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Enhancing Urban Resilience through Integrated Energy, Climate, and Spatial Planning: Introducing the IN-PLAN Practise

Katharina Höftberger, Anna Lindorfer, Fabrizia Salvi, Marco Slavich, Simona Tršinar, Gloria Callinan

(DI Katharina Höftberger, BA, UIV Urban Innovation Vienna GmbH, Operngasse 17-21, 1040 Vienna, hoeftberger@urbaninnovation.at)
(DI Anna Lindorfer, UIV Urban Innovation Vienna GmbH, Operngasse 17-21, 1040 Vienna, lindorfer@urbaninnovation.at)
(Fabrizia Salvi, BA, Area Science Park, Padriciano 99, 34149 Trieste, fabrizia.salvi@areasciencepark.it)
(Marco Slavich, MArch, Area Science Park, Padriciano 99, 34149 Trieste, marco.slavich@areasciencepark.it)
(Simona Tršinar, MSc, mag. oec., Regional Energy and Climate Agency for North-West Croatia, Andrije Žaje 10, 10000 Zagreb, strsinar@regea.org)
(Gloria Callinan, MA, Technological University of the Shannon, Nenagh Road, Thurles, E41 PC92, gloria.callinan@tus.ie)

1 ABSTRACT

Fragmented sectoral policies hinder spatial planning from driving sustainable development and diminish the impact of EU-funded investments, posing a significant challenge for urban development in Europe (ESPON, 2018). The IN-PLAN project addresses this problem by empowering local and regional authorities to integrate climate adaptation, energy and mobility policies and spatial planning. The developed IN-PLAN Practice provides a structured framework, milestones and strategies for action and stakeholder engagement to support integrated planning. Pilot projects in Croatia, Ireland, Italy, Sweden and Romania demonstrate the adaptability and feasibility of implementation of the practice. This paper presents the findings throughout the project and highlights the lessons learnt from these pilot projects to stimulate a wider uptake of integrated planning approaches across Europe. It also reflects the provision of support structures and documents for integrated planning.

Keywords: Governance, Sustainability, Integrated Planning, IN-PLAN, Integrated Energy, Climate, and Spatial Planning

2 INTRODUCTION

Since 2021, the European Climate Law has established a legally binding target of net zero greenhouse gas emissions by 2050 (EU Regulation 2020/0036/COD from 30/06/2021) in alignment with the UN Paris Agreement of 2015. For the period from 2021 to 2030, EU Member States developed integrated National Energy and Climate Plans (NECPs) outlining their strategies for achieving the necessary greenhouse gas emissions reduction to meet the EU's climate neutrality objective.

In recent years, many local and regional authorities have set ambitious climate neutrality targets and are actively transforming energy and mobility systems to achieve them (Net Zero Cities, 2025). Despite operating under different overarching frameworks, these authorities play a crucial role in translating national and European climate targets into practical actions. They have control over spatial development within their jurisdictions and often hold the legal mandate to develop and enforce spatial development plans. These plans outline future settlement and economic development while imposing restrictions on land use. Given the close link between spatial structures, energy demand and supply, large and small-scale climate adaptation measures and mobility patterns, spatial planning is an enabler for municipalities to take meaningful action on climate change and advance toward net-zero targets.

2.1 Integrated planning as a holistic approach

Accelerating the transition to climate-neutral and climate-friendly cities requires not only the implementation of diverse sector-specific measures but also the adoption of a holistic approach. Given the constraints on time and financial resources, this approach should seek to harness synergies and proactively identify potential conflicts to develop effective solutions. Integrated energy, climate, mobility and spatial planning is pivotal to achieving climate neutrality while simultaneously preserving or enhancing the quality of life in municipalities. The concept of integrated planning can be illustrated through three key dimensions:

- Vertical integration involves cooperation across different levels of governance, from local to national and international bodies. This coordination ensures that policies and plans are harmonised to minimise redundancies and to create coherent development strategies.

- Horizontal integration focuses on cross-departmental collaboration within municipalities. Therefore, challenges are tackled holistically rather than in silos, integrating climate adaptation, sustainable mobility and renewable energy issues into spatial planning.
- Territorial integration entails regional partnerships among municipalities. Joint efforts enable them to tackle common issues, optimise resources, and implement strategies that extend beyond individual borders, resulting in a more coordinated and effective regional development.

