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An Emerging Energy Community. The Case Study of Viladecans in Catalonia

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1. *Introduction*

The global transition from fossil fuels to renewable energy has redefined spatial patterns of development, challenging traditional paradigms of urban planning and governance (Valentine *et alii*, 2017). As cities become critical nodes in the energy transition, understanding how local initiatives address technological, physical, and social dimensions becomes imperative. Viladecans, located in Catalonia, is an exemplary case of integrating innovative energy governance through the Vilawatt project (Viladecans 2030 Urban Agenda, 2024). While addressing regional patterns of socio-spatial inequality, this project expands on community cooperation, energy-efficient building renovations, and the use of renewable energy sources to further global sustainability goals. The energy transition should be viewed as a more comprehensive process of social and spatial change rather than just a change in technology. Viladecans' experience serves as an example of how local governments can navigate the complex relationship between spatial justice and equitable development while charting realistic paths towards sustainability with the support of EU frameworks (EU, 2023). By focusing on community-based solutions, the Vilawatt initiative integrates energy innovation into the fabric of the municipality, creating new opportunities for economic and social resilience (Oficina Vilawatt, 2025).

Viladecans's significance as a case study lies in its multifaceted approach to fostering sustainability. Its projects address energy efficiency, social cohesion, economic revitalisation, and environmental awareness. By doing so, Viladecans sets a benchmark for other municipalities striving for a comprehensive and inclusive energy transition.

This article explores Viladecans' experiences as an emerging energy community, analysing its strategic activities, outcomes, and challenges. Situating the study within the context of the geographies of energy transition contrib-

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utes to broader discussions on spatial justice and the uneven impacts of energy transitions.

Viladecans' case study serves as a lens to understand the transformative potential of localised energy policies. The article emphasises the interplay of various dimensions—technological advancements, physical infrastructure changes, and community engagement—to unpack the broader implications of the energy transition for urban planning and development.

1.1. *A Changing Urban Landscape: Energy Transition and Spatial Development* – The transition from fossil fuels to renewable energy sources represents one of modern history's most significant global shifts, with profound implications for urban landscapes (Burke & Stephens, 2017). Since the urban centres are the main places that make the attempt to reduce carbon emissions, they are turning into different kinds of experimental grounds for the new energy governance models. Viladecans is a very good example of such a process, demonstrating how local governments can use energy as the main idea to rethink the development of the city. The Vilawatt project is a perfect example of such a comprehensive policy, it is a living model of the interdependence of energy policy, planning of the city, and social well-being.

The main purpose of Vilawatt initiated under the European Union's Urban Innovative Actions (UIA) programme is to make the use of renewable energy widespread, to raise the energy efficiency, and to facilitate the voluntary engagement of citizens in energy transition (Urban Initiative, 2023). The incorporation of energy targets into a plan that is going to be used for different purposes is a very important moment in the development of a new paradigm: cities should no longer be considered as mere consumers of energy; they have to be seen as the principal drivers who are able to direct the future of energy systems. During such a transition, the spatial development should also be changed so that it has a chance of eradicating the socio-spatial disparities which have been around for ages. Similar to many other municipalities in the Barcelona metropolitan region, Viladecans is characterised by marked socio-economic disparities, notably in income levels, housing conditions and differential access to essential urban services. Thanks to its retrofitting initiatives, Vilawatt is able to tackle the issues that are at the core by making homes more energy efficient and lowering the energy prices. It is because of the focus on the lower-income households that the energy costs will be reduced.

This approach enhances environmental sustainability and fosters social equity, bridging gaps between marginalised communities and mainstream development.

2. *Vilawatt: A Community-Centered Energy Model*

At the heart of Viladecans' energy transition lies the Vilawatt initiative, which introduces a community-centred model for sustainable energy management

(Urban Initiative, 2024). The project's cornerstone is its innovative governance structure, which brings local authorities, residents, and businesses together to co-create energy solutions. Such a participatory method is a guarantee that different opinions will have an influence on the project's evolution, thus, making it in harmony with the community's requirements and dreams.

One of the major measures of Vilawatt is the creation of a local energy operator. The local entity handles all the processes of energy generation, distribution, and consumption in Viladecans while the first aim being the use of renewable sources like solar power. With the installation of a decentralised energy system, Vilawatt lessens the consumption of energy from the external providers and increases local resilience. Additionally, the project is equipped with smart technologies like energy monitoring systems to make the use of energy more efficient and to detect the areas that need further work.

Additionally, Vilawatt is devoted to residential and public buildings retrofitting as a crucial part of the energy transition. The programme seeks to upgrade the energy performance of both residential and public buildings while at the same time to lower the emissions and the use of energy. These modernization works involve the installation of insulation, energy-efficient windows, and modern heating systems. What is more, Vilawatt takes into account the retrofitting in the districts with high energy poverty levels, thus, the transition's advantages are fairly distributed.

Community participation is the core around which the Vilawatt project is revolving. The project is committed to raising awareness and educating through workshops, campaigns, and training programs about sustainable energy practices. These activities give the power to the residents to become the masters of their energy consumption and at the same time take on the role of contributors to the municipality's sustainability goals by the actions they adopt.

