EVERY1

The EU Policy Framework for the Digital Energy Transition

Case Study – EN

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About **EVERY1**

Every1 project sets the goal of delivering an impactful concept that includes all elements needed to enable an effective participation of all European stakeholders in the digital energy market. The project starts with a deep, data-informed understanding of stakeholders and ecosystems to map who they are, what they know, how they use information and where they look for it. Similarly, existing and emerging solutions will be assessed and validated, and use cases will serve to understand what stakeholders need to know in order to take on a role that matches their potential. This gap is used to develop learning pathways that lead to the identification of the needed capacity building material. In parallel, Every1 works on making a market by exchanging best practices with policy makers and energy regulators, enabling discussions on barriers, and developing joint communication material for their peers.

Want to dive deeper into the digital energy transition? Scan the QR code below or visit the EVERY1 project website at https://every1.energy/ for resources, case studies, and insights on how you can play a role in shaping a clean energy future.

Target audiences

Primary Audience

This case study is primarily intended for policymakers, regulators, and industry stakeholders within the European Union who are actively involved in shaping and implementing energy and digital policies. It aims to provide a clear, concise, and evidence-based overview of the EU's strategic approach to the digital energy transition, offering valuable insights for informed decision-making and collaborative efforts.

Secondary Audience

Additionally, this material serves as a crucial resource for energy communities, businesses, researchers, and citizens interested in understanding the foundational policies, funding opportunities, and the broader impact of digitalisation on Europe's energy future. By demystifying complex legislative frameworks and presenting key facts and figures, it seeks to empower a wider audience to engage effectively with and contribute to the ongoing energy transformation.

Introduction
Navigating the Digital Energy Transition in the EU

The European Union (EU) stands at the forefront of a profound transformation, moving towards a sustainable, secure, and competitive energy system. This shift, often termed the "digital energy transition," is underpinned by an extensive and evolving policy framework. It leverages advanced digital technologies – from Artificial Intelligence (AI) and the Internet of Things (IoT) to blockchain and smart grids – to revolutionise how energy is produced, distributed, consumed, and managed across the continent. The ultimate objective is to achieve climate neutrality by 2050, a commitment enshrined in the European Green Deal.

This case study aims to provide a detailed overview of the EU's policy landscape governing the digital energy transition. It will explore the foundational strategies, key legislative instruments, and the financial mechanisms designed to facilitate this complex transition. Furthermore, it will highlight concrete facts and figures demonstrating the progress made, discuss the persistent challenges, and identify future opportunities. By delving into the intricacies of EU energy policy, we can better understand the comprehensive and multifaceted approach the Union is taking to build a digital, decarbonised, and resilient energy future for all its citizens.

The importance of this transition cannot be overstated. With **92%** of the population in the European Union having access to the internet in 2023, digital tools are critical enablers for addressing environmental challenges and ensuring the success of initiatives like the Green Deal. The EU's commitment is not merely aspirational; it is backed by concrete legislative packages and significant investment, making the digital energy transition a central pillar of Europe's long-term strategic agenda.

To ensure accuracy regarding frequently changing EU policies, you should always refer to the official EUR-Lex database (for legal acts), the European Commission's "Have your say" portal (for upcoming initiatives), and the European Parliament's "EU Legislation in Progress" briefings.

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> **This case study serves as a guide for policymakers, industry stakeholders, energy communities, and individual citizens seeking to comprehend the regulatory environment and their role within Europe's transformative energy journey.**
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A | The European Green Deal: Setting the Ambition

The European Green Deal, launched in December 2019, is the EU's overarching growth strategy, aiming to transform the Union into a modern, resource-efficient, and competitive economy. Its central objective is to make Europe the first climate-neutral continent by 2050, simultaneously enhancing its energy security and ensuring a just transition for all. Digitalisation is explicitly recognised as a crucial accelerator for achieving these ambitious goals.

I. Decarbonisation Targets and Digitalisation's Role

The cornerstone of the European Green Deal is the legally binding commitment to achieve climate neutrality by 2050. This ambitious target is supported by an intermediate goal to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels. Digitalisation is not merely a policy requirement; it offers tangible benefits by empowering energy communities, which are currently increasing across the EU, to take control of local production.

Digital technologies offer unparalleled capabilities for optimising energy systems, integrating renewable sources, and managing demand more efficiently:

→ **Smart Grids:** These advanced electricity networks utilise digital communication technologies to monitor and control energy flows in real-time, enabling the seamless integration of variable renewable energy sources like solar and wind power. By facilitating dynamic supply-demand balancing, smart grids minimise curtailment of renewable energy and enhance grid stability. The European Commission estimates that **smart grid deployment could contribute to a 10-15% reduction in CO$_2$ emissions by 2030** in the energy sector.

→ **Data Analytics and AI:** Advanced data analytics and Artificial Intelligence (AI) are instrumental in predicting energy consumption patterns, optimising energy production from renewables, and identifying opportunities for energy efficiency across industries and households. AI-driven systems can manage energy storage, predict equipment failures, and enable predictive maintenance, reducing energy waste and operational costs.

→ **Internet of Things (IoT):** IoT devices, from smart meters to connected appliances and industrial sensors, collect vast amounts of real-time data on energy consumption and system performance. This data provides granular insights, empowering consumers to make informed decisions about their energy use and enabling automated energy management solutions that reduce overall consumption.

