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## NEW CHALLENGES FOR CITIES IN THE TWENTY-FIRST CENTURY

Regenerative Design - Climate Adaptation & Mitigation  
Circular Economy - Citizen Agency - Urban Livability

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TeMA Journal has the objective of fostering and integrating studies on urban transformation and urban mobility, within a scientific context focused on adapting cities to global warming and oriented towards economic, social and environmental sustainability. The three issues of the 2026 propose articles that deal with the effects of climate change adaptation, reduction of energy consumption, AI-driven solutions to support urban planning, immigration flows, optimisation of land use, analysis and evaluation of civil protection plans in areas especially vulnerable to natural disasters.

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# TeMA

Journal of  
Land Use, Mobility and Environment

**NEW CHALLENGES FOR CITIES IN THE TWENTY-FIRST CENTURY:**  
Regenerative Design - Climate Adaptation & Mitigation - Circular Economy - Citizen Agency  
- Urban Livability

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1 (2026)

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## **REVIEW NOTES - Regulation and legislation for the energy transition**

### Digital governance of the energy transition: regulatory frameworks, data infrastructures, and spatial planning

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#### **Abstract**

Starting from the relationship between urban planning and mobility management, TeMA has gradually expanded the view of the covered topics, always remaining in the groove of rigorous scientific in-depth analysis. This section of the Journal, Review Notes, is the expression of continuously updating emerging topics concerning relationships between urban planning, mobility and environment, through a collection of short scientific papers written by young researchers. The Review Notes are made of four parts. Each section examines a specific aspect of the broader information storage within the main interests of TeMA Journal. This section, International Regulations and Legislation for the Energy Transition, explores the challenges and opportunities in the urban context to understand the evolving landscape of the global energy transition. The convergence between European energy legislation and data governance is transforming the energy transition into a fundamentally territorial and data-driven process. The contribution analyzes how the EU directives are redefining the operational framework of territorial planning through binding interoperability and digital infrastructure requirements. It concludes with a reflection on the evolutionary role of the urban planner as a mediator between legislation, data ecosystems and territorial transformation.

#### **Keywords**

Energy transition; Data governance; Spatial planning; European regulation

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## 1. Introduction

Contemporary cities face unprecedented energy and climate challenges. Despite occupying less than 3% of the planet's surface, urban agglomerations host most of the world's population and consume over 65% of global energy, producing more than 70% of CO<sub>2</sub> emissions (EEA, 2023). In this context, urban areas can become drivers of the energy transition: thanks to the density of supply and demand, cities offer opportunities for the widespread diffusion of renewable sources, the development of sustainable district heating networks and the promotion of new forms of decentralized energy production (Russo et al., 2025; Stiuso, 2025). Cities and local governments have the potential to play a central role in decarbonisation, integrating energy objectives into urban planning and contributing to national and European climate goals (Ulpiani et al., 2023). If the technological dimensions of the energy transition have been widely discussed in the literature, an equally transformative, but less explored, dimension concerns the role of data and digital infrastructures as enabling conditions for the effective implementation of energy policies at the territorial scale (Fistola & La Rocca, 2025; Horak et al., 2022). The European Union has responded to this challenge with a dense regulatory architecture that embeds digital requirements directly into the fabric of energy and territorial governance. The Digitalising the energy system - EU Action Plan (COM 2022), the Common European Energy Data Space (CEEDS, 2023), the Data Act (EU, 2023), the Interoperable Europe Act (EU, 2024) and the main energy directives, in particular the Renewable Energy Directive III (EU2023/2413, 2023) and the recast Energy Performance of Buildings Directive (EU 2024/1275, 2024), are progressively building a regulatory landscape in which data interoperability, open access and digital platforms are not simply encouraged, but prescribed (ENTSO-E, 2024). This contribution focuses on the link between regulatory evolution and progressive digitalisation of territorial governance for energy transition.