Furthermore, Vilawatt has introduced an innovative local currency linked to energy savings, incentivising participation and reinvestment in the community.

2.1. *Spatial Justice and Equitable Development* – The concept of spatial justice is integral to understanding Viladecans' energy transition. Spatial justice refers to the fair distribution of resources, opportunities, and benefits across different geographic areas. In the energy transition context, this means ensuring that all residents—regardless of their socioeconomic status or neighbourhood—can access the advantages of renewable energy and energy efficiency (Sovacool *et alii*, 2020).

Viladecans approach to spatial justice can be seen in the different ways it has intervened to help the vulnerable population. Energy poverty, which is a situation where a household cannot afford to heat, cool, or use electricity properly, is a problem that is mostly recurring in low-income families. By giving these households first access to the VilaWatt retrofitting and energy efficiency programs, the city of Vilawatt through these programs is solving not only the envi-

ronmental problems but also the social ones. The two emphases bring out the idea that social justice and sustainability are interdependent goals.

Equitable development also involves creating economic opportunities for residents (Sovacool, 2016). Vilawatt contributes to this by stimulating green job creation in construction, renewable energy installation, and maintenance. The project collaborates with local businesses and training centres to build capacity and ensure that residents benefit from emerging green economy opportunities.

2.2. *Challenges and Lessons Learned* – While the Vilawatt project offers valuable insights, it also highlights the challenges inherent in local energy transitions. One of the major hindrances is the shortage of money for funding large-scale initiatives. Even though the EU support has been a great help, the financial sustainability of projects like Vilawatt is still reliant on the continuous investment and the ability to attract more resources.

However, the challenge is also about coordinating among different stakeholders. The participatory governance model, which is open to everyone, needs the support of good communication and dispute resolution mechanisms in order to reach decision-making of the interests' alignment. Making sure that everyone has their say, especially the voices of the most disadvantaged groups, is imperative for the community's trust and support to be kept alive.

In addition, there are technical issues involved in the execution of advanced energy systems and retrofit activities. Among them are dealing with regulatory frameworks, making sure they are compatible with the current infrastructure, and confronting the technical limitations. Thus, to get rid of these difficulties, it takes the work of coming up with new solutions and cooperation with the experts from the fields of urban planning, engineering, and environmental science.

In spite of these difficulties, the experiences of Viladecans serve as a reference for the local governments which are planning the same kind of transitions. The list of important things learned from the project includes promoting community ownership, bringing social equity to sustainability goals, and using external funding to start up transformative projects. The story of Viladecans is a reminder that energy transitions cannot be standardized; they call for different approaches that mirror the local contexts and priorities.

2.3. *Broader Implications for Urban Planning and Development* – The Vilawatt project's implications extend beyond Viladecans, offering valuable insights for urban planning and development in the context of energy transitions. First, the integration of energy considerations into urban planning challenges traditional silos between sectors. Treating energy as a cross-cutting issue, municipalities can simultaneously develop holistic strategies that address environmental, social, and economic dimensions (Urban Initiative, 2024).

Secondly, community-based energy proposals, such as the ones carried out in Viladecans, demonstrate how radical changes can be achieved by bottom-up

strategies. Even though big-scale policies and agreements are necessary, local projects are usually the ones that can most effectively meet the needs of the communities. This, in turn, reveals the significance of giving local governments the authority and responsibility to lead the way in the energy transition (Jasanoff, 2018).

Indisputably, the focus on fair distribution of resources in Viladecans is an excellent example of how the energy transitions can be converted into less detrimental socio-economic phenomena.

As cities adopt renewable energy and energy efficiency measures, they must consider how these changes affect different populations. Ensuring that benefits are equitably distributed is not only a matter of fairness but also essential for building public support and fostering long-term sustainability.

3. *Methodology*

This study employs a secondary case study approach, drawing on documented sources to analyse Viladecans' energy transition strategies and activities. The methodology focuses on understanding the processes, results, and the spatial aspects of Viladecans by using existing literature, reports, and official documents.

The secondary case study overwhelmed by research method is the chosen line of inquiry due to its strengths in unravelling complex phenomena in a real-world context. When using documented sources, the research is enriched with the work that has been extensively done by various stakeholders, including researchers, policymakers, and local authorities. In that way, it is possible to get a panoramic view of the energy transition in Viladecans, which is inclusive of different opinions and data sources.

The research starts by conducting a systematic review of the existing literature on energy transitions, with an emphasis on theoretical frameworks, best practices, and challenges commonly faced. The review establishes the basis for understanding the general background in which the strategies of Viladecans are located. It is accomplished by the scoping of the themes: renewable energy adoption, energy efficiency, stakeholder participation, and policy implementation, which are fundamental in the case study analysis.