→ **Sector Integration:** Digitalisation facilitates the integration of different energy sectors (electricity, heating/cooling, transport) through smart solutions. For instance, Vehicle-to-Grid (V2G) technology, enabled by digital communication, allows electric vehicles to not only consume but also feed electricity back into the grid, acting as mobile storage units and contributing to grid flexibility.

By leveraging these digital tools, the EU aims to create a highly interconnected, efficient, and resilient energy system that can rapidly transition away from fossil fuels.

II. Energy Security and the Digital Backbone

Enhancing energy security is another critical pillar of the European Green Deal, particularly in light of geopolitical developments that have underscored the need for reduced reliance on imported fossil fuels. Digital technologies play a pivotal role in strengthening the EU's energy independence and resilience.

By enabling greater integration of diverse, decentralised renewable energy sources, digitalisation inherently diversifies the energy mix and reduces dependence on large, centralised power plants often reliant on fossil fuels. Smart grids enhance the stability and reliability of the grid, making it more resilient to external shocks, whether geopolitical or climatic. They allow for rapid identification and isolation of faults, minimising the impact of disruptions.

Furthermore, digital platforms facilitate the development of local energy communities and peer-to-peer energy trading, empowering citizens and local entities to generate and manage their own energy. This decentralisation contributes to energy independence at a local level, reducing strain on national grids and promoting self-sufficiency. The REPowerEU plan, launched in 2022, explicitly aims to rapidly reduce dependence on Russian fossil fuels and accelerate the clean energy transition, with digitalisation highlighted as a key enabler for this strategic objective.

Cybersecurity, as an integral part of the digital backbone, is paramount to energy security. Protecting critical energy infrastructure from cyber threats is essential to prevent disruptions to supply. The EU has strengthened its cybersecurity framework, notably through the NIS2 Directive and the Cybersecurity Act (discussed further in Section B.III), to ensure the resilience of digital energy systems.

FIGURE 1: "EUROPEAN UNION FLAG ON THE BLUE BACKGROUND" BY GPOINTSTUDIO LICENSED UNDER CC BY-SA 4.0

III. Just Transition and Digital Inclusion

A "just transition" is a fundamental principle of the European Green Deal, ensuring that the shift to a climate-neutral economy is fair and leaves no one behind. This includes addressing the social and economic impacts on workers and communities heavily reliant on fossil fuel industries, as well as ensuring that all citizens can benefit from the digital energy transition. Digital inclusion is key to this aspect.

Digital technologies can democratise access to energy and its benefits:

→ **Empowering Consumers:** Digital tools such as smart meters and online energy platforms provide consumers with real-time data on their energy consumption, enabling them to better manage their usage, reduce bills, and participate in demand response programmes. This empowers individuals, especially vulnerable households, to gain greater control over their energy costs. For instance, the deployment of smart meters is a priority, with projections indicating that by 2024, nearly 72% of European consumers were expected to have a smart electricity meter, and 40% a smart gas meter.

→ **Energy Communities:** Digital platforms facilitate the creation and operation of energy communities, allowing citizens, local authorities, and SMEs to collectively produce, consume, share, and sell renewable energy. This fosters local economic development, creates new job opportunities, and helps address energy poverty by providing affordable, locally-sourced clean energy. The Renewable Energy Directive (RED II) and Electricity Market Directive (EMD) explicitly recognise and promote these communities, ensuring their legal and regulatory frameworks are supportive.

→ **Skills and Education**: To ensure a just transition, the EU emphasises the need for reskilling and upskilling the workforce to meet the demands of a digitalised energy sector. Initiatives under the Digital Decade Policy Programme 2030 (discussed below) aim to enhance digital literacy and provide targeted training for new green and digital jobs, ensuring that citizens can participate actively in the new energy economy.

The Just Transition Mechanism, a key financial tool under the Green Deal, provides targeted support to regions and sectors most affected by the transition. Digitalisation projects that promote energy efficiency, renewable energy uptake, and local economic diversification in these regions are eligible for support, contributing to equitable growth.

B | Key EU Policy Instruments Driving Digitalisation in Energy

The EU's commitment to the digital energy transition is underpinned by a robust legislative framework, primarily stemming from the "Clean Energy for All Europeans" package and the broader Digital Strategy for Europe. These instruments provide the regulatory basis for market design, consumer empowerment, and the integration of digital technologies.

I. The Clean Energy for All Europeans Package

Adopted in 2019, the "Clean Energy for All Europeans" package (CEP) is a comprehensive set of legislative proposals designed to facilitate the EU's clean energy transition. Digitalisation is a cross-cutting theme, enabling the package's objectives of increased renewables, energy efficiency, and a more integrated internal energy market.

1. Renewable Energy Directive (RED II and RED III)

The revised Renewable Energy Directive (RED II – Directive (EU) 2018/2001) established a binding **EU-level target of at least 32% renewable energy in the EU's gross final consumption by 2030**. It also introduced key provisions that directly support the digital energy transition:

→ **Self-consumption and Energy Communities:** RED II explicitly empowered citizens to become active participants in the energy system, including through individual and collective self-consumption of renewable energy, and through the establishment of 'Renewable Energy Communities' (RECs). Digital platforms are essential for managing peer-to-peer energy sharing within these communities and for connecting them to the wider grid.

→ **Guarantee of Origin (GoO) Systems:** The directive reinforced the importance of Guarantees of Origin, which are electronic documents that prove to a final customer that a given quantity of energy was produced from renewable sources. Digitalisation is fundamental to the transparency and efficiency of these tracking systems.