## 2. The European regulatory framework: energy, data and land governance

The convergence between energy regulation and data governance within the European Union has accelerated significantly since 2022, producing an intertwined regulatory architecture that is reshaping the conditions within which spatial planning operates. The Digitalising the energy system - EU Action Plan (COM/2022/552), adopted in October 2022, was the first document to formally link the digitalisation of the energy system to the broader climate objectives of the Fit for 55 package and the REPowerEU plan (EC, 2022). Articulating twenty-four priority actions on six axes: citizen empowerment, energy data exchange, cybersecurity, ICT sustainability, investments in digital infrastructures and a coordinated approach at EU level, the Plan explicitly links digitalisation to the National Energy and Climate Plans (PNIEC) envisaged by the Governance Regulation (EU) 2018/1999 (European Parliament & Council, 2018), thus establishing the institutional channels through which the energy agenda digital enters national planning systems.

At the heart of this framework is the Common European Energy Data Space (CEEDS), an ecosystem for the safe and efficient sharing of energy data between actors, based on common rules and standards. Presented to the European Commission in March 2024 and currently being deployed across six Horizon Europe-funded projects, CEEDS promises to overcome one of the most persistent barriers to integrated energy-territory governance: the fragmentation and inaccessibility of energy data across different institutional levels and sectoral silos (IEA, 2024). The enabling regulatory pillars of CEEDS are the Data Governance Act, the Data Act and the Interoperable Europe Act (International Data Spaces Association, 2025).

The Data Act builds a real regulatory framework for the sharing of data between users, businesses and the public sector, requiring that such exchanges take place under fair, reasonable and non-discriminatory conditions and on transparent contractual bases (European Parliament & Council, 2023a). The Interoperable Europe Act extends these obligations to all public sector entities providing European digital public services and creating a unitary legal basis for the integration of energy data into territorial information infrastructures at all

levels of governance (European Parliament & Council, 2024a). These horizontal data rules are complemented by sectoral planning directives that increasingly incorporate specific digital requirements. RED III (EU 2023/2413) requires Member States to create a coordinated mapping of the territory for the potential of renewable energy (art. 15b) and the designation of Acceleration Areas for Renewables (art. 15c); the Commission guidelines (SWD/2024/333) explicitly identify GIS technology as a key tool for fulfilling this mapping obligation, a result confirmed by the scientific literature on the integration of multi-criteria analysis and GIS for the spatial planning of renewable energy (EC, 2024; Soares et al., 2025). The EPBD recast (Directive (EU) 2024/1275), introduces digital Building Renovation Passports, digital building logbooks and mandatory updated national energy performance databases (European Parliament & Council, 2024b), creating for the first time a building-scale digital dataset with direct relevance for neighborhood and district energy planning. The overall result is a multilevel regulatory architecture in which energy regulations, data regulations and territorial information systems regulations intertwine with increasing coherence, producing binding effects on the governance systems of municipalities, regions and territorial planning authorities (Martinelli, 2025a; Mazzeo, 2023).

### 3. Digital platforms and data for territorial energy planning

The convergence between energy regulation and data governance is generating a new generation of spatial information infrastructures: integrated digital ecosystems that combine geospatial data, energy performance data, network data and environmental data within interoperable frameworks (OECD, 2023). The energy transition requires new approaches to urban data management and the use of digital tools for both decision making and operation, as recognized by the Driving Urban Transition Partnership 2024 program (DUT, 2024) in launching the call dedicated to data management and decision support systems as a central challenge for planning Positive Energy Districts (PEDs). This need is confirmed by scientific literature, which has highlighted how energy system models at a national scale still present partial spatial capabilities and how soft linking with explicit spatial models represents the most promising methodological direction to robustly integrate territorial dimensions in energy system modeling (Vrhovac et al., 2025). In this context, interoperability represents the essential enabling condition. The International Data Spaces Association's (IDSA, 2025) updated position paper on the Energy Data Spaces Interoperability Framework outlines strategies to address information barriers, standards diversity, and interoperability issues within the energy sector and across sectors, providing a framework for the governance and policy considerations essential for cross-data-space collaboration.

