e.g., smart meter data, grid management data). This will ensure seamless information exchange with the EU in case of future energy market integration. Following these regulations and frameworks, Ukraine can ensure its digitalization efforts in the energy sector are aligned with European best practices. This will not only contribute to a more sustainable domestic energy system but also position Ukraine for smoother potential future integration with the EU Single Market.
Modernized Grid Infrastructure**: Ukraine's electricity grid infrastructure is aging and inefficient, limiting the integration of renewable energy sources and causing energy losses during transmission.** Investment in grid modernization, including smart grid technologies**, is necessary to optimize energy distribution and enable a more flexible**	**Smart grid technologies**: Digital tools like **smart meters and advanced distribution management systems** can optimize energy flows within the grid, reducing transmission losses and improving overall grid efficiency. **Predictive maintenance**: Sensor-based systems can **monitor grid infrastructure for potential problems**, allowing for proactive	

and efficient energy system.	maintenance and minimizing disruptions. **Demand response programs**: Digital platforms can connect energy consumers with utilities to implement demand response programs. These programs incentivize **consumers to reduce electricity usage during peak demand** periods, alleviating stress on the grid.	

5.5.3. Status of digitalisation in the energy sector

Ukraine's **energy sector is undergoing a digital transformation**, driven by both domestic strategies and collaboration with international partners, particularly the European Union (EU). While significant progress has been made, there is room for improvement. Ukraine is **aligning its energy policies with EU directives such as the Renewable Energy Directive (RED) and the Energy Efficiency Directive (EED)**. Additionally, the country actively participates in EU-funded initiatives aimed at digitalizing the energy sector.

Projects like twinning projects pair Ukrainian energy institutions with EU counterparts to facilitate knowledge exchange and **capacity building in areas like smart grid development and smart metering implementation**. The INSO-EU Framework Programme supports research and innovation projects focusing on clean energy technologies, including digital solutions for the energy sector.

Next Steps and Initiatives include the "Strategy for the Development of the Energy Sector of Ukraine for the Period Up to 2030," outlines specific digitalization goals and action plans. These include **expanding pilot projects for smart grid technologies and developing a regulatory framework to incentivize investments in smart grid infrastructure and smart metering deployment**.

Addressing **cybersecurity** concerns **associated with smart grid technologies** is a priority with plans to **develop robust data security protocols** and collaborate with international partners on cybersecurity best practices. The National Commission for State Energy and Utility Regulation (NCSEUR) has adopted a separate strategy **focusing on smart grid development**, which includes phasing out outdated metering infrastructure, developing communication standards, and investing in grid modernization projects.

There are several funding schemes. The Ukrainian **government allocates funds for digitalization initiatives in the energy sector through the national budget, but resources are often limited**. International financial institutions like the World Bank and the European Investment Bank provide loans and grants to support specific digitalization projects, such as smart grid development and energy efficiency upgrades. Private sector investments also play a role, with energy companies and technology startups contributing to the development and deployment of the digital solutions.

There are developments underway regarding smart meter solutions and data utilization. **Pilot projects for smart metering are underway in both electricity and gas sectors,** with companies like Siemens and DTEK leading the way. **Data management platforms are being developed to optimize grid monitoring and energy flows**, with initiatives like YASNO energy company's project for electricity distribution network[180].

Regarding market data accessibility and consumer-oriented services, **efforts are underway to develop online platforms providing consumers with real-time and historical energy market data**. This should empower them to make informed choices about their energy consumption. The National Commission for State Regulation of Energy and Utilities (NCREKP) presented Ukraine's first **mobile application "Energy Online",** which provides consumers with an opportunity to receive timely information on current tariffs, to check the bill for electricity and gas services, to find answers to topical questions about granting subsidies, timing of payment of bills for services, debt repayment, energy saving, evaluate the work of the centres.[181] The application was developed by the analytical centre DiXi Group and NKREKP as part of the USAID project "Energy Window"[182]

Independent initiatives like **Hotline Finance** and **e-Tender** offer transparency and facilitate market access for new players by **aggregating data on energy tariffs and auctions**. Consumer-oriented digital services are also emerging, with companies like **Easy Meter** and **Ajax Systems providing smart metering solutions and smart home security systems** with energy monitoring features [183].

Ukraine's journey towards digitalizing its energy sector is marked by collaboration, innovation, and effort to leverage digital solutions for greater efficiency, sustainability, and consumer empowerment. Ukraine is making significant progress in digitalizing its energy sector, aligning with EU directives and participating in international initiatives. Ongoing pilot projects and data management initiatives are optimizing energy use, while efforts to provide accessible energy market data and consumer-oriented digital services are empowering consumers and enhancing market transparency. **Key to further progress are clear strategic goals and a strong focus on cybersecurity**. **Continued support from the government, international financial institutions, and the private sector is crucial**.

5.6. SMART MOBILITY

5.6.1. Sector definition, role of digitalisation

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 put in place to drive the transition.[184] 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 digitalisation will shape how passengers and freight move around in the future if the right conditions are put in place.

In the digitalisation report we will complement the work done under the smart mobility theme and will focus on enabling factors that are crucial in reaching smart mobility goals. For that purpose,

[180] https://yasno.com.ua/business/energymanagement
[181] http://energopostachalnyk.com/en/energyonline
[182] https://www.nerc.gov.ua/news/nkrekp-prezentuvala-pershiy-v-ukraini-mobilniy-dodatok-energetika-onlayn
[183] https://www.sea.com.ua/ua/asoe/
[184] https://transport.ec.europa.eu/transport-themes/mobility-strategy_en

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 and governance as well as 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 means further harmonisation and coordination of relevant traffic rules and liability for automated vehicles; and data portability should protect the users and offer them clear and transparent view on how the data can be used or transferred.

5.6.2. Main smart mobility-related challenges in Ukraine

There are several challenges regarding smart mobility in Ukraine. The most notable ones are described below.

- **Limited Infrastructure:** The **development of 5G and IoT networks is still in its infancy**, limiting the implementation of advanced smart mobility solutions. While the number of EV charging stations is growing, it is still insufficient to support widespread adoption of electric vehicles.
- **Regulatory and Policy Challenges:** Ukraine lacks comprehensive policies that promote the development and integration of smart mobility solutions. Ensuring data security and protecting personal data are ongoing challenges that require a robust regulatory framework.
- **Financial Constraints:** Limited financial resources and investment opportunities can slow down the development and deployment of smart mobility infrastructure. The high initial costs of implementing such solutions can be a barrier for both the public and private sectors.
- **Public Awareness and Adoption:** Public awareness and acceptance of smart mobility solutions are still growing, which can slow down their adoption and effectiveness.