Building on RED II, the 'Fit for 55' package introduced a proposal for a recast Renewable Energy Directive (RED III), which was provisionally agreed upon in March 2023. RED III significantly raises the EU's binding renewable energy target to at least **42.5% by 2030**, with an ambition to reach **45%**. This higher ambition necessitates an even greater reliance on digital tools for grid management, flexibility, and accelerated deployment of renewable projects. Digitalisation aids in streamlining permitting procedures, optimising site selection, and enhancing grid integration capacity for larger volumes of variable renewable generation.

42.5%

2. Electricity Market Design (EMD)

The revised Electricity Market Directive (EMD – Directive (EU) 2019/944) and the Electricity Regulation (Regulation (EU) 2019/943) are central to adapting the EU's electricity market for a decarbonised and digitalised future. Key digital-enabling provisions include:

→ **Smart Metering Rollout:** EMD mandates the widespread deployment of smart metering systems. As of 2020, about 56% of EU consumers had a smart electricity meter installed, with projections for 72% by 2024 (European Commission, 2014). These meters provide consumers with detailed information on their consumption and enable time-of-use tariffs, demand response, and automated energy management.

→ **Active Consumers and Demand Response:** The EMD empowers "active customers" to generate, store, consume, and sell electricity, individually or through aggregators. Digital platforms and real-time data are crucial for enabling these activities and for the effective participation of consumers in demand-side flexibility markets.

→ **Data Access and Interoperability:** The directive promotes non-discriminatory access to consumption data for consumers and authorised third parties (e.g., energy service companies), fostering innovative digital services. It also emphasises the need for interoperability standards for data exchange, essential for the smooth functioning of a digitalised energy system.

→ **Energy Communities:** Similar to RED II, EMD also introduces the concept of 'Citizen Energy Communities' (CECs), which can engage in generation, distribution, supply, and other energy services. Digital tools are vital for their internal management and their interaction with the wider energy market.

These provisions aim to create a more flexible, decentralised, and consumer-centric electricity market, heavily reliant on real-time data exchange and digital intelligence.

3. Energy Efficiency Directive (EED)

The recast Energy Efficiency Directive (EED – Directive (EU) 2018/2002) and its subsequent proposals under 'Fit for 55' set binding energy efficiency targets and outline measures to achieve them. Digitalisation is a key enabler for improving energy efficiency across sectors:
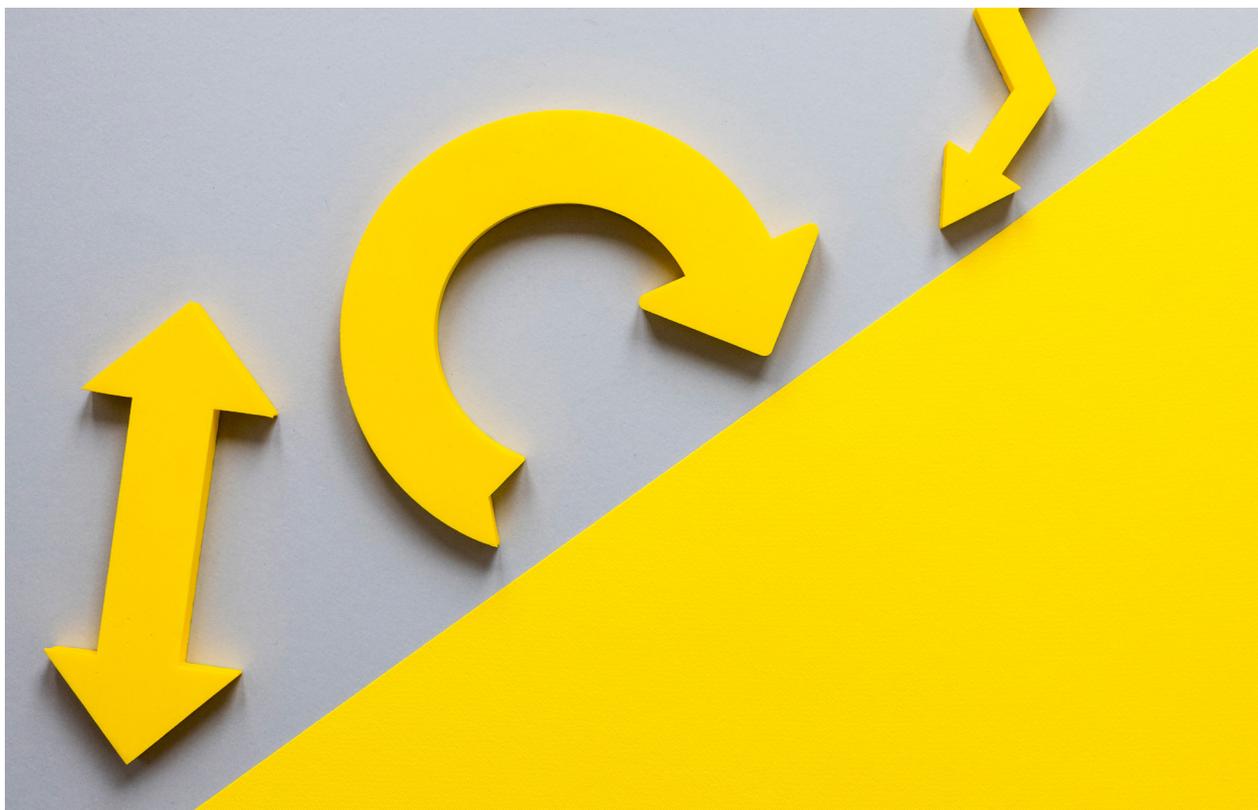

FIGURE 2: "TOP VIEW YELLOW ARROWS AND CARDBOARD ON WHITE BACKGROUND" BY FREEPIK LICENSED UNDER CC BY-SA 4.0

→ **Smart Building Technology:** EED encourages the deployment of smart building technologies, such as building automation and control systems, which use digital sensors and software to optimise energy consumption for heating, cooling, lighting, and ventilation.