An emblematic example of this new generation of information infrastructures is the EU Energy Atlas of the Joint Research Center (JRC) of the European Commission (Fig.1), an interactive GIS platform that integrates high-resolution geospatial data on industrial and residential energy consumption, network infrastructures and production sources on a European scale. Cartographic visualization allows you to read the differentiated spatial distribution of the energy intensity of the territory, a fundamental element for any integrated territory-energy planning process and represents an operational prototype of the information infrastructures that European legislation is progressively making mandatory at all levels of governance (European Commission, JRC, 2023). On a national level, the implementation of European standards is producing concrete digital infrastructures of great relevance for territorial planning. In Italy, the Ministerial Decree of 21 June 2024 regulated the operating rules of the Piattaforma Aree Idonee (PAI), developed by the GSE with the support of the Ministero dell'Ambiente e della Sicurezza Energetica (MASE), designed to provide characterization and quantification of the territory, estimate of the installable potential, exchange and integration of data with other public administrations and full interoperability with the single digital platform for renewable energy plants (GSE, 2024). The PNIEC Monitoring Platform allows progress towards national decarbonisation objectives to be tracked in almost real time, improving the transparency of information for Regions, Autonomous Provinces and private operators (MASE, 2024).

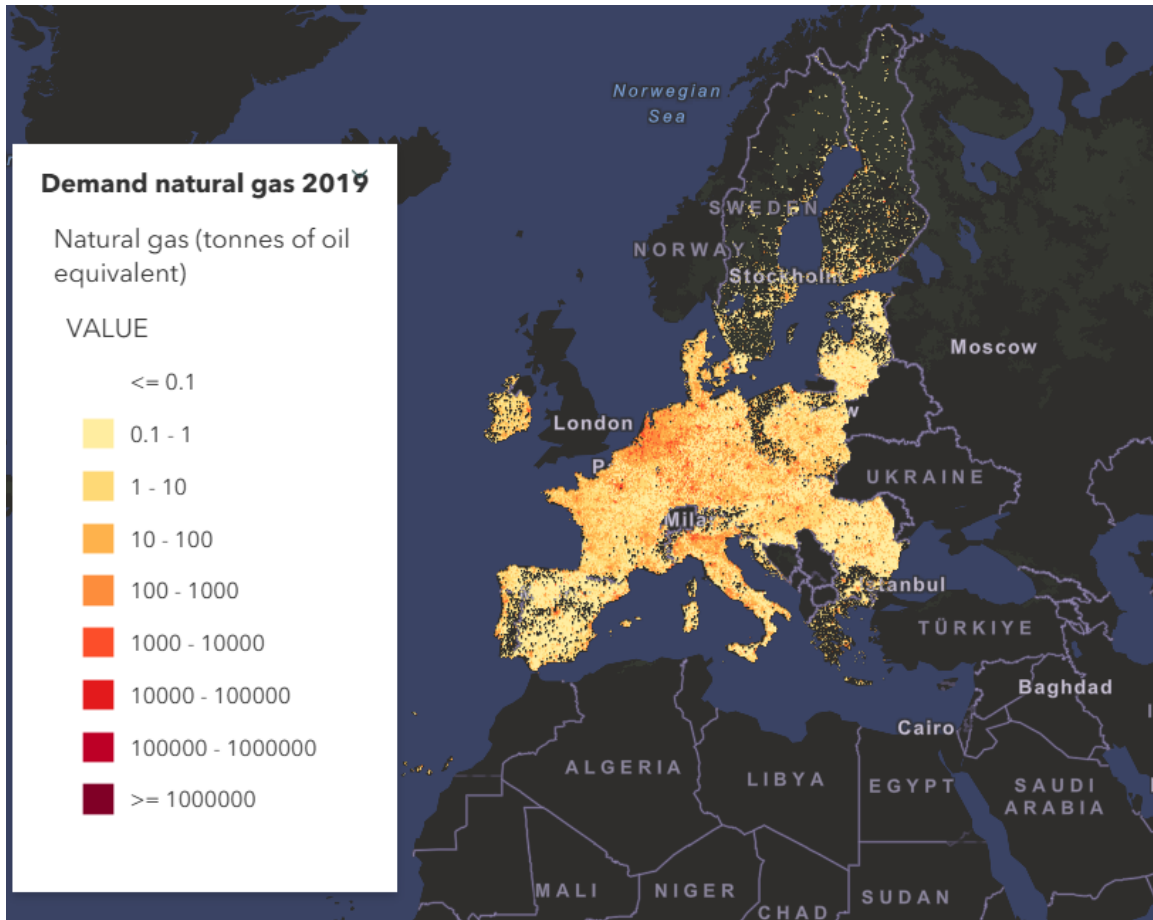


Fig.1 Demand for natural gas in Europe

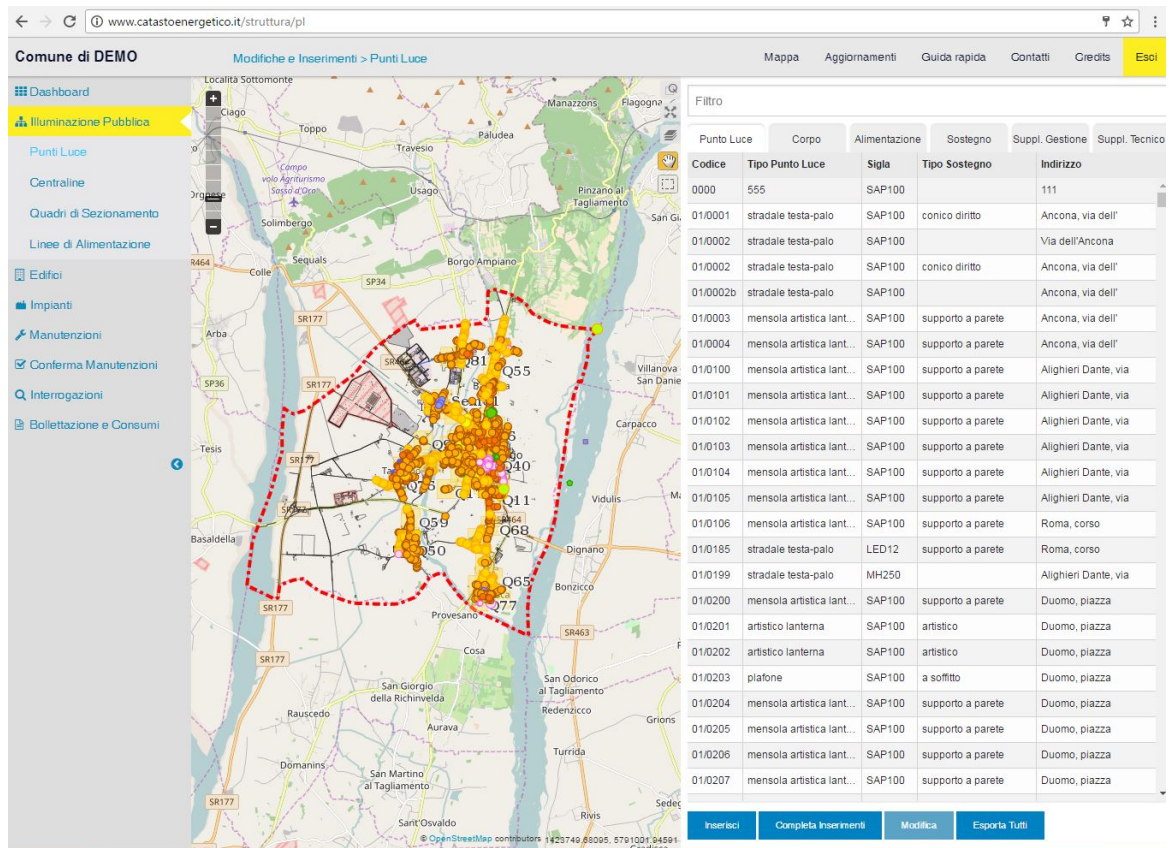


Fig.2 WebGIS of the energy register developed by the Friuli Venezia Giulia Region

Integrated regional energy registers that combine energy performance certificates (APE), inventories of heating systems and municipal consumption data, such as the one developed by APE FVG in Friuli-Venezia Giulia (Fig.2) to support the drafting of SECAPs within the Covenant of Mayors further illustrate how georeferenced energy databases can concretely support local energy governance (APE FVG, 2026).

Finally, the Organization for Economic Cooperation and Development (2023) documented how good data governance can strengthen data quality, expand data collection capacity and define processes and responsibilities in information management to support the monitoring of regulatory compliance in urban development, well-being and environmental sustainability, with the recognition that cities and territories are simultaneously producers, managers and users of their information infrastructure (OECD, 2023).