2.2 Theory of integrated planning and its state of implementation

Considerations concerning energy production and consumption in urban environments first emerged during the 1920s energy crisis. De Pascali and Bargaini (2018) trace the evolution of spatial and energy planning integration, noting that the link between urban characteristics and energy systems has been studied since the 1970s. In 1974, "The Cost of Sprawl" examined the relationship between settlement density and energy consumption (Real Estate Research Corporation, 1974), whereas Knowles et al. (1974) highlighted the connection between urban environmental conditions and quality of life. The two-way relationship between energy and urban planning, stressing the need for a systemic approach that considers urban structure, mobility, and distribution of urban activities was defined by Owens et al. (1986).

Despite the concept of integrated spatial planning existing in various forms since the 1960s, a clear gap remains between theory and practical implementation at the municipal and regional levels in the EU. While some EU countries have been able to develop integrated planning processes, aligning sectoral policies under shared goals and creating joint policies spanning different sectors, others have a rather coordinated practice, which reflects clear efforts to align policies and enable mutual adjustment across sectors. Only a few Member States entirely neglect the integration of sectoral policies in spatial planning and therefore miss tangible relationships between sectors or acknowledgment of other sectoral policies (Nadin et al., 2020). Independent of their level of integrated planning, most of the European regions and municipalities continue to face the challenges of integrating different policy disciplines.

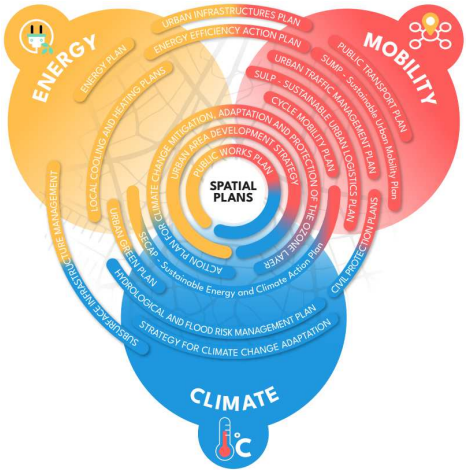

Fig. 1: Diagram mapping the intersections and overlaps between sectoral plans. https://fedarene.org/wp-content/uploads/2024/10/IN-PLAN_SPATIAL-PLANS.pdf

Several reasons can be identified to explain the discrepancy between the theory and the level of integration as well as the difficulties arising from a stable integration. With the Covenant of Mayors initiative in 2015, more than 8,000 municipalities signed up for the development of SECAPs – Sustainable Energy and Climate Action Plans (United Nations, 2024). Despite the enormous success of the initiative, it seems that SECAPs still miss the opportunity to translate energy, climate and environmental policies into ordinary spatial planning instruments because of sectoral-based responsibilities of urban strategies, as e.g., SECAPs and SUMPs (Sustainable Urban Mobility Plans) lie within different municipal and regional departments. Furthermore, local and regional governments often lack the authority to establish and enforce binding energy and climate strategies, plans and policies, as their competencies in developing and implementing such measures are typically limited, frequently restricted to voluntary schemes such as the SECAP. This lack of institutionalization also hampers the monitoring of measure implementation and the integration of plans into municipal and regional budgets. As a result, local and regional governments rarely have the necessary

financial resources to plan and implement energy and climate measures and therefore end up acting reactively.

2.3 A methodological approach to roll out integrated planning

The LIFE project IN-PLAN running from 2022 until 2026, addresses various planning systems across Europe with a diverse set of project partners entailing the Institute for European Energy and Climate Policy, UIV Urban Innovation Vienna GmbH, Technological University of the Shannon, Area di Ricerca Scientifica e Tecnologica di Trieste Area Science Park (IT), and FEDARENE as well as regional climate and energy agencies from Tipperary (IR), Alba (RO), North-West Croatia and West-Sweden. To help local and regional governments integrate climate and energy considerations into spatial planning, it offers general guidelines adaptable to different legal and planning contexts instead of a one-size-fits-all approach. Therefore, the project developed a long-lasting support structure with the IN-PLAN Practice and a two-step Capacity-Building Programme to empower regional agencies and local authorities to implement and monitor integrated strategies aligned with budget commitments to foster sustainable development.