→ **Digitalisation of Energy Audits and Monitoring:** The directive promotes the use of digital tools for energy audits and continuous monitoring of energy consumption in buildings and industries, allowing for more precise identification of energy saving opportunities.

→ **District Heating and Cooling:** Digitalisation facilitates the efficient operation and management of district heating and cooling networks, which are crucial for integrating renewable heat sources and waste heat. Smart controls and sensors can optimise heat distribution and minimise losses.

The 'Fit for 55' package proposes a further revision of the EED, raising the EU's energy efficiency target to a binding **11.7% reduction in final energy consumption by 2030**, compared to the 2020 reference scenario (Council of the EU, 2023b). Achieving this ambitious target will heavily rely on widespread adoption and effective utilisation of digital energy management solutions across all sectors.

II. Digital Strategy for Europe and the Digital Decade Policy Programme 2030

Beyond energy-specific legislation, the broader EU Digital Strategy, particularly the "Digital Decade Policy Programme 2030", provides the overarching framework for Europe's digital transformation. This strategy directly impacts the energy sector by fostering an environment conducive to digital innovation, data sharing, and enhanced digital skills.

1. Connectivity and Data Spaces

A fundamental pillar of the Digital Decade is ubiquitous connectivity and the establishment of common European data spaces.

→ **Gigabit Connectivity:** The programme sets targets for gigabit connectivity for all households and 5G coverage for all populated areas by 2030 (European Commission, 2021a). This high-speed and reliable connectivity is essential for the real-time data exchange required by smart grids, distributed energy resources, and IoT devices in the energy sector.

→ **Common European Data Spaces:** The EU is developing common European data spaces, including a dedicated 'Common European Energy Data Space' (European Commission, 2022d). This aims to facilitate secure, trusted, and efficient data sharing across the energy ecosystem – from generators and grid operators to consumers and new service providers. Standardised data formats and interoperability mechanisms within this data

space will unlock new digital services, enhance grid observability, enable predictive maintenance, and foster cross-sectoral integration (e.g., between energy and mobility).

These initiatives are crucial for unlocking the full potential of data-driven innovation in the energy sector, supporting the development of AI applications, and enabling a more integrated and flexible energy system.

2. Digital Skills and Public Services

The Digital Decade also emphasises boosting digital skills across the population and digitalising public services, both of which are vital for a successful digital energy transition.

→ **Digital Skills:** The programme targets **that at least 80% of adults should have basic digital skills**, and there should be 20 million ICT specialists employed in the EU by 2030 (European Commission, 2021a). This skilled workforce is necessary for developing, deploying, and managing the complex digital infrastructure and services of the future energy system. Beyond specialists, a digitally literate citizenry is better equipped to engage with smart energy technologies and participate in demand response programmes or energy communities.

→ **Digital Public Services:** Digitalising public services, including those related to energy permits,

licensing, and access to energy market information, streamlines administrative processes. This reduces bureaucratic hurdles for renewable energy projects and digital energy service providers, accelerating deployment and fostering innovation.

These efforts contribute to a more inclusive digital society, ensuring that the benefits of the digital energy transition are accessible to all citizens and that the necessary human capital is available to drive innovation.

III. Cybersecurity Framework: NIS Directive and Cybersecurity Act

As the energy sector becomes increasingly digitalised and interconnected, cybersecurity becomes paramount. The EU has developed a robust cybersecurity framework to protect critical infrastructure, including energy systems, from cyber threats.

→ **NIS Directive (Directive (EU) 2016/1148) and NIS2 Directive (Directive (EU) 2022/2555):** The original NIS Directive was the first EU-wide legislation on cybersecurity. It required Member States to adopt national strategies for the security of network and information systems and established cooperation mechanisms. Importantly, it placed obligations on 'Operators of Essential Services' (OES), which include energy companies (electricity, oil, gas, district heating/cooling), to implement appropriate security measures and report significant incidents. The NIS2 Directive, which entered into force in January 2023, significantly strengthens these requirements, expanding the scope to more entities and sectors (including district heating/cooling operators, hydrogen production), tightening security obligations, and streamlining incident reporting. This aims to enhance the overall resilience and incident response capabilities of critical entities in the energy sector.

→ **Cybersecurity Act (Regulation (EU) 2019/881):** This Act strengthens the mandate of the EU Agency for Cybersecurity (ENISA) and establishes a European cybersecurity certification framework for ICT products, services, and processes. For the energy sector, this means that digital components used in smart grids, IoT devices, or energy management systems can be certified for their cybersecurity robustness, providing assurance to operators and consumers. This framework helps to build trust in digital energy technologies and promotes common cybersecurity standards across the EU.

These legislative acts are vital for ensuring the security and resilience of the digital backbone of the energy transition, mitigating risks of cyberattacks that could disrupt energy supply, compromise data, or undermine public trust. ENISA plays a crucial role in supporting Member States and EU institutions in these efforts, providing expertise and fostering cooperation.

