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Global warming, ageing of population, reduction of energy consumption, immigration flows, optimization of land use, technological innovation

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REVIEW NOTES – International Regulation and Legislation for the Energy Transition

Governance of the energy transition: the role of local authorities in Italy

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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 contribution explores how Italian local authorities contribute to the energy transition, in line with European directives. It highlights the importance of territorial governance plans and urban transformation tools in promoting the use of renewable energies and reducing emissions. Renewable Energy Communities (RECs) are identified as key instruments, thanks to the direct involvement of citizens and local energy autonomy. Finally, the contribution also highlights the challenges related to regulatory fragmentation and the need for greater coordination.

Keywords
Energy transition; Renewable energy comunities; Local regulations; Urban planning.

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1. Role of local planning authorities in the energy transition

The energy transition, supported by the UN 2030 Agenda, aims to reduce the use of fossil fuels in favour of renewable energy by promoting local production (Savino, 2023). This need is both environmental and geopolitical, as international crises have exposed energy systems to high and unstable costs. In this context, the shift to a decentralised model translates into opportunities to innovate production systems, making consumers key players in the transition and promoting respect for local energy resources. Moreover, the energy crisis can push urban contexts towards a more sustainable future (Cumo et al., 2022; Papa et al. 2016). Local authorities, such as regions and municipalities, play an essential role in adapting European directives to the needs of their territories, as established by the Piano Nazionale Integrato per l'Energia e il Clima (PNIEC). Directives such as Renewable Energy Directive (RED II) and the Clean Energy for All Europeans package (CEP) entrust local authorities with the concrete implementation of targets to increase the use of renewables and reduce greenhouse gas emissions (Cutini, 2023). In Italy, the transition is regulated on several levels, from European directives to national strategies, from Piani Energetici Ambientali Regionali (PEAR) to municipal plans. This system allows a flexible response to local specificities but can slow down progress due to bureaucratic obstacles and regulatory fragmentation (Sarrica et al., 2018). The regions, with Law No. 10/1991, have acquired relevant competences for the efficient use of energy and the development of renewables. Despite this, they must comply with national regulations and European obligations, limiting regional autonomy. This configuration creates territorial differences that risk hindering the harmonisation of progress towards national targets (Di Gesù, 2021). Regions and municipalities play a key role in facilitating authorisation processes for renewable energy infrastructure, which are often slowed down by fragmented regulations (Barbaro & Napoli, 2023). Local action goes beyond planning and includes implementing sustainable measures, initiating partnerships for renewable energy projects and offering tax incentives to promote decentralised energy models and local energy autonomy (Legambiente, 2023). Among the innovative solutions proposed by the EU with RED II are energy communities: legal entities that enable citizens, entities and small businesses to produce and share renewable energy. Local authorities support the adoption of these configurations that not only reduce CO_2 emissions but also strengthen the local economy through self-production and energy sharing (Lennon & Dunphy, 2024; Trevisan et al., 2023).

2. Renewable energy communities as a key instrument for energy transition

Renewable Energy Communities (RECs) represent an innovative approach to promote energy transition. The EU's RED II Directive establishes a regulatory framework to incentivise RECs but leaves it up to Member States to define the operational, technical and financial details. This has led to significant differences between countries, influenced by local geographical, cultural and political factors. Therefore, effective implementation of the Directives at national level is essential in order to transform European objectives into local actions (Hoicka et al., 2021). RECs are based on a decentralised and shared model of energy production and consumption, which reduces dependence on fossil fuels. Through collective self-consumption, they contribute to the reduction of greenhouse gas emissions and lower energy costs for members, while also helping to combat energy poverty and encouraging active community participation. Local authorities are crucial in promoting RECs by facilitating the removal of regulatory barriers and the adoption of appropriate regulatory frameworks (Bashi et al., 2022). According to a study by Elemens for Legambiente, RECs in Italy can significantly contribute to decarbonisation by shifting consumption from fossil to renewable sources. The study predicts that by 2030 RECs could generate a capacity of around 17.2 GW, covering 30% of the production increase required by the PNIEC (Legambiente, 2022). In Italy, the RED II directive was transposed by Decree-Law no. 199/2021. The Piedmont region anticipated the national legislation with Regional Law No. 12/2020, launching the first REC in Magliano Alpi, implemented in collaboration with the Polytechnic University of Turin. This project demonstrated how local authorities can act as promoters of the energy transition (Musolino et al.,

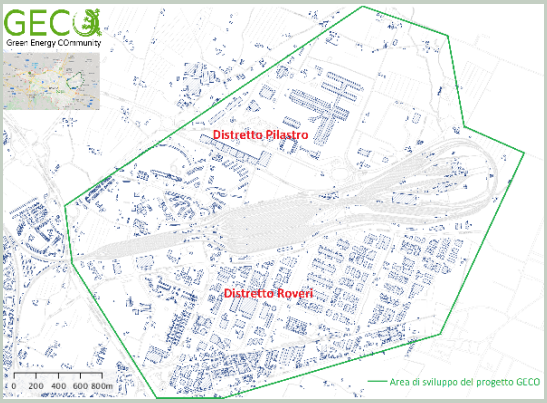
2023). Some regions, such as Piedmont, Lombardy and Emilia-Romagna, have introduced concrete incentives by allocating European funds to support RECs, while others face difficulties due to budget constraints and administrative obstacles. This gap between regions reflects the complexity of multi-level governance, which can create regulatory barriers that slow down the energy transition (Gargiulo & Papa, 2021). To overcome these obstacles, local authorities are experimenting with public-private partnerships and collaborations with universities. One example is the RECOCER project in Friuli, which involves local authorities and universities to provide technical support for RECs. Local authorities are therefore essential players in promoting RECs, but more widespread dissemination would require greater regulatory harmonisation at national level. Effective coordination between European, national and local levels is crucial to achieve an energy transition that minimises environmental impact and respects territorial specificities (Krug et al., 2022).