Following the literature review, a targeted collection of reports and official documents specific to Viladecans is undertaken. These sources include municipal plans, government publications, technical assessments, and progress reports related to energy projects in the area. Emphasis is placed on obtaining the most recent and relevant documents to ensure the findings reflect the current state of Viladecans' energy transition efforts. The study is set to achieve data verification by cross-referencing several sources with the help of which, reliability and accuracy will also be enhanced.

Content analysis is introduced to get significant insights out of the documents that have been collected. Uniting one's codes with categories, and data based on set themes such as renewable energy infrastructure, public-private partnerships, community engagement, and environmental outcomes form the core part of this activity. Through this approach, the examination of the data becomes less haphazard and more systematic as it also points to different patterns that lead to the storyline of Viladecans' energy transition.

To strengthen the argument, the research also uses spatial data and mapping technology. This is because, gaining knowledge about the space aspect of the energy transition is essential as it lets one know where the different renewable energy installations, the areas that can provide sustainable resources, and the places that will have to face environmental consequences lie in Viladecans. Furthermore, GIS tools as well as spatial analysis methods are there to serve as the means through which these facets get to be attracted and turned into images having a profound and more evident relationship with reality.

What is more, this research works on the hypothesis that stakeholder significance comes to the energy transition in Viladecans. Besides, it is inclusive of scenarios of the local government's leadership in the private sector, the community groups, and NGOs' roles. It analyses the information provided by the documented evidence in order to discover the complexities of governance and the modes of participation that are behind the effectiveness of the energy initiatives.

The research also outlines the possible shortcomings of the secondary case study method that it is using. As an example, depending on the documents that have already been prepared for different purposes can lead to partiality or insufficiency since it may be that the available sources are not fully covering all directions of Viladecans' energy transition. Consequently, this study incorporates triangulation whereby information from several documents and views is compared to come up with a well-balanced and trustworthy discourse.

Besides which, the study's timeframe is well thought-out so as to help capture not only the past but also the recent developments of Viladecans' energy transition. Through a historical overview of the strategies and activities, the research delivers a temporal vision enriching the understanding of the progress made and the problems faced. Looking into time is pivotal in this case for it allows to easily spot long-term patterns, gauge the sustainability of the final products, and even obtain energy transition lessons for the future.

The methodological framework is a guarantee for rigour and transparency in the research process. The team keeps very detailed records of the data sources, the procedures for analysis, and the criteria for interpretation that they use so that they can be accountable and the results can be reproduced. This approach is in line with the best practises of case study research emphasising the significance of methodological strength in yielding dependable and usable insights.

To sum up, this research's secondary case study approach offers a solid structure for the examination of the energy transition in Viladecans, in terms of the strategies and works-of-actions. The study provides a revealing and in-depth understanding of the energy transition processes, outcomes, and their spatial impacts observed in Viladecans by utilizing documented sources, carrying out thematic and spatial analysis, and taking account of potential limitations.

This methodology contributes to the academic discourse on energy transitions and provides valuable insights for policymakers and practitioners seeking to advance sustainable energy practices in similar contexts.

3.1. *Data Collection* – Data for this study were gathered through a comprehensive review of:

1. Policy Documents: Key municipal plans such as the Urban Agenda of Viladecans and reports from the Vilawatt project.
2. European Union Frameworks: Relevant EU-funded initiatives, including the Urban Innovative Actions (UIA) program and the PIREP program, which supported retrofitting activities in public buildings.
3. Published Case Studies: Analysis of prior research on Viladecans' energy initiatives.
4. Field Visit Descriptions: Information on locations visited during the EU City Lab on Energy Transition (23-24 November 2023) from the provided document.

The reliance on secondary sources ensures that the study maintains a robust and evidence-based foundation while also providing flexibility in synthesising diverse perspectives on the energy transition in Viladecans.

3.2. *Case Studies* – Secondary information from documented case studies forms the foundation of this research. Activities at the following locations were examined in detail:

- *Oficina Vilawatt*

As the central hub for the municipality's energy transition, Oficina Vilawatt serves multiple functions, including energy consultancy, training programs, and coordination of bulk energy purchases. The office also facilitates the formation of energy communities, ensuring that residents and local businesses are active participants in the transition (Urban Initiative, 2024). Located in the Montserratina district, Oficina Vilawatt plays a pivotal role in implementing the Vilawatt project's objectives, bridging policy initiatives and community action.

The Oficina Vilawatt serves as a dynamic example of how municipalities can lead in renewable energy adoption and energy efficiency. Beyond its administrative functions, it is an educational and collaborative space where citizens can make informed energy choices. Workshops, seminars, and community meetings organized in this local area create a feeling of proprietorship among the resi-

dents, thus they are converted from indifferent consumers of energy into active co-workers. Such a participatory method is a guarantee that the process of energy transition will be a directive from above, but at the same time, it will involve and be driven by the community.

Moreover, Oficina Vilawatt has established relationships with the stakeholders at the local and regional levels, in order to extend the influence of its projects. For instance, it co-operates with the universities and research institutions to bring the state-of-the-art technology and the most advanced practices into its programs.

Such partnerships enable the municipality to access technical expertise and funding opportunities, strengthening its capacity to drive change.