C | Funding and Investment Mechanisms for Digital Energy Transition

The ambitious goals of the EU's digital energy transition require substantial investment. The EU provides various funding and investment mechanisms to support research, innovation, and deployment of digital technologies in the energy sector, often leveraging both public and private capital.

Immediate Actions: Use the EU Funding & Tenders Portal to filter for 'Digital Energy' calls and access the Smart Cities Marketplace for data portal blueprints.

I. Horizon Europe and LIFE Programme

→ **Horizon Europe** (2021-2027): This is the EU's key funding programme for research and innovation, with a budget of **€95.5 billion**. It plays a critical role in supporting the digital energy transition by funding projects related to smart grids, energy storage, AI for energy optimisation, cybersecurity for energy systems, and the development of new renewable energy technologies (European Commission, 2021c). For example, Cluster 5 ("Climate, Energy and Mobility") and Cluster 4 ("Digital, Industry and Space") within Horizon Europe directly support digital energy innovation. Projects under these clusters often focus on developing prototypes, testing new solutions, and fostering collaboration between academia, industry, and SMEs.

→ **LIFE Programme** (2021-2027): With a budget of **€5.4 billion**, the LIFE Programme is the EU's funding instrument for the environment and climate action. It supports projects that contribute to the EU's climate mitigation and adaptation goals, including those focused on energy efficiency and renewable energy deployment (European Commission, 2021d). Digitalisation features prominently in many LIFE projects, particularly those demonstrating innovative approaches to energy management, smart community solutions, and integrated energy systems at a local level.

These programmes are crucial for driving the technological advancements and pilot projects necessary to scale up digital solutions for the energy sector.

II. Connecting Europe Facility (CEF) Digital

The Connecting Europe Facility (CEF) Digital is a dedicated programme with a budget of **€2 billion** for 2021-2027, focused on investing in digital connectivity infrastructure (European Commission, 2021e). While not exclusively for energy, it supports **high-capacity networks, 5G corridors, and backbone infrastructure** that are essential for the digitalisation of the energy sector. Reliable and secure connectivity is the bedrock upon which smart grids, IoT applications, and real-time data exchange operate. CEF Digital therefore indirectly but fundamentally enables the digital energy transition by providing the necessary digital backbone. Projects that develop cross-border digital infrastructure critical for integrated energy markets can also receive support.

III. Recovery and Resilience Facility (RRF)

The Recovery and Resilience Facility (RRF), the centrepiece of the EU's NextGenerationEU recovery plan, has a total budget of **€723.8 billion** in grants and loans (European Commission, 2021f). Member States design their national Recovery and Resilience Plans (RRPs), which must allocate at least 37% to climate-related investments and 20% to digital investments. This dual focus makes the RRF a powerful instrument for accelerating the digital energy transition.

Many RRPs include significant investments in renewable energy deployment, smart grid upgrades, energy efficiency measures (e.g., building renovation waves), and the digitalisation of public services and industries. For example, several Member States have included specific measures to support smart meter deployment, develop energy data platforms, or invest in cybersecurity for energy infrastructure through their RRPs. By 2022, RRF-supported investments in clean energy technologies and energy efficiency were estimated to trigger around €250 billion in investments (European Commission, 2022e). The RRF provides a unique, large-scale opportunity to rapidly implement digital solutions in the energy sector as part of the post-pandemic recovery.

FIGURE 3: "TECHNOLOGICAL ECOLOGY CONCEPT" BY FREEPIK LICENSED UNDER CC BY-SA 4.0

D | Impact and Progress: Facts and Figures

The EU's comprehensive policy framework and investment mechanisms are yielding tangible results in advancing the digital energy transition. Progress is evident across renewable energy deployment, smart grid infrastructure, and increasing citizen engagement.

I. Renewable Energy Deployment

The EU has made significant strides in increasing its share of renewable energy.

→ **Share of Renewables:** In 2022, **the share of energy from renewable sources in the EU's gross final consumption of energy reached 23.0%** (Eurostat, 2023a), demonstrating consistent progress towards the 2030 targets. This figure has steadily increased from 17.5% in 2016.

23%

→ **Solar and Wind Capacity Growth:** The deployment of solar PV and wind power has seen exponential growth, largely facilitated by digital tools for grid integration and forecasting. In 2023, the EU added approximately 56 GW of solar PV capacity (SolarPower Europe, 2023) and 18 GW of wind power (WindEurope, 2024), setting new records. These additions are heavily reliant on digital management systems to handle their intermittency and integrate them into the grid efficiently.

→ **Reduced Emissions:** As a result of increased renewables and energy efficiency measures, the EU has successfully reduced its greenhouse gas emissions by 32.5% in 2022 compared to 1990 levels, moving closer to the 'Fit for 55' target of 55% reduction by 2030.

II. Smart Grid Rollout and Data Utilisation

The deployment of smart grid components and the increased utilisation of energy data are foundational to the digital energy transition.

→ **Smart Meter Penetration:** As noted earlier, **by 2020, approximately 56% of EU electricity consumers had a smart meter**, with projections to reach 72% by 2024. This rollout facilitates detailed consumption data collection, enabling demand response, dynamic pricing, and better grid management.