However, the opportunities for Smart Mobility in Ukraine include:

- **Collaboration and Partnerships:** Collaboration with EU countries and international organizations can bring necessary expertise, funding, and best practices to accelerate smart mobility projects. Public-private partnerships can also leverage resources and drive innovation.
- **Technological Advancements:** The expansion of 5G networks and IoT infrastructure can enable more sophisticated and widespread smart mobility solutions. Ukraine still does not have a 5G mobile network but aimed to launch a pilot version in 2024. The use of artificial intelligence and big data analytics can improve traffic management, predictive maintenance, and personalized mobility services.

- **Sustainability Initiatives:** Promoting electric vehicles, bike-sharing, and e-scooters can reduce carbon emissions and contribute to sustainable urban transport. Smart grid and metering solutions can enhance energy efficiency and support the transition to renewable energy sources. Digitalization and the adoption of multimodality can streamline cargo transport, reduce congestion, and minimize empty miles. Sustainable practices in freight transport, such as route optimization and fuel efficiency, can result in cost savings for businesses. Encouraging the transfer of goods from road transport to more environmentally friendly modes of transport, such as rail or inland waterways, would be beneficial.
- **Consumer-Oriented Services:** Providing real-time information on public transport and traffic conditions can improve the user experience and encourage the use of smart mobility options. Developing user-friendly mobile apps and platforms for route planning, ticketing, and service booking will enhance convenience and accessibility.

Addressing these barriers and leveraging the opportunities will enable Ukraine to accelerate the adoption of smart mobility solutions, creating a more efficient, sustainable, and user-centric transportation system.

5.6.3. Status of smart mobility

Smart mobility approaches are gradually being implemented in Ukraine. For example, **Smart Public Transportation** in Kyiv, **the Kyiv Smart City initiative,** is implementing electronic tickets, real-time tracking systems for buses and trams, and mobile apps for route planning. **Lviv has developed a smart transport system** that includes GPS tracking for public transport, electronic ticketing, and centralized traffic management.

Electric Vehicle (EV) Infrastructure includes The Chargemap network of EV charging stations, and it is expanding **in major cities**, promoting the adoption of electric vehicles. EcoFactor provides smart charging solutions and infrastructure for EVs.

Bike-Sharing and E-Scooters: Nextbike, a bike-sharing service, operates in several Ukrainian cities, offering an environmentally friendly alternative for short trips. E-scooter sharing services like Bolt and Lime provide convenient and sustainable urban mobility in major cities.

Smart Traffic Management: Intelligent Transport Systems (ITS) have been implemented in cities like **Kyiv and Lviv** to manage traffic flow, reduce congestion, and improve road safety through real-time data analytics and adaptive traffic signals.

Currently, Ukraine has potential for the development of public transport and cycling, as well as rail and water transport for passenger and freight transport, so these points from the EU's mobility strategy can become a reference point for Ukrainian cities and the government. Ukraine is already **creating incentives for the development of electric mobility thanks to easier taxation of the import of electric cars**, so now it is appropriate to focus on recommendations for expanding the network of electric charging stations and encouraging the use of electric bicycles and electric scooters.

The integration of the transport network of Ukraine into the TEN-T requires the fulfilment of the requirements for the development of this network. Cities that are "hubs" of the network should develop plans for sustainable urban mobility.

At the national level, it is **necessary to develop and implement a transparent and automated carbon footprint calculation system** to collect carbon footprint data from different types of

transport and make it public. It is necessary to **increase the share of electrified railway tracks** to 70% by 2030 (currently about 50% are electrified), **modernize public transport** and **switch it to electric** (trams, trolleybuses, trolleybuses with autonomous driving), install cameras for recording violations of the Traffic Rules, in particular, exceeding speed limit, driving on public transport lanes and other violations.[185] Further, it is important to propose and initiate research and innovation in the field of connectivity and automation of transport, especially multimodal, and road safety (through universities, scientific institutes).

In 2021, the Ministry of Infrastructure of Ukraine began the active implementation of several digital solutions related to infrastructure areas. Including:

- Introduction of an electronic passenger ticket (SmartTicket)
- Implementation of the E-cargo system - provision of multimodal cargo transportation, integration with other systems, and digitization of processes in the ports of Ukraine
- several industry digitization projects - PayGovUA payment service, i-Cyber industry cyber protection system, automated fare payment system, IT strategy of Ukrzaliznytsia, a project to implement an automation system and process applications for unmanned flights, toll collection systems, etc.

Due to the war, the implementation of digital solutions took place only partially: the E-cargo system and projects on digitalization of the industry were suspended; the e-ticket is valid only in some cities (Kharkiv, Kyiv, Mukachevo, Lviv, etc). However, JSC "Ukrzaliznytsia" in 2023 implemented a single digital window for the work of cargo transportation customers - "e.Portal UZ-Cargo"

In June 2023 Ukraine signed the Agreement with the EU on joining the EU Connecting Europe Facility Program, under which Ukraine will receive support for the development of projects of common interest, such as safe and reliable high-bandwidth digital networks and 5G systems, as well as the digitization of transport and energy networks.

Ukraine still does not have a 5G mobile network, but plans to try to launch a pilot version in 2024.

5G bandwidth offers a wide range of capabilities, such as real-time traffic management, detailed weather studies, and coordination of thousands of AI-driven vehicles. However, this expansion of the Internet's capabilities also increases the dependence of various economic sectors on its functionality, especially critical infrastructure enterprises. The risks of implementing 5G technology in Ukraine are exacerbated by Russia's potential attacks on the telecommunications infrastructure. In addition, some tasks related to the release of radio frequency spectrum for 5G networks cannot be performed during martial law because it is used by the military.

The introduction of 5G technology will provide new opportunities for both civilian and military use, but increasing network bandwidth without improving monitoring capabilities will significantly increase the vulnerability of Ukrainian infrastructure to cyberattacks. Therefore, the implementation of 5G should especially focus on cybersecurity.

Ukraine is making progress towards implementing smart mobile solutions, but data availability and security of data flows and personal data remain critical areas that need improvement. **Big cities like Kyiv and Lviv have started collecting public transport data using GPS tracking, electronic tickets, and real-time monitoring systems**. This data is crucial for optimizing routes, planning, and improving public transport services.