- *Montserratina District*

This neighbourhood has undergone significant retrofitting and renovation projects, focusing on improving energy efficiency in residential and commercial buildings. The district's transformation includes adopting solar energy systems, enhanced insulation techniques, and innovative technologies to monitor and optimise energy consumption (Montserrativa district, 2018). These initiatives make clear how local energy policies have a real effect on cities.

Through the Montserratina District, the retrofitting projects have shown that it is not only the technical aspects of energy transitions that matter but also the social ones. To address the technical ones, the district has seen energy consumption lowered to a great extent due to the installation of solar panels and the use of highly effective insulation, which has contributed to energy savings for residents and businesses. The use of smart technologies like energy management systems, which provide real-time energy use monitoring and optimisation, has also been instrumental in achieving energy savings.

Socially, the district's transformation has been underpinned by extensive community engagement. Residents were consulted during the planning stages to ensure that retrofitting measures met their needs and wishes. The local people had been also invited to training sessions in order to get them acquainted with the new technologies and practices. The implementation made smoother by this collaborative approach, and therefore, the residents felt pride and the sense of ownership among them being raised.

- *Municipal Library*

A landmark of sustainable public infrastructure, the library's renovation included the installation of solar panels, a vertical garden, and an upgraded HVAC system. These changes significantly reduced the building's energy consumption and carbon emissions while providing a model for integrating sustainability into municipal projects.

The Municipal Library's transformation is a testament to how public buildings can exemplify sustainable design. Moreover, the stylish vertical garden is functioning as a pretty good natural insulator, thus the building requires less

heating and cooling. To a great extent, the library is making use of clean energy generated by solar panels and thus its electricity needs are being offset. The improved HVAC system is doing the job in the best possible way for indoor air quality and temperature control while using very little energy.

The library has gone beyond the physical renovations and has embraced sustainability in its operations and programming as well.

It hosts regular workshops and exhibitions on topics such as renewable energy, climate change, and waste reduction. By engaging the community in these activities, the library reinforces its role as a centre for education and awareness, extending its impact beyond its immediate infrastructure.

- *Plaça Europa Municipal Market*

As a bustling hub of commerce, the market showcases collaborative approaches to energy efficiency. Vendors and customers have embraced collective energy-saving measures, such as installing LED lighting, shared renewable energy systems, and educational campaigns to raise awareness about sustainable practices (Plaça Europa Municipal Market, 2025).

The Plaça Europa Municipal Market is a perfect example of how commercial spaces can become a significant part of the sustainability goals. The use of LED lighting, for example, has decreased the energy consumption and has brightened the market area, thus making the shopping experience more pleasant. Common renewable energy systems, like a photovoltaic installation on the vendors' rooftop, offer them cheap and clean electricity, thereby cutting down the running costs.

The market is full of educational programs that help to change the behavior of the consumers, and that is their main role.

Informational kiosks and signage inform customers about the market's sustainability initiatives and encourage them to adopt eco-friendly practices, such as bringing reusable bags and reducing food waste. These efforts create a ripple effect, spreading awareness about sustainable practices to the broader community.

- *Enxaneta School*

The school exemplifies how educational institutions can lead by example in promoting sustainability. Enxaneta School, equipped with a photovoltaic system and receiving an Energy Certification A from the Catalan Institute of Energy, is their first line of integrating energy efficiency into teaching and their daily life. This institution, through its practices, spreads the environmental culture among students, families, and teachers. (Enxaneta School, 2025).

The photovoltaic system at the Enxaneta School is responsible for producing a large part of the electricity needed by the school. Thus, the school is less dependent on the non-renewable energy sources. The high energy efficiency rating of the school is a reflection of its environmental commitment. To make themselves even more sustainable, they have installed energy-efficient lighting, insulating, and water-saving fixtures.

The Enxaneta School educational program includes topics of renewable energy, climate change and, resource conservation. The school is very aware of these issues and thus prepares the younger generation through such topics. Making the learning process more interesting for the students, they do have some practical tasks to perform like, they could fabricate solar-powered models or take energy audits for real-world applications of the concepts they learned.

These initiatives enrich the educational experience and instil lifelong values of environmental responsibility.

- *Broader Implications of Localised Energy Initiatives*

Each location represents a unique facet of Viladecans' energy transition, providing valuable insights into the broader implications of localised energy initiatives (Catalan Institute of Energy, 2025). Together, they illustrate how tailored strategies can address different sectors' specific needs and characteristics, from residential neighbourhoods and public buildings to commercial and educational institutions.

These case studies reveal how energy changes are deeply interconnected. As an example, the District of Montserratina can only see the success of its retrofitting projects if this success is supported by technical upgrades, community engagement, and education. In the same way, the energy-efficient accomplishments of the Plaça Europa Municipal Market are pretty much to the collaborative efforts of vendors, customers, and local authorities.

Additionally, the case studies emphasize the significance of embedding sustainability in all facets of urban planning and governance. When energy measures are in harmony with the wider goals of economic development, social equity, and environmental protection, cities like Viladecans are capable of making a much more profound and long-lasting impact. These instances function as excellent benchmarks for other cities willing to make the same energy transition journey.