→ **Smart Grid Investment:** Investment in smart grid technologies across Europe has been steadily increasing. **In 2022, annual investment in smart grid infrastructure in Europe reached approximately €5 billion**, reflecting the commitment to modernising grid infrastructure. These investments include advanced metering infrastructure, distribution automation, and grid management software, all of which are digitally enabled.

→ **Data Availability and Services:** While precise figures on energy data utilisation are still emerging, the growing adoption of smart meters and the development of energy data platforms are enabling a new generation of digital energy services. These include online energy management tools for consumers, predictive maintenance for grid operators, and demand-side flexibility optimisation for businesses.

III. Citizen Engagement and Energy Communities

The EU policy framework actively promotes citizen engagement in the energy transition, with energy communities serving as a key vehicle for this participation.

→ **Growth of Energy Communities:** The number of renewable energy communities (RECs) and citizen energy communities (CECs) across the EU is growing rapidly, although precise, centralised figures are challenging to consolidate due to their diverse legal forms and local nature. However, estimates suggest there are over 10,000 energy communities in Europe, engaging millions of citizens (REScoop.eu, 2023). Countries like Germany, Denmark, and the Netherlands have a long history of citizen-led energy initiatives, with digital platforms increasingly facilitating their operations.

→ **Local Ownership and Investment:** Energy communities empower citizens to collectively invest in and own renewable energy projects. For example, a significant portion of renewable energy capacity in some Member States, such as Germany (where nearly half of renewable energy capacity in 2016 was owned by citizens and communities) (Agentur für Erneuerbare Energien), is community-owned. Digital platforms simplify the investment process, allowing more individuals to participate.

→ **Increased Energy Literacy:** Participation in energy communities and engagement with digital energy tools enhance citizens' energy literacy, fostering a deeper understanding of their energy consumption and the wider energy system. This leads to more informed decision-making and sustainable energy behaviours.
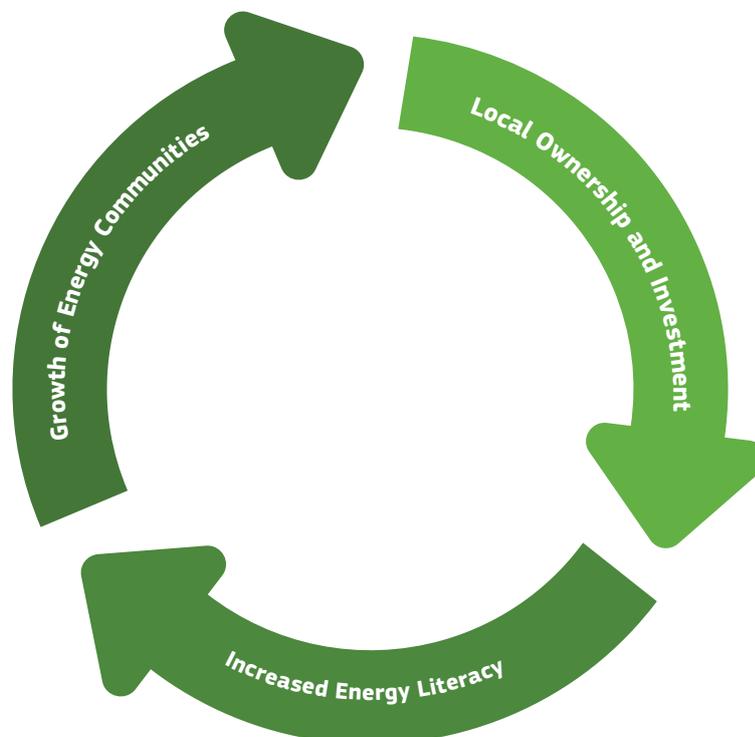
A Cyclical Policy Approach

FIGURE 4: A CYCLICAL POLICY APPROACH GRAPHIC CREATED BY EWORX.

E | Challenges and Opportunities in Policy Implementation

Despite significant progress, the implementation of the EU's digital energy transition policies faces several challenges, which, in turn, present opportunities for further refinement and innovation.

I. Regulatory Harmonisation and Interoperability

One of the primary challenges lies in ensuring consistent implementation of EU directives across all 27 Member States, particularly concerning regulatory frameworks for digital energy services and data exchange.

→ **Divergent National Approaches:** While EU directives set the overall framework, national interpretations and implementation can vary significantly, leading to fragmentation and hindering cross-border digital energy services. For example, rules on data access and sharing from smart meters may differ, creating barriers for energy service companies operating in multiple Member States.

→ **National and Local Implementation:** It is crucial to recognise that while the EU sets the overarching policy framework, the specific details of implementation, available incentives, and regulatory nuances can vary significantly from one Member State to another, and even at regional or local levels. This requires stakeholders to consult national energy agencies, regulatory authorities, and local government bodies for precise information relevant to their specific location. For instance, national energy and climate plans (NECPs) outline how each Member State intends to meet its EU targets, often including specific national measures and support schemes for digital energy solutions.

→ **Interoperability Standards:** The effective functioning of a digitalised energy system relies heavily on the seamless exchange of data between diverse devices, platforms, and actors. A lack of common technical and semantic interoperability standards can create silos, limit innovation, and increase integration costs.

→ **Opportunity:** The opportunity lies in strengthening EU-level coordination, promoting best practices, and investing in common digital platforms and open standards (e.g., through the Common European Energy Data Space initiative) to ensure a harmonised and truly integrated digital energy market. The new Data Act, while broad, will also contribute to fairer access to and use of data, which is crucial for the energy sector (European Commission, 2022b).