However, **data is fragmented and often closed** by different organizations, making it difficult to access and integrate. Although there are initiatives to collect real-time data, **comprehensive real-**

[185] https://ecoaction.org.ua/vykydy-vid-transportu.html

time data collection and integration across all modes of transport is still limited. In addition, there is a **need for standardized data formats and protocols** to ensure seamless data exchange between different systems and stakeholders.

Digitization and data collection are the directions that the Ministry of Infrastructure is developing. Today, there are digital tools that allow you to automate, collect, manage, and share data and information. Among them:

- eCherga https://echerha.gov.ua/ – online booking service for border crossings by cargo carriers;
- service for checking administrative offenses (WIM fines) – https://wim.dsbt.gov.ua/;
- License register of carriers - https://shlyah.dsbt.gov.ua/lc.html;
- Search for an application for border crossing "In the Way" - https://vshlyahu.dsbt.gov.ua//;
- UkrtransbezpekaBot – https://t.me/UkrTransBezpekaBot - a service of notification of Ukrtransbezpeka about violations of rights in the field of road transport.

The legal framework of Ukraine is in the process of bringing its legislation on data protection to EU standards, specifically the General Data Protection Regulation (GDPR). Some organizations have implemented advanced security measures, including encryption and secure data transfer protocols, to protect data flows and personal information. Moreover, there are currently data security challenges, primarily related to the **threat of cybersecurity: the growing digitalization of the mobility sector makes it a target for cyberattacks**. Robust cybersecurity measures are necessary to protect sensitive data and ensure the integrity of smart mobility systems.

5.7. ZERO POLLUTION

5.7.1. Sector definition, role of digitalisation

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 are to be fully met, enforcing all industrial activities to be within 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 are threatening the environment, aim to be substituted in order 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, there are areas such as air quality & health, emission reduction, pollution prevention and control, water quality and conservation, soil protection, chemicals management, green technologies and innovation, environmental monitoring and reporting. There are EU regulations/ policies covering these areas. For example, most broadly the European Green Deal 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 digitalisation, 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 Ukraine

Ukraine is working towards achieving zero pollution by **utilizing digital technologies for monitoring, controlling, and managing environmental processes**. The Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030" provides that by 2030, Ukraine will achieve significant improvements in the state of the environment through a balance between socio-economic needs and environmental protection tasks, ensuring the development of environmentally effective partnerships between the state, businesses, and the public, and sustainable low-carbon development.

In 2018, the Government approved the Low-Carbon Development Strategy of Ukraine until 2050, which envisaged the transition to an energy system using low-carbon energy sources, the development of clean electricity and heat energy sources, increasing energy efficiency and energy conservation in all sectors of the economy and housing and communal infrastructure, stimulating the use of alternative fuels to petroleum products and shifting freight and passenger transport to more environmentally friendly modes, increasing carbon absorption and retention through the application of best practices in agriculture and forestry adapted to climate change, and **reducing greenhouse gas emissions mainly related to fossil fuel production, agriculture, and waste. Unfortunately, many of these measures are currently limited due to full-scale invasion by Russian Federation.**

However, Ukraine continues to take measures aimed at achieving zero pollution where possible, including through digitalization. **By the Concept of Implementation of State Policy in the Field of Industrial Pollution, the Electronic Emission Permits System (E-permits) was created** and operates, **allowing for the issuance of electronic permits for emissions of pollutants into the atmosphere.** It simplifies the permitting process and ensures compliance with environmental standards. However, it does not yet provide for integrated permits.

Currently, there are approximately 100 enterprises in Ukraine that are the largest polluters and engage in activities listed in Annex 1 of Directive 2010/75/EU, including energy, metallurgy, chemical industry, and the agro-industrial complex[186]. **The Cabinet of Ministers of Ukraine has approved the Procedure for the Introduction of Automated Systems for Emission Control of Pollutants, which obliges enterprises to install monitoring systems at their facilities**. With their help, enterprises are to conduct appropriate measurements, and the obtained data on emissions from their equipment should be transmitted to the Ministry of Environmental Protection.

It should be noted that, in addition to enterprises, the consequences of full-scale invasion by Russian Federation significantly impact state of environment in Ukraine. Before the Russian aggression, it was planned that by 2025, 100% of enterprises would implement chemical management systems. However, **the current Procedure provides that businesses must install automated control systems within five years after the end or cancellation of martial law in Ukraine.**

The Ministry of Environmental Protection is responsible for the state environmental monitoring system, which collects and **analyses the quality of air, land, water, coastal water,**

[186] https://data.gov.ua/dataset/4989379f-7d90-4bd8-8da9-47aa7346911a

soil, radiation, and biodiversity indicators. This system provides for the exchange of information between departmental monitoring databases at the national and regional levels. Environmental data is available to the public through applications such as SaveEcoBot, EcoCity, and EcoZagroza. However, **parts of the country are insufficiently covered by monitoring networks**. This leads to the absence of data on the environmental conditions in some parts of the country, especially those that are occupied or where hostilities are ongoing. **Some of the monitoring equipment is outdated** and does not meet modern accuracy and reliability standards, which may lead to unreliable results. Furthermore, **environmental data is not always available in real time, complicating the quick response to environmental problems**. Further development of the sensor network and the integration of data from various sources will ensure more accurate and comprehensive air quality monitoring in Ukraine.

5.7.3. Status of zero pollution digitalisation efforts

Ukraine is making progress in greening and digitalising the production of chemicals, driven by a combination of national strategies, regulatory frameworks, and the adoption of advanced technologies. These initiatives are critical for reducing environmental impact and enhancing the efficiency and sustainability of the chemical industry.

Ukraine's commitment to environmental sustainability is evident in its comprehensive policies and strategies. **The National Strategy for Waste Management in Ukraine until 2030** is a cornerstone of these efforts. **This strategy aims to reduce industrial waste, including chemical waste**, by implementing better management practices and adopting clean technologies. The strategy, approved with the support of international partners like the European Union and the World Bank, **is in the implementation phase** and is considered a high priority for the country.

In addition, the **Law on Waste Management** (No. 2320-IX), enacted on June 20, 2022, establishes a robust framework for managing waste, including the proper handling and disposal of chemical waste. This law aligns with EU standards and is expected to fully come into force by June 2024, highlighting its high priority status in Ukraine's legislative agenda.

One of the key technological advancements in Ukraine is the **E-permits System**, an electronic **platform for obtaining permits for emissions, including those from chemical production**. This system simplifies the permitting process and ensures that industries comply with environmental standards. While the system is operational, efforts are ongoing to integrate comprehensive permit provisions, indicating its high priority and evolving nature.