Every single place stands for a different layer of the energy transition in Viladecans and offers valuable insights the localised energy initiatives might have broader implications.

4. *Activities*

4.1. *Oficina Vilawatt and Montserratina District* – The Oficina Vilawatt serves as the operational hub for Viladecans' energy transition. Established as part of the EU-supported Vilawatt project, the office offers services to promote energy efficiency and community engagement. Key activities include providing energy consultancy to residents and businesses, organising training sessions on sustainable practices, and coordinating bulk energy purchases to reduce costs. Moreover, the office has been instrumental in leading the establishment of neighborhood energy communities where users can locally control production, con-

sumption and self-generation of their energy. The Montserratina district is full of offices like the Oficina Vilawatt, which demonstrate how local governance, technology, and citizen involvement can be successfully linked up. The district has become a local energy efficiency and sustainability benchmark. Solar panel installations have been made on residential buildings along with the introduction of energy-efficient appliances, whereas public spaces have been renovated with the installation of smart lighting systems. Collectively, these actions intend to decrease the total energy demand, cut carbon emissions and, at the same time, improve the quality of life of the residents.

Moreover, Montserratina district has not forgotten about community engagement besides upgrading local infrastructure. The local government has organised a series of workshops, consultations, and public forums to educate local people about the advantages of energy-saving and renewable energy sources. Such participatory activities have enabled residents to feel more involved and accountable, thus making sure that the transition to renewables is not only feasible but also socially fair and inclusive.

4.2. *Municipal Library* – The Municipal Library represents a flagship project in Viladecans' energy transition. Renovated with support from the Next Generation EU funds through the PIREP program, the library has undergone a comprehensive transformation. Key upgrades include installing solar panels on the roof, which generate a significant portion of the building's energy needs, and a vertical garden on the main facade, which provides natural insulation and reduces energy consumption for heating and cooling.

With the installation of a brand new HVAC system, the library is now able to further its energy performance, thus keeping the building comfortable for the users while at the same time minimising the environmental impact. The local library has thus been transformed into a benchmark for green public infrastructures, showing how local governments can pave the way by implementing energy-efficient technologies.

Moreover, the library, through its upgrades, has turned into a hub of energy literacy promotion. Regular workshops and exhibitions on sustainability topics have been organised, attracting a diverse audience of residents, students, and professionals. These events aim to raise awareness about the importance of energy efficiency and inspire participants to adopt sustainable practices in their own lives.

4.3. *Enxaneta School* – At the Enxaneta School, sustainability is embedded in infrastructure and community practices. The school's photovoltaic energy production plant has earned it an Energy Certification A from the Catalan Institute of Energy. Such a certification is an indication of the educational institution's pledge towards lessening its environmental impact and being an example to other schools.

Energy-saving measures are a real commitment of the school community. Students, parents, and teachers work side by side to find ways of cutting down the use of energy through such means as efficient use of lighting, better insulation, and starting up waste reduction programs. These deeds not only help the school achieve its sustainability goals but also foster in the young people a feeling of environmental care.

Enxaneta School also integrates sustainability into its curriculum. Lessons on renewable energy, climate change, and environmental conservation are regularly taught, ensuring students develop a deep understanding of these critical issues. By fostering a culture of sustainability, the school prepares its students to become future leaders in the energy transition.

4.4. *Plaça Europa Municipal Market* – The Plaça Europa Municipal Market exemplifies how commercial spaces can contribute to the energy transition. Vendors and customers have embraced a range of energy-saving measures, including installing LED lighting, using shared renewable energy systems, and participating in educational campaigns on sustainable practices. These initiatives have transformed the market into a hub of innovation and collaboration, highlighting the role of public spaces in advancing the energy transition.

Educational events at the market have further amplified its impact. Energy efficiency, waste reduction, and sustainable consumption workshops were held and attracted a large audience of residents and visitors. These events are intended to create a common understanding of sustainability and to motivate the people to act together.

By these means, the Plaça Europa Municipal Market is turning out to be an example how public spaces can be instrumental in the local energy transition that is community-driven. The achievement of such a place points to the necessity of collaboration and innovation as a means of reaching the sustainability goals.

5. *Creation and Management of Energy Communities: Insights from the Catalan Guide*

5.1. *Introduction* – Creating energy communities (ECs) is a powerful mechanism for advancing the energy transition while fostering social, economic, and environmental benefits. Based on the practical guide for establishing energy communities in Catalonia, this section delves into the foundational principles, processes, and critical steps required to create and manage ECs effectively (Catalan Institute of Energy, 2025). These insights are intended to deepen the knowledge of EC frameworks and their contribution to mitigate climate change, solve local energy issues, and empower the community.

The Catalan guide describes energy communities as groups formed by people, companies, public institutions, or any other legal entities that decided to pool their resources to carry out joint energy projects, services, and activities.

These actions have the purpose of facilitating the use of renewable energy, encouraging common property, and making the local community independent of energy supply.