3 THE IN-PLAN PRACTICE

A central product of the project is the IN-PLAN Practice (Höftberger et al., 2024), a comprehensive guidebook for integrating climate adaptation, mobility, and energy planning into spatial planning processes. The Practice is designed to support local and regional governments in developing, implementing, and monitoring ambitious integrated spatial plans with climate neutrality targets. It provides municipalities, regions, and other public authorities with a structured framework for identifying high-impact areas for climate action, a clear outline for an integrated planning process, and practical tools to use alongside exemplary case studies from across Europe. By fostering institutionalised collaboration among departments and various stakeholders, the IN-PLAN Practice promotes civic engagement and participatory governance.

To identify specific barriers faced by municipalities in integrating climate, energy, and mobility planning, a Europe-wide survey and a series of consultations with municipalities were conducted. The insights gained informed the design of a series of workshops aimed at identifying key characteristics of spatial planning systems and the challenges of integrated planning in different national and regional contexts. A comprehensive capacity gap assessment summarizes the findings (Forstinger et al., 2023). Based on this, the IN-PLAN Practice was designed as an advisory tool, also synthesising best practices identified in a stocktake of effective planning approaches (Holodkov et al. 2023). The document was further refined through an iterative feedback process with local project partners, incorporating lessons learned from their engagement with municipalities. This participatory approach ensures that the IN-PLAN Practice is not just a theoretical framework, but a practical, hands-on guide tailored to the real needs of local and regional planners.

3.1 Leveraging Synergies: Focus Topics for Climate Action

According to the Torremolinos Charter (CEMAT, 1983), spatial planning gives geographical expression to the economic, social, cultural, and ecological policies of society. While this definition dates back several decades, it already acknowledges the multifaceted factors of spatial development. Today, however, we emphasise that spatial planning is also a powerful instrument for actively shaping how land is used, energy is distributed, and mobility systems are implemented. It offers essential tools to drive progress in key policy areas that must be integrated to maximise its impact: energy, mobility and climate adaptation. Addressing these interlinked areas holistically enables municipalities to create sustainable, adaptable environments.

Spatial planning is key to aligning energy demand with renewable energy supply. Cities and industrial areas have high energy needs, while renewable sources – such as solar, wind, geothermal, and waste heat – vary in availability and space requirements. Effective planning helps municipalities identify optimal sites for energy production while minimising land-use conflicts. Built-up areas, such as rooftops and infrastructure zones, should be prioritised for solar PV to maximise output without encroaching on natural spaces. Additionally, strategic heating and cooling planning ensures that district heating, geothermal systems, and energy infrastructure match settlement patterns of municipalities and regions. By embedding energy considerations into spatial planning, municipalities can enhance energy efficiency and drive decarbonisation while ensuring a secure and cost-effective energy supply.

Spatial planning is vital for climate adaptation, helping cities and regions manage extreme weather and biodiversity loss. Integrating nature-based solutions – like green corridors, permeable surfaces, and urban forests – can reduce heat islands and boost resilience. Flood-prone areas benefit from sustainable drainage and retention zones, while coastal and mountainous regions need protective zoning, shoreline management, and slope stabilisation to prevent erosion and landslides. Climate-resilient public spaces with vegetation, shade, and water features enhance liveability during heatwaves. Biodiversity conservation through habitat protection and ecological corridors supports ecosystems adapting to change. Regulatory frameworks should require climate-responsive building design, such as passive cooling, green roofs, and rainwater management. Embedding these strategies into spatial planning enables municipalities to build resilience, protecting public health, infrastructure, and ecosystems from the long-term impacts of climate change.

Finally, spatial planning sets the basis for sustainable mobility by designing compact, multimodal urban environments that prioritise walking, cycling, and public transport. By applying the Avoid–Shift–Improve approach, municipalities can reduce travel demand through mixed-use neighbourhoods, shift mobility towards low-carbon modes, and enhance vehicle efficiency. Streets should be restructured to support active transport, with shaded pedestrian paths, dedicated bike lanes, and well-integrated public transit. Parking reform, including reduced on-street parking and repurposing spaces for urban greenery and mobility hubs, discourages car dependency. Additionally, traffic calming measures such as pedestrian zones and shared spaces improve safety and liveability. Mobility hubs offering public transport, bike-sharing, and carpooling enhance accessibility while zero-emission zones and EV charging infrastructure support the transition to CO_2-neutral propulsion technologies. Integrating sustainable mobility into spatial planning helps municipalities reduce congestion, lower emissions, and foster vibrant, friendly urban spaces.