Another significant initiative is the promotion of **Best Available Techniques (BAT) in the chemical industry**. This involves **updating existing plants and facilities with the latest technologies to reduce emissions and improve efficiency**. The implementation of BAT is currently in progress, with guidelines being developed and disseminated to industry stakeholders, emphasizing its importance and urgency.

Ukraine is also embracing the principles of **Industry 4.0** to modernize its chemical industry. This includes the **integration of IoT, big data, and automation into production processes**. These technologies enable real-time monitoring and control, enhancing operational efficiency and reducing environmental impact. Although **these digitalization efforts are in the early stages, pilot projects are being implemented** in collaboration with technology providers, showcasing Ukraine's proactive approach to adopting cutting-edge technologies.

Ukraine is making progress in leveraging data-driven decision-making to tackle pollution and reduce emissions. **The country employs advanced monitoring, modelling, and prediction solutions to**

address environmental challenges. Here are some examples of how these technologies are being applied:

- One of the notable projects is the **Eco-City Project**, which involves a **network of sensors monitoring air quality in real-time across various cities** in Ukraine[187]. The data collected from these sensors tracks pollution levels and identifies sources of emissions. **Local governments and organizations use this information to implement targeted measures to reduce air pollution**.
- Similarly, **SaveEcoBot** is an innovative platform that **aggregates air quality data** from various sources, including governmental and independent sensors[188]. This data is **presented to the public in an accessible format, raising awareness** and driving community-based actions to reduce pollution.
- The **Ukrainian Hydrometeorological Center utilizes predictive models to forecast smog and pollution** events. These models, which **rely on historical and real-time data**, help predict air quality, enabling proactive measures to mitigate high pollution levels before they become critical.
- In the **Dnipro River Basin, automated systems are used to monitor water quality by collecting data on pollutants such as heavy metals, nitrates, and phosphates**. This data is crucial for assessing the health of the water body and identifying pollution sources. Additionally, **the EU Water Initiative Plus (EUWI+) supports the development of water monitoring systems in Ukraine**, which provide essential data for water management and pollution control strategies.

Ukraine's journey towards green and digital transformation is supported by several strategies, legal frameworks, substantial funding, and collaborative initiatives. These enablers are essential for driving sustainable development and achieving environmental goals.

- The following normative acts have been adopted at the policy level:
  National Renewable Energy Action Plan (NREAP): Sets targets for increasing the share of renewable energy, focusing on solar, wind, biomass, and hydro energy.
- **Law on Alternative Energy Sources**: Provides a legal framework with incentives like green tariffs and tax benefits, encouraging investment in renewable energy.
- **Law of Ukraine "On the Basic Principles (Strategy) of the State Environmental Policy of Ukraine for the period up to 2030"**: This law aims to achieve significant improvements in environmental conditions by balancing socio-economic needs with environmental protection, fostering environmentally effective partnerships, and promoting sustainable low-carbon development by 2030.
  Low-Carbon Development Strategy until 2050: Approved in 2018, this strategy envisages transitioning to low-carbon energy sources, developing clean electricity and heat, increasing energy efficiency and conservation, stimulating the use of alternative fuels, and reducing greenhouse gas emissions from fossil fuels, agriculture, and waste.
  National Transport Strategy 2030: Aims to modernize transport infrastructure, promote electric vehicles (EVs), and develop smart mobility solutions.
- **Law on Electric Vehicles**: Provides incentives for purchasing and using EVs, including tax exemptions and reduced import duties.
- **Law on State Support of Agriculture:** Offers subsidies and financial support for adopting precision agriculture technologies.

[187] https://eco-city.org.ua/
[188] https://www.saveecobot.com/

Projects funded by organizations like the EBRD and the World Bank support large-scale renewable energy projects. Collaboration between the government and the private sector is needed to expand the network of EV charging stations. More concrete data systems include:

- **The Electronic Emission Permits System (E-permits)** allows businesses to apply for and receive permits for emissions online. This system simplifies the permitting process, reduces paperwork, and ensures real-time tracking and updates on permit statuses. E-permits enhance regulatory compliance by providing a transparent, efficient, and standardized process for managing emissions. It helps monitor and enforce environmental standards more effectively.
- **The State System for Environmental Monitoring** integrates data from various sources, including air, water, and soil quality monitoring stations. It facilitates data sharing across different sectors and government agencies. Centralizing data allows for better coordination and decision-making across sectors, leading to more effective pollution control measures.
- **Integrated Environmental Management Systems** that integrate data from different environmental monitoring platforms to provide a holistic view of environmental health. These systems allow for comprehensive analysis and coordinated efforts across different sectors, improving overall environmental governance and pollution control.

5.8. BUILDINGS

5.8.1. Sector definition, role of digitalisation

The European Union prioritises the building sector as a key sector to support reaching Europe's green transition goals. Being one of the largest consumers of energy 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[189]. At the same time, private sector buildings (especially residential multi-apartment buildings and individual housing) play a crucial role in reaching the energy saving goals. On the European level, the key strategic goals are set in the Renovation Wave Strategy,[190] which aims to double annual energy renovation rates in the next 10 years as well as to significantly reduce emissions from the sector. The legislative framework to boost the energy performance of buildings is established in the Energy Performance of Buildings Directive[191] and the Energy Efficiency Directive[192].

Digitalisation measures must ensure data availability to understand the status of energy consumption and efficiency of buildings, including instruments such as the digital building logbook, 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 energy consumption of buildings.

[189] See, for instance, DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on energy efficiency and amending Regulation (EU) 2023/955 (recast)
[190] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1603122220757&uri=CELEX:52020DC0662
[191] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02010L0031-20210101
[192] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766

5.8.2. Main Buildings related digital challenges in Ukraine

In Ukraine's construction and renovation sector, digitalization is being taken up, albeit with varying intensity across different stakeholders. While traditional construction methods still dominate, a handful of innovative companies are pioneering the adoption of digital tools and embracing principles of the circular economy.

Challenges in the building & construction industry include:

- Many construction firms and renovation specialists remain entrenched in **paper-based systems for project management, stifling efficiency and collaboration** in an increasingly digital world.
- **Smaller companies, in particular, grapple with limited awareness and resources to invest in digital solutions**, further exacerbating the digital divide.
- **Concerns regarding standardization and data security create obstacles**. The lack of standardized data formats impedes seamless data exchange between different software and applications, while data privacy regulations and cybersecurity measures demand attention.

At the same time, the Government is **implementing the Digital Restoration EcoSystem for Accountable Management** (DREAM). Ukraine's restoration is a large-scale process. Its two priority areas are the restoration of critical infrastructure and long-term reconstruction and modernization. Together, these are tens of thousands of projects that will happen simultaneously, at different stages, throughout the country. DREAM is **a unique state digital ecosystem that provides a single pipeline for all restoration projects**.