#### 4. Implications for land governance

The progressive integration between energy regulations and digital infrastructures profoundly reconfigures the conditions in which territorial planning operates in the energy transition, placing urban planning techniques faced with new responsibilities that go well beyond traditional regulatory and design skills. The scientific literature has highlighted with increasing clarity that the delay in the urban energy transition is not primarily of a technological nature, but depends on the persistent separation between energy planning and territorial planning and on the lack of a holistic framework capable of integrating energy supply and demand with the spatial, environmental, social and economic dimensions of the territory (Regen & RTPI, 2025; Stoeglehner, 2020). As argued by Stoeglehner (2020) in developing the theoretical framework of Integrated Spatial and Energy Planning, options for energy strategies are profoundly shaped by local and regional spatial contexts, as both energy efficiency and renewable energy potentials are determined by spatial structures, making spatial planning and energy planning not two separate sides of the same coin but a continuum requiring integrated treatment (Stoeglehner & Abart-Heriszt, 2022). The 2025 report of the International Institute for Sustainable Development *Cities in Transition* documents how reducing emissions requires not only the diffusion of renewables but an overall redesign of neighborhoods to reduce total energy demand, and how structural barriers in planning such as obsolete governance models, costs of sprawl and lack of integration between energy and urban planning tools are actually preventing cities from building more sustainable communities aligned with climate objectives (IISD, 2025).

The lack of integration between energy planning and spatial planning constitutes a real risk for the energy transition, highlighting significant challenges for local authorities in the integrated implementation of clean energy, renewable heating and urban planning. The International Energy Agency *Cities Task 2 (2025-2029)*, specifically dedicated to "Data for Urban Energy Planning", identified data insufficiency, lack of standardized methodologies and legal barriers as key challenges for cities in transition, underlining that digital solutions are particularly powerful in cities, where the high-density environment creates economies of scale and new opportunities (IEA *Cities Task 2*, 2024; IEA, 2024). In this framework, the urban planner is called to play a role of critical mediation on a technical-analytical level, he must know how to operate within the digital infrastructures prescribed by law such as GIS platforms, energy data spaces, digital permitting systems, energy cadastres, digital twins, understanding not only the functionalities but also the classificatory assumptions and spatial logics incorporated in the tools, the design and governance of which is itself a planning problem that requires attention to usability, transparency and inclusiveness (Mey et al., 2024). On the political-institutional level, the planner must ultimately operate as a critical interpreter capable of territorializing abstract regulatory requirements, negotiating between competing spatial demands, deployment of renewables, biodiversity protection, agricultural preservation, urban regeneration, and ensuring that the digitalization of energy governance serves, rather than replaces, truly integrated territorial planning (Martinelli, 2025b; Grossi & Welinder, 2024; Caprari et al., 2022).

In this direction, an emerging proposal in the literature suggests the creation of a dedicated professional figure: the Energy Urban Planner (EUP) with the specific task of bridging the gap between the abundance of energy data available, often not integrated with that used in territorial decision-making processes, and the need for a more integrated and intentional planning approach (Boria et al., 2020). For spatial planning, this evolution represents both a mandate and an opportunity.

The mandate consists of the need to integrate an unprecedented volume and diversity of energy data into planning processes, to operate within increasingly digitalised regulatory frameworks and to ensure that the spatial dimension of the energy transition is governed with the rigor and comprehensiveness that the complexity of the challenge requires.

The opportunity lies in the potential to exploit the new data infrastructure for integrated territorial-energy planning capable of accelerating the deployment of renewables and improving the sustainability and equity of territorial transformations (Zhu et al., 2025).

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## Image sources

Fig.1: European Commission, Joint Research Centre (JRC) (2023). EU Energy Atlas - Demand natural gas 2019. <https://energy-industry-geolab.jrc.ec.europa.eu/energy-atlas/>

Fig.2: Agenzia per l'Energia del Friuli-Venezia Giulia (APE FVG), "Catasto energetico regionale". <https://www.ape.fvg.it/catasto-energetico/>

## Author's profile

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