II. Data Governance and Privacy

The vast amounts of energy data generated by smart meters, IoT devices, and smart grids raise significant concerns regarding data governance, privacy, and cybersecurity.

→ **Privacy Concerns:** Ensuring the privacy of sensitive energy consumption data, which can reveal personal habits, is crucial for building consumer trust and encouraging participation in digital energy services. The General Data Protection Regulation (GDPR) provides a strong legal framework, but its application in the energy sector requires careful consideration (European Parliament and Council, 2016b).

→ **Data Quality and Reliability:** The reliability of digital energy services depends on the quality and integrity of the underlying data. Mechanisms for ensuring data accuracy, preventing manipulation, and detecting anomalies are essential.

→ **Cybersecurity Risks:** As discussed, the increased interconnectedness of energy systems creates new vulnerabilities to cyberattacks. Protecting against these threats requires continuous investment in cybersecurity measures, threat intelligence sharing, and skilled personnel.

→ **Opportunity:** The ongoing development of the Common European Energy Data Space and robust cybersecurity frameworks (like NIS2 and the Cybersecurity Act) present opportunities to establish clear rules for data access, sharing, and protection, fostering a secure and trustworthy environment for data-driven innovation while upholding fundamental rights. Enhanced collaboration between energy sector actors and cybersecurity agencies (e.g., ENISA) is also vital.

III. Investment Gaps and Market Barriers

Despite the availability of EU funding, significant investment gaps remain, particularly for large-scale digital infrastructure upgrades and the integration of new digital solutions into existing energy systems.

→ **Grid Modernisation Costs:** Modernising Europe's electricity grids to become fully smart and digitally enabled requires massive investments. The European Commission estimates that **between €375 billion and €475 billion are needed for grid investments by 2030**, with a significant portion going towards digitalisation (European Commission, 2022f).

→ **Slow Adoption by SMEs:** Small and Medium-sized Enterprises (SMEs) in the energy sector, including many energy communities, often face challenges in adopting new digital technologies due to limited financial resources, lack of technical expertise, and perceived complexity.

→ **Market Design Barriers:** In some areas, existing market rules or regulatory uncertainty may still create barriers for new digital energy service providers or for the full participation of demand-side flexibility.

→ **Opportunity:** The EU's multiannual financial framework (MFF) and NextGenerationEU provide substantial funds (e.g., RRF, Horizon Europe). Leveraging these funds effectively, attracting private investment through supportive regulatory frameworks, and providing targeted technical assistance and financing tools for SMEs and energy communities are crucial opportunities. Continued efforts to adapt market rules to accommodate new digital services and business models are also essential.

F | Future Outlook and Recommendations

The EU's policy framework for the digital energy transition is a dynamic and evolving landscape, constantly adapting to technological advancements and emerging challenges. The future outlook points towards deeper integration, increased intelligence, and broader participation, all driven by digital innovation.

I. Policy Evolution and Emerging Technologies

Future policy developments will likely focus on:

→ **Deepening Sector Integration:** Further legislation and initiatives will aim to break down remaining silos between electricity, gas, heating/cooling, and transport sectors, using digital platforms to enable smart sector coupling and enhance overall system efficiency and flexibility.

→ **Advanced Digitalisation of Grids:** Policies will likely push for more advanced functionalities in smart grids, including greater automation, self-healing capabilities, and sophisticated predictive analytics for managing highly decentralised energy systems.

→ **AI and Blockchain Integration:** Expect increased policy attention on regulating and facilitating the responsible deployment of AI and blockchain technologies in energy. This includes developing governance frameworks for AI algorithms used in energy management and exploring the full potential of blockchain for secure energy trading and data management. The proposed AI Act will provide a

FIGURE 5: "RING BINDER USED FOR STORED DOCUMENTS" BY FREEPIK LICENSED UNDER CC BY-SA 4.0

common regulatory and legal framework for AI applications, including those in critical sectors like energy (European Commission, 2021g).

→ **Digital Twins and Virtualisation:** The concept of 'digital twins' – virtual replicas of physical energy assets and systems – will gain traction, enabling advanced simulation, optimisation, and risk assessment for complex energy infrastructure.

→ **Circular Economy for Digital Energy:** Policies may also address the environmental footprint of digital technologies themselves, promoting the circularity of hardware and responsible data management.

II. Strengthening International Cooperation

While the EU leads in many aspects of the digital energy transition, strengthening international cooperation is crucial for global decarbonisation efforts and for addressing shared challenges.

→ **Global Standards and Interoperability:** Collaborating with international partners on developing common digital and technical standards for energy technologies and data exchange can facilitate cross-border energy trade and accelerate the global energy transition.

→ **Cybersecurity Resilience:** International cooperation on cybersecurity best practices, threat intelligence sharing, and coordinated responses to cyberattacks is essential given the global nature of cyber threats.

→ **Sharing Best Practices:** The EU can share its experience in policy design, market integration, and the deployment of digital energy solutions with third countries, fostering global learning and accelerating the transition worldwide.

> **"**
>
> The digital energy transition is not just a technological shift; it is a societal transformation. The EU's policy framework provides a robust foundation, but its ongoing success will depend on continuous adaptation, strong collaboration across sectors and borders, and sustained investment to realise a truly digital, sustainable, and secure energy future for all.
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> **"**

Glossary

Active Customer
A customer who generates, stores, consumes, or sells electricity, or participates in demand response or energy efficiency schemes, individually or through aggregators.