The DREAM project office has created a user support and training centre for working with the ecosystem and restoration in general, which includes integrated training materials, tips, explanations, regulatory framework, video and text instructions, Massive Open Online Courses, examples of successful projects, reuse projects, etc.[193]

In addition, amidst these challenges lie promising **opportunities** for digital transformation:

- **Building Information Modelling (BIM)** offers a digital twin of buildings that streamlines collaboration and optimizes resource utilization throughout the lifecycle of a project.
- **Smart building technologies**, driven by sensor-based systems, hold the promise of revolutionizing energy management. These systems monitor energy consumption, identify inefficiencies, and automate functions like heating and lighting, ultimately leading to significant reductions in energy usage.
- **Digital renovation planning tools** allow more efficiency and sustainability. By analysing building data, these software platforms recommend renovation strategies that prioritize energy efficiency while embracing circular economy principles such as material reuse.
- **Digital marketplaces for used building materials** represent a significant step towards sustainability. Online platforms connect sellers of reusable building materials with potential buyers, thereby reducing construction waste and fostering the circular economy.

5.8.3. Status of Buildings-related digitalisation efforts

In Ukraine, pioneering companies are already leading the charge towards digitalization and sustainability:

[193] https://dream.gov.ua/ua

- **UVT GROUP leverages BIM technology** to optimize energy efficiency in building projects. By integrating energy-saving technologies and offering innovative building management systems, they strive to enhance operational efficiency and sustainability.
- **Ecobud** (ecobud.com.ua) is a **developer and manufacturer of energy-efficient building materials**. Their products include insulated concrete forms (ICFs), which can help reduce heating and cooling costs in buildings
- **iBud** (ibud.ua) is an **online platform that connects property developers with potential buyers**. The platform also provides information on sustainable construction practices and energy efficiency ratings for buildings

These examples illustrate the potential of digitalization and circular economy principles in Ukraine's construction and renovation sector. By overcoming existing challenges and embracing a digital-first approach, Ukraine can direct itself towards near-zero energy buildings and a more sustainable construction industry.

The modernization and digital transformation of the domestic construction industry, particularly through the implementation of BIM technologies, will address several systemic problems. These include low design and construction quality, inefficient use of resources, unpredictability of operating costs for constructed facilities, building and structure accidents, lack of investment, high resource consumption, and low energy efficiency in the industry. Therefore, **to systematically and comprehensively implement information modelling in construction, the Ministry of Regional Development has developed a Concept and an action plan for its implementation.**

The primary implementation of BIM technology requires state regulation, including the creation of the necessary legal framework, development of a set of norms and standards, state support for pilot projects, training of qualified specialists, and informational, organizational, and methodological support. **There are already results in this direction. Amendments to the Procedure for Developing Design Documentation for Construction Projects have come into effect,** allowing the use of BIM technologies, as well as amendments to the Procedure for Approving Construction Projects and Conducting Their Expertise, which can be submitted in paper and electronic form or as electronic documents. Currently, the Ministry is working on updating 20 state building codes (DBN), developing national cost norms, and creating a comprehensive plan for reviewing construction norms until 2025.[194]

In short, handful of developments exist and there are several national level initiatives to further sustainable construction practices via digital means. BIM technologies are key and need further government efforts.

[194] https://www.kmu.gov.ua/news/bim-tehnologiyi-pidvishchat-yakist-budivnictva-v-ukrayini

6. ASSESSMENT OF OTHER CROSS-CUTTING AREAS

6.1. RESEARCH AND INNOVATION

6.1.1. Background and scope of the area under scrutiny

Over the last decade, the EU´s R&I policy has been redesigned to ensure that the results of public funding are supporting, enabling, and driving 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 European Green Deal and developing an economy that works for people.

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

- preventing or minimising pollution, degradation, or natural resources depletion;
- repairing damage to air, water, waste, noise, biodiversity, and landscapes;
- reducing, eliminating, treating, and managing pollution, degradation, and natural resource depletion;
- carrying out other activities such as measurement and monitoring, control, R&D, education, training, information, and communication 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&I

Research and innovation (R&I) in IT is a key driver of the green transition, leveraging Ukraine’s IT industry. Ensuring adaptation of public services to different population groups, including marginalized or vulnerable groups (e.g., IDPs, war veterans, disabled, single-parent families, elderly), promotes inclusiveness and supports a just transition.

Focusing on green technologies, AI, IoT, and other emerging technologies is crucial for achieving climate, energy, and environmental protection objectives. IT is a priority for R&I under current legislation, and its application in other EGD areas to address pressing challenges is emphasized in various sectoral strategic documents. The Ministry of Education and Science (MoES) is working on digital tools like Science.City to enhance R&I policy implementation.

Ukraine's Strategic Efforts include**:**

- **National Economic Strategy 2030:** Emphasizes the role of scientific research in developing digital technologies and innovations, fostering cooperation between research institutes, universities, and the private sector.
- **National AI Development Strategy 2025:** Focuses on AI research and development, aiming to create a supportive environment for AI innovations.

- **ICT and Digital Economy Strategy 2030:** Highlights the importance of scientific research in the digital economy, promoting innovation and investment in digital technologies.
- **Low-Carbon Development Strategy 2050:** Stresses the need for research and innovations in energy efficiency, nuclear energy, digital grids, transport modernization, and energy storage technologies.

Digitalization can play an important role in supporting the green transition in Ukraine. Therefore, it is important to conduct research and implement digital technologies aimed at:

- Developing new artificial intelligence algorithms that can help optimize energy use
- Developing new sensors and networks for environmental monitoring
- Developing new platforms for data exchange and cooperation on green transition issues

Scientific research must align with digitalization policies to address green transition challenges and develop effective digital solutions. Despite strategic documents, real support for innovation and research is often insufficient. However, there is room for improvement, as the **inclusion of innovation and scientific research in strategic documents is often merely declarative. Real support for innovation and scientific research is insufficient.**

ICT Skills for Digital and Green Transition:

As of 2022, the IT sector contributed 4.9% to Ukraine's GDP, with IT services exports averaging nearly $7 billion annually[195] In 2023, the sector saw a 7% increase in tech specialists[196]. STEM education in Ukraine is strong but needs further adaptation to meet the IT industry's evolving needs. Due to war, population outflow, and military mobilization, the sector might face a skilled labour shortage for green transition efforts.[197]

Key areas for ICT skills development and retraining include:

- **Improving Energy Efficiency.** Skills in managing energy systems and using digital tools for monitoring and optimizing energy consumption are necessary. For example, the platform "Greencubator.Academy"[198] offers programs and training in energy management and digital technologies to improve energy efficiency, including practical sessions using software for energy consumption analysis.
- ► **Reducing Greenhouse Gas Emissions.** Knowledge of environmental monitoring and data analysis is needed. Courses in environmental management, using ICT for environmental monitoring, and emissions modelling are important. Similar courses are offered by the company "Atestor,"[199] which provides training on "environmental management" for the successful and effective integration of environmental management systems for enterprises across Ukraine.
- **Developing New Renewable Energy Sources.** Skills in renewable energy engineering, programming, and data analysis are essential. Training programs can include courses on the development and implementation of renewable energy technologies. The Prometheus platform offers an online course on "Sustainable and Renewable Energy".[200]
- **Promoting Sustainable Development.** Interdisciplinary knowledge in sustainable development, including project management, the use of ICT for data analysis, and modelling sustainable systems, is required. Courses cover sustainable management topics and the use of ICT to support sustainable development.

195 https://sifted.eu/articles/ukrainian-tech-2024-brnd
196 https://www.nucamp.co/blog/coding-bootcamp-ukraine-ukr-most-in-demand-tech-job-in-ukraine-in-2024
197 https://itukraine.org.ua/files/ITU_GT.pdf
198 https://greencubator.info/greencubator-academy/
199 https://atestor.ua/uk/training/learn-ekologicnii-menedzment/
200 https://prometheus.org.ua/course/course-v1:Prometheus+ENERG101+2023_T1

- **Developing New Sensors and Networks for Environmental Monitoring.** Knowledge in engineering, programming, and data analysis is necessary. Training programs include courses in hardware development, programming, and data analysis.
- **Developing New Data Exchange Platforms.** Skills in programming, data management, and cybersecurity are essential. Courses in software development, database management, and cybersecurity are important.

The Ministry of Digital Transformation's "Digital Education" project enhances digital skills among the population through online courses and training. Universities and private companies also offer ICT courses for upskilling workers. Over 2016-2021, the number of **BA graduates in IT specialties** stood at **16,2 students per year on average**[201]. There is a trend in the **decreasing number of MA graduates** in IT over the last decade. **On-the-job training and non-university training seem to have played a key role** in the robust growth of skilled IT specialists in Ukraine and the rapid development of the IT sector. However, taking into consideration the continued growth of the IT industry in wartime, growing demand for IT specialists given sector's importance for resilience and war effort, **Ukraine risks having a lack of IT specialists in the coming years** (e.g., pre-war, the expected demand is 30-50 000 per year of IT graduates vs 16-17 000 currently[202]).

There are **several MA/PhD programs, research centres, and R&D projects in Ukraine that focus on supporting green transition via digital skills**. Here are a couple of examples:

- **National Technical University of Ukraine (KPI):** Offers advanced degree programs and houses research centres focusing on renewable energy and digital technologies.
- **National University of Kyiv-Mohyla Academy**: Has the Center for ecosystems, climate change and sustainable development research that also focuses on the application of ICT in environmental monitoring, data analysis, and sustainable resource management.
- **Institute of Renewable Energy at NASU:** Conducts extensive research in renewable energy, collaborating with international organizations and private companies.

Digitalization as a Flagship Reform: Since 2014, digitalization has significantly improved public services through innovations like Diia. Ongoing digitalization of the research and science sector aims to connect researchers, academia, and businesses, providing information to innovators. The Concept of Development of the Digital Economy and Society 2018-2020 outlines priorities like digital infrastructure, e-governance, cybersecurity, and digital skills training.

Potential and Challenges: Ukraine's digital sector has made significant progress in IT infrastructure development. Tech hubs like UNIT. City in Kyiv and Lviv IT Cluster supports digital startups and innovations. However, continuous investment, especially in rural areas, is needed for comprehensive digital infrastructure. Ukraine has a robust IT talent pool, but ongoing education and upskilling are crucial, particularly in areas linked to the green transition.

Support for Social Innovation: Digital tools enhance collaboration, data-driven decision-making, and access to resources, supporting social innovation initiatives. Examples include:

- **Greencubator:** Promotes energy efficiency and renewable energy projects through hackathons and innovation labs.
- **Impact Hub Odessa:** Supports social entrepreneurs and community projects using innovative approaches for sustainable urban development.
- **EcoHike by Save Dnipro:** Uses a mobile app to report and map illegal dumpsites, organizing community clean-ups[203].

[201] https://www.abtosoftware.com/blog/ukrainian-it-industry-key-facts
[202] https://itukraine.org.ua/files/ITU_GT.pdf
[203] https://www.savednipro.org/

- **EcoCity in Ivano-Frankivsk:** Implements smart sustainable city initiatives.

Engagement of Private and Non-Governmental Sector: Private and third-sector actors are active and capable in R&I for the green and digital transition. Tech firms like SoftServe and GlobalLogic develop digital solutions for energy management and environmental monitoring. NGOs like Save Dnipro and Ecoaction lead environmental advocacy and innovation. Continuous support, investment, and collaboration between these sectors are crucial for achieving sustainable development goals in Ukraine.

6.2. SOCIAL IMPACT AND JUST TRANSITION

6.2.1. Background and scope of the area under scrutiny

Just transition and social impact assessment are crucial for the green transition. Social sustainability ensures that moving to a low-carbon economy does not compromise social well-being. This involves guaranteeing access to basic needs like housing, healthcare, and education, especially for vulnerable populations. The aim is to ensure the transition is economically viable, environmentally sustainable, and socially equitable. Principles of just transition emphasize fairness to workers, communities, and sectors most affected by the transition. This involves assessing social impacts, ensuring job opportunities, retraining, and support mechanisms for a smooth transition.