With spatial planning as a major lever for advancement in these three climate-relevant fields, many synergies can be exploited when these fields are approached together.

3.2 Breaking Silos: How to Design and Implement an Integrated Spatial Plan

Integrated planning maximises synergies by addressing spatial interventions holistically:

(1) The process starts by establishing a planning framework, securing political support, and defining clear roles. A cross-sector team and steering committee enable collaboration across departments and governance levels, while a stakeholder engagement plan ensures broad, inclusive participation.

(2) The baseline assessment reviews existing policies, legal frameworks, and best practices to align sectoral strategies with spatial planning. Comprehensive data collection and analysis on energy, mobility, and climate risks informs decision-making, identifying conflicts and synergies.

(3) A common vision and goals provide strategic direction. Stakeholders align on priorities such as climate neutrality, sustainable land use, and resilient infrastructure, with measurable objectives ensuring a structured implementation.

(4) The planning phase translates this vision into actionable measures. Scenario planning assesses long-term impacts, and stakeholder feedback refines interventions. Ensuring regulatory coherence strengthens the spatial plan as a tool for implementation.

Fig. 2: Five phases of an integrated planning process according to the IN-PLAN Practice.

(5) Monitoring and evaluation of key performance indicators like emissions reduction, energy efficiency, and mobility improvements ensures adaptability. GIS mapping and digital tools support ongoing assessment,

while stakeholder feedback loops drive continuous improvement, keeping the plan responsive to evolving climate and sustainability targets.

3.3 Practical Tools and Good Practices for Implementation

The IN-PLAN Practice supports spatial, energy, and mobility planners with hands-on tools and international best practices. Each chapter includes structured approaches, decision-making frameworks, technical guidelines and practical tools as well as good practices to address complex planning challenges. Below are some key tools, while a comprehensive overview is available in the IN-PLAN Practice. The U4SSC Guideline (Rodriguez et al., 2021) highlights digital tools that support sustainable urban planning like the Digital Transformation Toolkit (International Telecommunication Union, 2022) which facilitates data-driven governance.

The IN-PLAN Checklist provides a structured overview of key considerations in energy, climate adaptation, and mobility planning. It ensures that planners systematically address all relevant aspects within their projects.

The guide for developing a Heating and Cooling (H/C) plan (Gnehm et al., 2022) offers a detailed methodology for creating an H/C plan. It covers infrastructure assessment, heat demand and potential mapping, feasibility analysis of heat supply, economic considerations, data quality, and the integration of H/C with the power grid amid increasing electrification.

Climate-ADAPT is a platform designed to support Europe's adaptation to climate change. It provides accessible data and insights on expected climate impacts, vulnerability assessments, adaptation strategies, case studies, and planning tools. Information is categorized by EU policy sectors, countries, and cities (European Environment Agency, 2024).

Two cities serve as examples of innovative tools supporting integrated planning:

- Zurich's climate information maps (Kanton Zürich, 2024) offer detailed data on air temperatures, cold air currents, and bioclimatic conditions during summer days and nights. These maps identify heat islands, compensation areas, and ventilation routes, helping planners mitigate urban heat.
- Paris' Climate Resilience Strategies integrate climate adaptation into public spaces through initiatives such as the Paris Resilience Strategy and the Bioclimatic PLU. These strategies enhance urban mobility and summer recreation while strengthening climate resilience (City of Paris, 2017).

4 GOOD PRACTICE: APPLICATION OF INTEGRATED PLANNING IN MUNICIPALITIES

Many municipalities already have different energy and climate action plans, strategies, and policy frameworks, yet struggle to translate them into enforceable measures within spatial planning often slowing down the energy transition, preventing key measures from being effectively implemented. The IN-PLAN project helps bridge this gap by providing municipalities with a structured methodology to embed sustainability into legally binding spatial plans. By leveraging existing energy and climate documents, cities can align their planning processes with long-term decarbonisation and resilience goals.

The following section presents two case studies in Karlovac (HR) and Narni (IT) where local partners have supported municipalities in strengthening spatial plans as tools for driving the energy transition. Their experiences demonstrate how technical expertise, stakeholder collaboration, and regulatory adaptation can turn climate commitments into actionable urban development policies.