This chapter explores these themes, drawing parallels to Viladecans' energy transition experiences to contextualise the broader significance of energy communities.

5.2. *The Step-by-Step Process for Creating Energy Communities* – The Catalan guide provides a roadmap comprising six key steps for the creation and operation of energy communities (UAB, 2023):

1. Dynamisation and Stakeholder Engagement:
   - Forming a core group, or "Grup Motriu," to lead the initiative.
   - Engaging residents, businesses, and institutions through targeted outreach, informational meetings, and participatory activities.
   - Emphasising inclusivity to ensure diverse representation and shared ownership.
2. Strategic Planning and Viability Studies:
   - Identifying the community's energy needs and available resources.
   - Conducting feasibility studies to determine proposed actions' technical, economic, and regulatory viability.
   - Assessing options for collective energy solutions, such as shared photovoltaic installations or energy demand management systems.
3. Organisational Setup:
   - Deciding on the appropriate legal structure, such as cooperatives, associations, or public-private partnerships.
   - Drafting the community's statutes and operational guidelines, covering governance, roles, and member contributions.
   - Registering the entity and obtaining necessary certifications and authorisations.
4. Implementation of Energy Projects:
   - Design technical solutions and select trusted providers to install energy infrastructure (e.g., solar panels and energy storage systems).
   - Overseeing installation, commissioning, and legal compliance to ensure the functionality and safety of energy systems.
   - Incorporating innovative technologies like digital platforms for energy management and consumption monitoring.
5. Community Management and Growth:
   - Establishing processes for operating, maintaining, and governance of the community's energy assets.
   - Enabling transparency through periodic reporting on energy production, usage, and financial performance.

- Encouraging member participation in decision-making and the exploration of new projects to expand impact.

6. Monitoring and Adaptation:
   - Conducting regular evaluations to identify areas for improvement in energy production, efficiency, and engagement.
   - Adjusting strategies to incorporate emerging technologies and respond to evolving community needs.

5.3. *Insights for Viladecans* – Viladecans' journey as an emerging energy community aligns closely with the principles outlined in the Catalan guide. The municipality's experience underscores the following lessons:

1. Empowering Leadership: The Oficina Vilawatt is a model for the "Grup Motriu", providing leadership and fostering community cohesion.
2. Tailored Solutions: Retrofitting initiatives in Montserratina and innovative projects like Enxaneta School's photovoltaic plant highlight the value of customised solutions that reflect community-specific energy demands.
3. Transparent Governance: The participatory frameworks employed in Vilawatt's workshops and public forums reinforce the importance of inclusivity and accountability in decision-making.

5.4. *Challenges and Opportunities* – Despite the successes achieved by Viladecans and other Catalan energy communities, several challenges persist:

- Overcoming Regulatory Barriers: Simplifying administrative procedures and ensuring legal clarity are critical for facilitating community-driven energy projects.
- Ensuring Financial Viability: Securing funding through innovative mechanisms, such as crowdfunding or public-private partnerships, remains a priority.
- Addressing Inequalities: Strategies must be developed to bridge the gap between resource-rich and underserved areas, ensuring equitable access to renewable energy benefits.

However, growth opportunities are abundant. Emerging trends in digitalisation, decentralised energy systems, and policy support offer promising avenues for expanding energy communities. Enhanced collaboration between municipalities, regional authorities, and international organisations will be instrumental in scaling these initiatives.

5.5. *Future Directions for Catalonia and Beyond* – Looking ahead, the success of energy communities in Catalonia, including Viladecans, hinges on several factors:

- Policy Innovation: Catalan policymakers can further refine incentives, such as tax benefits or grants, to encourage the formation and operation of energy communities.

- Education and Capacity Building: Expanding educational programs to empower citizens with the knowledge and skills needed to lead and participate in energy communities will ensure long-term sustainability.
- International Knowledge Exchange: Sharing best practices and lessons learned across regions and countries can accelerate global progress in the energy transition.

6. *Discussion*

The Viladecans case study offers a compelling lens through which to examine the geographical dimensions of energy transitions. By integrating innovative governance, community engagement, and technological advancements, the municipality has redefined local urban landscapes to align with sustainability goals. This section explores key themes that emerge from the case study, including the implications of spatial differentiation, the role of governance in fostering equity, and the broader lessons for urban energy transitions.

- *Spatial Differentiation and Inequalities*

Viladecans' energy transition initiatives reveal the inherently spatial nature of low-carbon transformations. While projects such as the Montserratina district retrofits and the Municipal Library renovation have demonstrably enhanced energy efficiency and their spatial concentration highlights persistent socio-economic differentiation across neighbourhoods. Preliminary analysis of municipal data suggests that participation rates in advisory services and incentive schemes correlate with pre-existing income gradients, with higher uptake in more affluent areas despite targeted outreach to vulnerable districts (Viladecans City Council, 2023). Wealthier neighbourhoods, benefiting from superior access to resources and information, appear structurally advantaged, while less privileged areas encounter systemic barriers to engagement. This pattern aligns with broader findings in critical energy geography, where 'just transition' interventions risk reproducing uneven development unless explicitly redistributive mechanisms are embedded (Sovacool *et alii*, 2020). Addressing such disparities is essential to realising spatial justice.