Evaluating the just transition processes involves:

- The impact of the green and digital transition on jobs
- Measures to improve equal access to basic services (including e-services)
- Examining gender-specific, age-related, and location-based impacts regarding digital skills and access
- Socio-cultural acceptance and public awareness of the need for green and digital transition
- Community engagement and participation in promoting a just digital transition

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

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

Ukrainian sectoral digitalization policy has been taking steps to address potential job loss, gender inequality, and other issues affecting vulnerable groups. Here are some key measures and initiatives that highlight these efforts:

Job loss and retraining

- **The IT Generation initiative**, launched by the Ministry of Digital Transformation, aims to **retrain individuals from various sectors for IT careers**. This program is designed to mitigate job loss in traditional industries by providing new employment opportunities in the growing digital sector. It offers courses in programming, data analysis, and other essential IT skills, targeting those who might be at risk of unemployment due to digital transformation.[204]
- **The Diia.Business hubs** provide resources and training for small and medium-sized enterprises (SMEs) to adapt to digitalization. These hubs help businesses integrate digital tools, which can

[204] https://it-generation.ithillel.ua/

mitigate job loss by enhancing business efficiency and competitiveness. They also offer support for entrepreneurs, encouraging the creation of new jobs within the digital economy.[205]

- **Gender inequality and support for vulnerable groups**

► **The Diia.Digital Education platform** offers free online courses to improve digital literacy across the population. Special emphasis is placed on reaching women, rural communities, and other vulnerable groups to ensure they are not left behind in the digital transition. By providing accessible education, the program aims to bridge the digital divide and promote equal opportunities for all.[206]

► **Women in tech initiatives**: Various NGOs and private sector initiatives focus on encouraging women to pursue careers in technology. Programs like the **Women Techmakers** initiative and the STEM is FEM project provide mentorship, training, and networking opportunities for women and girls. These initiatives aim to increase female participation in the tech industry, addressing gender inequality and empowering women through digital skills.[207]

Addressing broader social impacts

- **Equal access to services**: The digitalization strategy in Ukraine includes measures to ensure equal access to e-services. The Diia app, for instance, provides a wide range of government services online, making them accessible to people regardless of their location. This is particularly beneficial for rural populations and those with limited mobility, ensuring that everyone can access essential services like healthcare, education, and administrative support.

Ukraine's digitalisation sector is actively addressing potential job loss, gender inequality, and the needs of vulnerable groups through various initiatives and policies. Programs focused on retraining, education, and equal access to services are central to these efforts. By promoting inclusivity and social equity, Ukraine aims to ensure that the benefits of digital transformation are shared widely, supporting a just and sustainable transition.

Job Creation and Skill Development: Digitalization may reduce traditional low-skilled jobs while increasing demand for specialists in smart grid management, renewable energy, energy efficiency, digital technologies, environmental monitoring, and precision agriculture. Ukraine should invest in retraining and upskilling programs to ensure a smooth transition to the digital economy. The war has led to massive job losses, but reconstruction efforts can create jobs in energy, healthcare, and public services. Government and international partners focus on support and labour market recovery measures, including retraining programs and infrastructure restoration.

Potential New Jobs in Digital/IT Sector: The digital and IT sector in Ukraine is expanding significantly. Approximately 307,000 people are employed in the IT industry, with women comprising around 25% of the workforce.[208] Additional investments in retraining and upskilling programs will prepare the workforce for new opportunities, ensuring a smooth transition to a sustainable and digitally integrated economy.

Examples of Company Initiatives:

- **DTEK:** Investing in renewable energy projects and modernizing infrastructure, DTEK implements retraining programs focused on digital technologies, smart grid management, and energy efficiency[209].

[205] https://business.diia.gov.ua/
[206] https://osvita.diia.gov.ua/en
[207] https://developers.google.com/womentechmakers
[208] https://aihouse.org.ua/research/ai-ecosystem-of-ukraine-talent-companies-education/
[209] https://dtek.com/en/

- **SoftServe:** Offers internal training programs on green technologies and digital skills, upskilling employees in data analysis, IoT for environmental monitoring, and energy-efficient software development[210].
- **GlobalLogic:** Provides training on digital technologies and their applications in green transition projects, including renewable energy systems and environmental data management[211].
- **Metinvest:** Launches retraining programs for energy efficiency, digitalization of production processes, and environmental management, collaborating with educational institutions and international organizations[212].

Examples of national and municipal initiatives supporting a fair and inclusive green and digital transition in Ukraine:

National Initiatives

- One of the key national initiatives is the creation of **Diia.Digital Education Hubs** in collaboration with UNDP and the Swedish government. Over 3,000 libraries across the country have been transformed into Digital Education Hubs, providing training in basic and advanced digital skills, cybersecurity, and the practical application of green technologies. These hubs ensure digital education access for both urban and rural populations, bridging the digital divide and promoting social equity.[213]

Municipal Initiatives

- **In Kharkiv, the Smart City initiative** integrates digital technologies to enhance urban management and sustainability. The project includes smart street lighting, waste management, and public transportation systems, which promote energy efficiency and improve public services, ensuring that technological benefits are accessible to all residents.[214]
- **Lviv has developed the Green City Action Plan** focusing on sustainable urban development. This plan includes initiatives for waste reduction, green public spaces, and the promotion of electric mobility. By involving public participation in planning, Lviv ensures that all community members benefit from green initiatives, supporting environmental sustainability and social equity.[215]
- **Kyiv's Digital Transformation Strategy** involves implementing digital solutions to improve city services, such as e-governance platforms, smart traffic management, and digital public services. This strategy ensures that digital advancements improve service delivery and accessibility for all residents, including marginalized groups.[216]

International and Collaborative Efforts

- The **EU4Digital** Initiative extends the benefits of the EU's Digital Single Market to Eastern Partnership countries, including Ukraine. This initiative focuses on enhancing digital skills,

[210] https://www.softserveinc.com/uk-ua
[211] https://www.globallogic.com/ua/
[212] https://metinvestholding.com/ua
[213] https://www.undp.org/ukraine/press-releases/digital-education-hubs-over-3000-libraries-now-teaching-ukrainians-digital-literacy
[214] https://smart.citynet.kharkiv.ua/
[215] https://city-adm.lviv.ua/lmr/utilities/lkp-zelene-misto
[216] https://kyiv.digital/start

cybersecurity, and digital entrepreneurship, ensuring equitable access to digital technologies and supporting a fair green transition.[217]

- **USAID's** Energy Security Project aims to improve Ukraine's energy security by promoting renewable energy and energy efficiency. It includes training programs for workers to develop skills in managing new green technologies, supporting job creation, and a fair transition to a green economy.[218]
- **GIZ's** Climate and Energy Initiative supports projects in renewable energy, energy efficiency, and capacity building in Ukraine. These initiatives promote sustainable development and ensure that all regions, including disadvantaged ones, benefit from green energy initiatives through training and community engagement.[219]

These initiatives, implemented at the national and municipal levels, aim to promote a fair transition to green and digital technologies in Ukraine. However, despite the conduct of individual activities, there is a need for additional initiatives and funding to focus on green and digital transformations (particularly in areas with polluting economic activities and areas affected by military actions). Such initiatives should primarily focus on educational activities in different regions to enhance skills (retraining and upskilling in the green economy) and awareness of green and digital transformations.