4.1 Case study I: City of Karlovac

Through the IN-PLAN project, Karlovac became the first city of the IN-PLAN project to embed its SECAP measures into its General Urban Plan (GUP), ensuring enforceable, long-term sustainability commitments. This case outlines the initial urban and energy challenges faced by Karlovac, the opportunities leveraged for transformation, and the concrete planning and regulatory modifications made to align spatial development with energy transition goals. A detailed examination of the integrated planning process highlights how the City of Karlovac is effectively bridging the gap between strategic ambition and practical implementation.

4.1.1 Initial Situation of the Municipality

Karlovac, a mid-sized city in central Croatia, with approximately 50,000 residents, is uniquely positioned at the intersection of lowland and mountainous regions. Its strategic location in the narrowest part of Croatia, approximately 50 km from Slovenia and Bosnia and Herzegovina gives it significant transport and economic importance. The city is well connected to key regional hubs, lying less than 50 km from Zagreb, 90 km from the major port of Rijeka, and within 400 km of Ljubljana, Sarajevo, Budapest, and Vienna. Karlovac is also known as the "City on Four Rivers", referring to the Kupa, Korana, Mrežnica, and Dobra rivers, which shape both its landscape and environmental challenges, including frequent flooding risks.

Despite its historical and economic strengths, Karlovac, like many European cities, faced challenges in integrating sustainability measures into its urban development framework. The city's energy infrastructure was historically centred around gas, creating obstacles for decarbonisation. District heating systems existed but were underutilized, while renewable energy adoption remained limited. Urban planning was guided by multiple strategic documents, yet they often operated in isolation, leading to inefficiencies in energy distribution, mobility planning, and sustainability initiatives.

While Karlovac had adopted a SECAP to outline its long-term climate and energy goals, the lack of an implementation mechanism meant that these strategies were not effectively translated into action. At the same time, spatial planning policies governed zoning and construction permits but did not systematically incorporate climate resilience and energy efficiency measures. This disconnection between strategy and execution highlighted the need for a more integrated, enforceable planning framework – one that would align Karlovac's urban development with its energy transition and climate adaptation commitments.

4.1.2 Challenges as an Opportunity for Change

The decision to integrate energy planning into the spatial framework stemmed from a recognition that urban development and sustainability efforts must be interlinked. The North-West Croatia Regional Energy and Climate Agency (REGEA) and the City of Karlovac identified several structural challenges that, if properly addressed, could be transformed into opportunities for innovation and long-term resilience.

The primary challenge was the lack of enforcement mechanisms for the city's SECAP. While the document detailed decarbonisation pathways, its recommendations held no legal power, meaning proposed measures were dependent on political will and voluntary implementation. In contrast, the city's spatial plan had binding authority, making it a logical vehicle for embedding sustainability into urban governance.

Another issue was the inefficiency of Karlovac's energy infrastructure. The city had both a gas network and a district heating system, but they operated in competition. Gas infrastructure expansion conflicted with district heating development, preventing the efficient use of existing energy resources. Without regulatory intervention, the city's energy transition would remain stalled by entrenched infrastructure dynamics.

From a governance perspective, Karlovac faced the fragmentation of strategic documents, where urban mobility, energy planning, zoning, and climate adaptation were treated as separate spheres rather than components of a unified vision. This led to inefficiencies such as disjoint transport policies, weak incentives for energy-efficient construction, and no guidance on the integration of renewables for new construction. The city leadership recognised that integrating SECAP measures into the GUP could create a legally binding framework for sustainability, ensuring that energy transition and climate resilience became structural components of urban development rather than optional initiatives.

4.1.3 Influence of the IN-PLAN Project in the Change Process

Karlovac's participation in the IN-PLAN project played a critical role in supporting its energy transition and defining context-specific sustainability measures. Through collaboration with IN-PLAN experts, Karlovac received technical guidance and a structured methodology for integrating energy and climate policies into spatial planning.

A key outcome was the development of a systematic approach for future spatial planning iterations, ensuring that new energy and climate measures could be continuously integrated into the GUP. The IN-PLAN Practice methodology provided Karlovac with a clear framework for assessing sustainability policies, refining them over time, and aligning them with European energy transition goals.

The IN-PLAN team also advised Karlovac on which energy and climate measures could be expanded beyond individual pilot projects and incorporated into city-wide spatial planning regulations. Through further consultations with REGEA and key stakeholders, recommendations were developed for ensuring coordination between municipal departments, infrastructure providers, and urban developers. This collaborative process strengthened Karlovac's ability to institutionalise integrated planning, aligning urban development with long-term decarbonisation and resilience strategies.