3. The role of territorial governance and urban transformation for energy transition

The close relationship between energy autonomy and territorial development, promoted by EU regulations to support energy communities, has given rise to several implementation models (REScoop.eu, 2020). To stimulate the development of efficient distributed generation, it is essential to start with local planning. The energy transition requires an integrated approach that combines urban and energy planning, actively involving local governments to adapt urban and territorial spaces to the new renewable energy infrastructure (Martinelli, 2024). Local authorities must develop plans that are aligned with sustainability goals and facilitate the implementation of renewable energy (Lai et al., 2021; Mazzeo & Polverino, 2023). A central aspect is participation and sustainability, especially for local authorities in the context of decentralisation and liberalisation processes, which require a revision of energy governance. This revision aims at promoting forms of self-government in vulnerable and marginal areas, starting with the strengthening of existing levels of government. Integrating energy planning into urban plans is essential to reduce greenhouse gas emissions and promote the systematic adoption of renewable energy (Cecchini, 2023). A spatial knowledge framework that identifies energy consumption and potential supply from renewable energy sources is needed to develop scenarios on future energy demand considering demographic and urban development (Bevilacqua & Milazzo, 2022). Local governments can integrate energy communities through strategies that emphasise sustainability and resilience. Energy planning should promote a long-term vision for sustainable, low-impact cities by enhancing a sense of community and active participation (Neves et al., 2024). By integrating energy communities into urban planning, energy losses can be reduced and efficiency increased through local energy management, contributing to the sustainability and resilience of cities. Spatial planning optimises the use of local energy resources, improving urban autonomy and sustainability (Gjorgievski et al., 2023). Energy planning can be included in spatial planning tools, such as Piani Urbanistici Comunali (PUC) to identify areas suitable for renewable installations while avoiding conflicts with other land uses. Some Italian municipalities, such as those in Emilia-Romagna, have already allocated areas for solar and wind power plants, promoting urban energy self-sufficiency. To this end, the Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC), adopted by many municipalities, integrate energy and climate objectives, promoting CERs and local energy efficiency. Instruments such as PAESCs support the use of green infrastructure, such as solar roofs and central heating systems, and promote Positive Energy Districts (PEDs), where renewable energy production exceeds local energy consumption, generating a redistributable or storable surplus (Derkenbaeva et al., 2022). In Italy, the PED concept is growing, with some cities collaborating with universities and research centres to design sustainable, self-sufficient neighbourhoods equipped with smart grids for energy management. The integration of energy and land use planning optimises the use of resources, increasing urban energy efficiency and fostering local autonomy. However, the spread of RECs is limited by urban planning constraints and bureaucratic complexities, which require a uniform and simplified regulatory framework. Local authorities play

a central role, collaborating with institutions and citizens to implement sustainable solutions and promote community involvement. Economic support through dedicated funds and incentives is essential, as is greater regulatory harmonisation to facilitate the transition to a decarbonised energy system.

Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC) of Bologna, 2021



The "Piano d'Azione per l'Energia Sostenibile e il Clima (PAESC)" of Bologna, 2021, approved in 2021, is a strategic document aimed at reducing CO_2 emissions and strengthening territorial resilience to climate change. Aiming to align with European directives and reduce emissions by 40 % by 2030, the PAESC integrates urban energy and climate policies and promotes energy transition and environmental sustainability. Priorities include the deployment of RECs and Positive Energy Districts (PEDs) as models of urban energy self-sufficiency. The integration of RECs into Bologna's urban policies is articulated in specific instruments, such as the Piano Operativo Comunale (POC) and the Piano Urbanistico Generale (PUG). These instruments identify areas suitable for the installation of renewable energy production plants and encourage collective self-consumption. In addition, they provide incentives and constraints for new buildings and renovations to integrate photovoltaic and storage systems, facilitating building participation in CERs. The city promotes sustainable neighbourhoods and Positive Energy Districts (PEDs), areas with a low environmental impact where the production and consumption of clean energy is maximised. The GECO (Green Energy COmmunity) project, active in the Pilastro and Roveri neighbourhoods, is a significant example of this: in these neighbourhoods, shared technologies such as photovoltaic and biogas plants encourage energy efficiency and active participation of residents. On the regulatory side, the municipality has revised building regulations to facilitate the installation of photovoltaic systems and energy sharing between buildings. These tools, favouring collective participation, include RECs as a key element in the city's sustainability and resilience strategy.

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