6.3. TRANSITION FINANCE

6.3.1. Background and scope of the area under scrutiny

Both green and transition finance aim to promote improvements to environmental outcomes of organizations. Transition finance is best defined as financial activities conditional on entities achieving contextually relevant environmental and socially sustainable criteria within a limited time frame. In contrast to green finance, transition finance recognizes the importance of addressing social issues along with environmental issues.[220] Further, transition finance is about financing private investments to reduce today's high greenhouse gas (GHG) emissions or other environmental impacts and transition to a climate-neutral and sustainable economy.[221]

Sustainable finance has a key role in delivering the policy objectives under the ESG and the EU's international commitments on 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 system, 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.[222]

Digitalization can provide a means for a green transition. There have been examples from the previous chapters, but to summarize, digitalization can help with building smart grids, developing precision agriculture and digital monitoring systems, so funding measures can have these goals as priorities. Furthermore, transition finance can cover preconditions for a green and digital

[217] https://eufordigital.eu/uk/
[218] https://energysecurityua.org/
[219] https://www.giz.de/en/worldwide/152140.html
[220] Schumacher, J. B. (2023). Transition finance and its relationship to green finance. In EconPol Forum (Vol. 24, No. 1, pp. 13-16). Munich: CESifo GmbH.
[221] https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en
[222] https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en

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

Ukraine has identified digitalization as a key enabler of its green transition, with the aim of reducing greenhouse gas emissions, improving energy efficiency, and promoting sustainable development. These efforts align with the European Green Deal and Ukraine's own Green Deal Action Plan.

One of the priority areas in this transition is the implementation of smart grids for optimising energy production, distribution, and consumption. Digital technologies play a crucial role in monitoring and managing energy flows, integrating renewable energy sources, and enabling demand-side management. Projects in this area are funded through both internal and external sources. For instance, the Ministry of Energy of **Ukraine allocates budget funds for the development of smart grids, while international donors, such as the European Union through the EU4Energy programme, provide grants and technical support**.

Another critical priority is the development of digital platforms for collecting, analysing, and visualising environmental data. These platforms gather essential information on air and water quality, deforestation, and biodiversity loss, which is vital for informed decision-making and policy development. Projects related to environmental monitoring receive **funding from the state budget**, managed by the Ministry of Environmental Protection and Natural Resources of Ukraine. Additionally, the United Nations Development Programme (**UNDP**) and the German Society for International Cooperation (**GIZ**) **offer grants** and technical assistance to support these initiatives.

Furthermore, the promotion of **circular economy** principles through digital solutions is a significant aspect of Ukraine's green transition. This involves product traceability, waste tracking, and resource optimization to reduce waste, conserve resources, and minimize environmental impact. **The State Environmental Investment Agency** (SEIA) is instrumental in managing and **disbursing funds** for environmental projects that include digital components. International organizations, such as the **European Union** and the **UNDP**, also contribute funding and support for these efforts.

Concrete examples of funding include the establishment of the **Energy Efficiency Fund by the Ukrainian government**, which finances energy-saving projects in residential buildings. This fund utilizes financial contributions from international donors like the European Union and the national budget. Another example is the **EU4Energy Programme**, funded by the European Union, which supports energy reforms and the green transition in Ukraine, encompassing digitalization projects in the energy sector.

Despite significant progress, **several areas still face funding gaps**. Scaling up smart grids requires substantial investment in infrastructure and technology, as current efforts are primarily limited to pilot projects. Building comprehensive environmental monitoring systems and developing data analytics capabilities also necessitates ongoing financial support. Moreover, promoting circular economy practices, particularly in industries with significant environmental impact, requires investment in digital tools and platforms.

While donor support has been crucial, Ukraine **needs to strengthen internal funding mechanisms** to ensure the long-term sustainability of its green digitalization efforts. This includes increasing budget allocations for relevant projects, exploring innovative financing models such as green bonds, and encouraging private sector investment.

Looking forward, Ukraine should strategically prioritize digitalization projects with the highest potential for environmental impact and cost-effectiveness. **Improved coordination among international donors is necessary to avoid duplication and ensure efficient use of resources.** Investing in training and skills development for government officials, researchers, and businesses is crucial for effectively utilizing digital tools in the green transition. Expanding public-private partnerships will help leverage expertise and resources for digital projects. Additionally, developing a comprehensive policy framework that incentivizes green digitalization and supports innovation in this field is essential.

ANNEX 1

Services in Diia pre-war:

- Taxation: file tax return, make payment, and access tax-related information.
- Health care: connects patients and doctors; appointment booking with doctors; electronic

medical records; access medical information and prescriptions; COVID-certificates; location of

health services.

Banking: open a bank account (2.1 million opened online) using driver's license or digital ID; deposit savings; most banks in Ukraine offer online banking services, allowing customers to perform transactions, view account balances, pay bills, and access other banking services.

- Documents: obtain digital IDs; apply for passports, driver's licenses, etc.
- Education: student ID; apply to college; e-learning platforms offer a range of courses and programs (95 educational series).
- Vehicles: registration and driver's license renewal.
- E-baby: register births; includes a combination of nine services.
- Transportation: purchase train and bus tickets.
- Hotels: check in.
- Insurance: purchase life and automobile insurance.
- Home: register residence; apply for mortgage.
- Courts: access enforcement proceedings.
- Business: registration (420,000 in a year); 70 free online consultancies; classes for entrepreneurs; connect partners; map of business support infrastructure; services and opportunities.

Services launched during the war

► eDocument provides citizens with a temporary document to show police and territorial defence soldiers at checkpoints to confirm identity.

- Donations to United 24platform and Back Alive Fund;
- Financial assistance for business.
- Social assistance: 4,752,911 citizens had received payments totaling 30.9 billion UAH ($ 862 million) as of March 2023.
- eRecovery: registry to report damaged property.
- Services for IDPs that include an IDP certificate and financial assistance.
- Military obligations.
- TV and radio broadcasting.
- Chatbot eVorog: used for citizens to report movement and coordinates of Russian troops and provide photographic evidence of damage.
- Purchase war bonds.
- Grants for veterans.
- eResidency allows foreigners to open a business and pay taxes without a physical presence in the country.
- eMortgage provides housing loans at 3% interest.

Sources: Olivia Neal; interview with Gulsanna Mamediieva, Ministry of Digital Transformation; podcast. "Diia"; PowerPoint from the TAPAS program. "State services online", website. "Diia in DC.