The retrofitting efforts in the Montserratina district exemplify the positive spatial impacts of targeted interventions. These projects have reduced energy consumption and carbon emissions by improving building insulation and integrating renewable energy systems. However, similar initiatives must be scaled to other parts of Viladecans to prevent the entrenchment of spatial disparities. Achieving this requires a comprehensive policy framework prioritising equitable resource allocation and inclusive planning processes.

From a geographical perspective, scaling these interventions demands not merely replication but a multi-scalar approach: integrating neighbourhood-level targeting with metropolitan-level equity audits to monitor intra-urban benefit distribution and prevent the consolidation of 'green enclaves'.

- *Governance and Community Engagement*

Governance plays a critical role in shaping the outcomes of energy transitions. The Vilawatt project exemplifies innovative governance through its multi-stakeholder approach, integrating input from municipal authorities, residents, and EU institutions. Qualitative evaluations indicate that participants perceive greater ownership of initiatives, which correlates with sustained engagement in co-design processes (Urban Innovative Actions, 2023). Nevertheless, longitudinal data reveal challenges in maintaining involvement, particularly among marginalised groups facing time, mobility or digital access constraints (Vilawatt Progress Report, 2024).

The execution of community engagement programmes—such as the 50+ workshops and training sessions delivered by Oficina Vilawatt since 2018—demonstrates the efficacy of participatory governance in fostering behavioural change. The community members have felt through this model that they are the owners of the projects which has led to the accomplishment of the projects. But it has always been a problem to keep people involved and interested especially those who are marginalized and do not have the means or the ability to engage fully.

The execution of community engagement programs like the workshops and the training sessions arranged by Oficina Vilawatt is a living proof of the effectiveness of participatory governance. Building on urban political ecology frameworks, future efforts should operationalise 'deep participation' by coupling socioeconomic targeting with capacity-building for underrepresented voices, thereby mitigating governance capture by resourced actors.

These initiatives have cultivated a culture of collaboration and shared responsibility by empowering residents with knowledge and skills. To build on this success, future efforts should address socioeconomic inequities that hinder participation and expand outreach to underrepresented communities.

- *Lessons for Broader Urban Energy Transitions*

Viladecans' experiences provide valuable lessons for other cities navigating the complexities of energy transitions. The most important lesson learned from this is that it is very important that the policies be adapted to the local contexts. Take as an example the solar panel integration at the Municipal Library and the Enxaneta School, which demonstrates not only the understanding of the special needs but also the opportunities of these places. This local approach makes sure that the interventions are both feasible and effective.

One more essential point that was learned is the necessity of having a multi-scalar viewpoint. The coordination of local actions with the wider EU frameworks, such as the Urban Innovative Actions program has been the reason of Viladecans' success. This coordination indicates that it is very important to collaborate across different levels of governance in order to have access to resources, engage in the knowledge exchange and increase the successful practices to a higher level.

Lastly, the case study is a strong argument in favor of education and awareness-raising as a powerful means to change. By embedding sustainability in the curriculum at Enxaneta School and holding workshops at accessible places like the Plaça Europa Municipal Market, Viladecans has educated their citizens to energy issues which has contributed to their engagement. This cultural shift is essential for sustaining long-term transitions and building resilience.

The discussion underscores the multifaceted nature of energy transitions and the need for integrated approaches that address technological, social, and spatial dimensions. Villadecans' initiatives demonstrate that while challenges persist, innovative governance and community engagement can drive meaningful progress toward sustainable urban futures.

7. *Conclusion*

The insights from the Catalan guide and Viladecans' practical experiences underscore the transformative potential of energy communities in driving the energy transition. These communities can be engines of local empowerment and global climate action by prioritising collaboration, transparency, and innovation. Viladecans exemplifies municipalities' pivotal role in fostering energy communities, setting a benchmark for others to follow.

The Viladecans case study highlights the transformative potential of local energy initiatives in advancing the global energy transition. By addressing the technological, social, and spatial dimensions of sustainability, the municipality has set a benchmark for innovative urban energy strategies. This section consolidates the key findings from the analysis and offers reflections on the broader implications of Viladecans' experiences.

The Viladecans case and the Vilawatt project is a story of how local governments can be the pioneers of the worldwide energy transition. Viladecans, by infusing innovation, community involvement, and social fairness into its energy policies, is presenting a model of sustainable and inclusive urban development. The city journey is a source of numerous insights to other urban areas, which are energy transition challenges, and it points out that the solution lies in localised measures, participatory governance, and adherence to spatial justice principles.

As the planet is still facing climate change and resource scarcity issues, the call for breakthrough energy policies is getting louder and louder. The story of Viladecans conveys that the energy shift is not only about cutting down on emissions but also about changing the face of cities, giving power to communities, and fashioning a future that is fair and sustainable. Other cities, by taking lessons from the Vilawatt project, can map out their way leading to resilience and equity in the era of renewable energy.