Artificial Intelligence (AI)
The simulation of human intelligence processes by machines, especially computer systems, used in the energy sector for optimisation, prediction, and automation.

Carbon Neutrality / Climate Neutrality
The state of achieving net-zero greenhouse gas emissions by balancing emissions with removals or by eliminating emissions entirely.

Citizen Energy Community (CEC)
A type of energy community under EU law that can engage in generation, distribution, supply, and other energy services, typically controlled by citizens, local authorities, or SMEs.

Circular Economy
An economic model aimed at eliminating waste and the continual use of resources, including the reuse and recycling of digital hardware in the energy sector.

Common European Energy Data Space
An initiative under the EU's Digital Strategy to facilitate secure, trusted, and efficient data sharing across the energy ecosystem.

Demand Response
Changes in electricity usage by consumers from their normal consumption patterns in response to price signals or other incentives, contributing to grid flexibility.

Digital Energy Transition
The transformation of the energy sector towards a more sustainable, efficient, and secure system, driven by the integration and application of digital technologies.

Digital Twin
A virtual replica of a physical asset, process, or system, used for real-time monitoring, simulation, optimisation, and predictive maintenance in the energy sector.

Energy Communities
Groups of citizens, local authorities, or SMEs that collectively produce, consume, share, or sell renewable energy, fostering local economic development and energy independence.

Greenhouse Gas (GHG) Emissions
Gases in the Earth's atmosphere that trap heat, contributing to the greenhouse effect and climate change (e.g., carbon dioxide, methane).

Renewable Energy Communities (RECs)
A type of energy community under EU law focused specifically on renewable energy projects, promoting citizen participation and local benefits.

Interoperability
The ability of different systems, devices, or applications to connect, communicate, and exchange data seamlessly, essential for a fragmented digital energy ecosystem.

Internet of Things (IoT)
A network of physical objects embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet, used for energy monitoring and control.

Just Transition
A framework for ensuring that the shift to a climate-neutral economy is fair and inclusive, addressing the social and economic impacts on workers and communities.

Smart Grid
An electrical grid that uses digital communication technology to detect and react to local changes in usage, enabling more efficient and reliable energy delivery and integration of renewables.

Smart Meter
An electronic device that records consumption of electric energy or gas in intervals and communicates that information back to the utility for monitoring and billing, empowering consumers with data.

Vehicle-to-Grid (V2G)
A technology that allows electric vehicles to communicate with the power grid to either draw electricity for charging or feed electricity back into the grid, acting as distributed energy storage.

Acknowledgements

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Further sources

Clean Energy for All Europeans Package (CEP)
A comprehensive set of EU legislative proposals adopted in 2019 aimed at facilitating the clean energy transition through increased renewables, energy efficiency, and an integrated internal energy market.

Connecting Europe Facility (CEF) Digital
An EU funding programme for digital connectivity infrastructure, supporting high-capacity networks essential for the digitalisation of the energy sector.

Cybersecurity Act
An EU regulation that strengthens the mandate of ENISA and establishes a European cybersecurity certification framework for ICT products, services, and processes, including those in the energy sector.

Data Act
A proposed EU regulation aiming to ensure fairness in the digital environment by establishing harmonised rules on fair access to and use of data, crucial for data-driven energy services.

Digital Decade Policy Programme 2030
The EU's strategic framework for digital transformation, setting targets for connectivity, digital skills, and digital public services, impacting the energy sector's digitalisation.

Energy Efficiency Directive (EED)
EU legislation (Directive (EU) 2018/2002) setting binding energy efficiency targets and promoting measures like smart building technology and digital energy audits.

European Green Deal
The EU's overarching growth strategy launched in 2019, aiming to make Europe the first climate-neutral continent by 2050.

General Data Protection Regulation (GDPR)
An EU regulation (Regulation (EU) 2016/679) on data protection and privacy in the European Union and the European Economic Area, relevant for handling sensitive energy consumption data.

Electricity Market Design (EMD)
EU legislation (Directive (EU) 2019/944 and Regulation (EU) 2019/943) that adapts the electricity market for a decarbonised and digitalised future, promoting smart metering, active consumers, and data access.

Horizon Europe
The EU's key funding programme for research and innovation (2021-2027), supporting digital energy transition projects.

LIFE Programme
The EU's funding instrument for environment and climate action, supporting projects related to energy efficiency and renewable energy deployment, often featuring digitalisation.

Recovery and Resilience Facility (RRF)
The EU's key financial instrument under NextGenerationEU, supporting reforms and investments in Member States, with significant allocations for climate and digital transitions.

National Energy and Climate Plans (NECPs)
Ten-year integrated plans by each EU Member State outlining how they intend to meet their energy and climate targets, including national measures and support schemes.

Renewable Energy Directive (RED II / RED III)
EU legislation (Directive (EU) 2018/2001 and its proposed recast) promoting the use of energy from renewable sources and setting binding targets, with provisions for self-consumption and energy communities.

NIS Directive (NIS2 Directive)
EU legislation (Directive (EU) 2016/1148 and its successor Directive (EU) 2022/2555) on measures for a high common level of cybersecurity across the Union, placing obligations on critical entities including those in the energy sector.

REPowerEU
A plan launched by the European Commission in 2022 to rapidly reduce dependence on Russian fossil fuels and accelerate the clean energy transition, highlighting digitalisation as a key enabler.

EVERY1

The EU Policy Framework for the Digital Energy Transition

Case study – EN

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