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An Emerging Energy Community. The Case Study of Viladecans in Catalonia

This article examines the emergence of an energy community in Viladecans, Catalonia, within the broader transition from fossil fuels to renewables. It examines how this shift reconfigures spatial development and interacts with pre-existing socio-economic differences, emphasising the interplay of technological, physical and social factors in shaping the local outcomes of the energy transition. Viladecans demonstrates how local initiatives can drive energy transitions while raising concerns about spatial justice. The municipality has adopted renewable energy, including solar power and efficiency measures, facilitated by a local energy community that mobilizes resources and fosters participation. However, the transition also carries the potential to reproduce or reconfigure existing inequalities, as wealthier neighbourhoods are often better positioned to access information, incentives and technical support. This raises critical questions about spatial justice and underscores the need for explicitly inclusive, localised energy policies. Beyond technological advancements, the energy transition in Viladecans represents a broader spatial and social transformation, reshaping urban landscapes and social interactions. The study underscores the importance of geographically sensitive policies to avoid reinforcing disparities. It advocates for a nuanced approach that promotes spatial justice and equitable access to renewable energy. This study contributes to the discourse on sustainable urban transitions by linking energy transitions to spatial differentiation and uneven development. Viladecans is a model for policymakers and researchers seeking equitable solutions, demonstrating that while local energy communities drive change, targeted policies are essential for a just transition.

Una comunità energetica emergente. Il caso studio di Viladecans in Catalogna

Questo articolo esamina la nascita di una comunità energetica a Viladecans, in Catalogna, nel contesto più ampio della transizione dai combustibili fossili alle energie rinnovabili. Esplora come questo cambiamento influisca sullo sviluppo territoriale e contribuisca alle disuguaglianze, sottolineando l'interazione tra fattori tecnologici, fisici e sociali.

Viladecans dimostra come le iniziative locali possano guidare la transizione energetica, sollevando al contempo preoccupazioni in materia di giustizia spaziale. Il comune ha adottato energie rinnovabili, tra cui l'energia solare e misure di efficienza energetica, facilitate da una comunità energetica locale che mobilita risorse e promuove la partecipazione. Tuttavia, questa transizione ha esacerbato le disuguaglianze esistenti, con i quartieri più ricchi che ne beneficiano maggiormente grazie a un migliore accesso alle risorse e alle informazioni. Ciò evidenzia la necessità di politiche energetiche inclusive e localizzate.

Al di là dei progressi tecnologici, la transizione energetica a Viladecans rappresenta una più ampia trasformazione spaziale e sociale, che sta rimodellando il paesaggio urbano e le interazioni sociali. Lo studio sottolinea l'importanza di

politiche sensibili alle differenze geografiche per evitare di rafforzare le disparità. Esso sostiene un approccio sfumato che promuova la giustizia spaziale e l'accesso equo alle energie rinnovabili.
Questo studio contribuisce al dibattito sulle transizioni urbane sostenibili collegando le transizioni energetiche alla differenziazione spaziale e allo sviluppo diseguale. Viladecans è un modello per i responsabili politici e i ricercatori alla ricerca di soluzioni eque, dimostrando che, mentre le comunità energetiche locali guidano il cambiamento, politiche mirate sono essenziali per una transizione giusta.

Una comunidad energética emergente. El caso práctico de Viladecans en Cataluña

Este artículo examina el surgimiento de una comunidad energética en Viladecans, Cataluña, en el marco de la transición más amplia de los combustibles fósiles a las energías renovables. Explora cómo este cambio afecta al desarrollo espacial y contribuye a las desigualdades, haciendo hincapié en la interacción de factores tecnológicos, físicos y sociales.
Viladecans demuestra cómo las iniciativas locales pueden impulsar las transiciones energéticas al tiempo que suscitan preocupaciones sobre la justicia espacial. El municipio ha adoptado energías renovables, incluida la energía solar y medidas de eficiencia, facilitadas por una comunidad energética local que moviliza recursos y fomenta la participación. Sin embargo, esta transición ha exacerbado las desigualdades existentes, ya que los barrios más ricos se benefician más debido a su mejor acceso a los recursos y la información. Esto pone de relieve la necesidad de políticas energéticas inclusivas y localizadas.
Más allá de los avances tecnológicos, la transición energética en Viladecans representa una transformación espacial y social más amplia, que remodela los paisajes urbanos y las interacciones sociales. El estudio subraya la importancia de las políticas sensibles a la geografía para evitar reforzar las disparidades. Aboga por un enfoque matizado que promueva la justicia espacial y el acceso equitativo a las energías renovables.
Este estudio contribuye al debate sobre las transiciones urbanas sostenibles al vincular las transiciones energéticas con la diferenciación espacial y el desarrollo desigual. Viladecans es un modelo para los responsables políticos y los investigadores que buscan soluciones equitativas, ya que demuestra que, si bien las comunidades energéticas locales impulsan el cambio, las políticas específicas son esenciales para una transición justa.