4.1.4 Description of the Integrated Planning Process

Driven by the City of Karlovac's ambition for a greener spatial plan, the integration of SECAP measures into the General Urban Plan was carried out through a structured, step-by-step approach, combining technical analysis, stakeholder engagement, and policy development. In partnership with the City of Karlovac, REGEA conducted a comprehensive assessment of existing urban planning and energy strategies to identify gaps and opportunities for embedding SECAP provisions into spatial planning regulations.

To enable data-driven decision-making, Karlovac conducted a detailed energy and climate analysis, mapping heating demand, hot water consumption, and renewable energy potential across the city. The results guided the identification of priority zones for district heating expansion, areas for phasing out gas, and optimal locations for renewable energy integration. By embedding these insights into spatial plans, the city developed zoning regulations that aligned land-use policies with its energy transition goals.

The Lušćić district was chosen as a pilot project to test the integration of energy and climate measures into spatial planning. The resulting plan introduced progressive sustainability measures, including the exclusion of gas infrastructure, mandatory use of district heating or renewable energy, and the implementation of higher energy efficiency standards for new buildings. Additionally, green infrastructure and sustainable mobility solutions were incorporated. After a public consultation process, the Lušćić spatial plan was officially adopted, confirming the feasibility of integrating decarbonisation measures into urban planning.

Building on this success, Karlovac expanded its efforts, receiving expert guidance and technical support to further incorporate energy and climate policies into the GUP. With the assistance of the IN-PLAN team, Karlovac adopted legally binding measures for all new urban developments, including:

- Prohibition of gas infrastructure in new residential and commercial buildings.
- Mandatory use of 100% renewable energy or district heating for heating and domestic hot water.
- Implementation of strict energy efficiency standards to reduce overall energy demand.

By embedding these sustainability measures into the GUP, Karlovac became the first city within the IN-PLAN project to successfully integrate energy and climate planning into its spatial development framework, setting a scalable example for other municipalities.

4.2 Case study II: Municipality of Narni

The municipality of Narni, is located in the province of Terni in central Italy. It spans an area of 198 km2 and has a population of approximately 18,000 inhabitants. The most populous area is Narni Scalo, followed by the old city centre situated on a hill above the Nera River. Narni, with its pre-Roman origins, has preserved its medieval old town, rich in historical, artistic, and cultural sites.

4.2.1 Initial Situation of the Municipality

The General Urban Plan (GUP) of Narni, developed over 20 years ago, remains valuable for its focus on high-quality outdoor spaces. However, it is now outdated and lacks the capacity to support climate-resilient urban development in the face of increasingly frequent extreme weather events.

Despite its small size, Narni has faced administrative fragmentation, leading to a lack of cooperation between departments. This fragmentation had historically hindered the municipality's ability to implement cohesive and comprehensive urban planning strategies.

Municipal staff also struggle with limited access to the knowledge and data needed for effective climate adaptation and spatial planning. The absence of up-to-date, reliable data further challenges the development of informed, data-driven plans. To address this, IN-PLAN is supporting the municipality in institutionalising integrated planning and embedding a data-driven approach from the earliest stages of drafting the new GUP.

4.2.2 Occasion or Challenge of the Municipality

The involvement as a lighthouse municipality in IN-PLAN coupled with the National Resilience and Recovery Plan (NRRP) funded projects – whose implementation requires an effective, multidisciplinary management team in order to meet the tight deadlines – and the initiation of a new GUP presented Narni with an opportunity for change. The municipality began the process of updating its GUP in 2024, starting the revision of the cartography through photogrammetric and topographic surveys, an essential step for enhancing the knowledge framework as a basis for the integrated planning process.

It quickly became evident that enhancing the quality of geospatial data – both in geometry and content – is essential to optimizing land management and urban planning processes. This initiative aims to create a Land Cover vector database that meets the latest EU and AgID (Agency for Digital Italy) standards, promoting the interoperability of urban plans and facilitating territorial exchanges (SNPA, 2024). The funding and support from National Recovery and Resilience Plan (NRRP) projects have provided the necessary resources to address long-standing issues and modernise the municipality's planning processes, aligning them with current standards and sustainability goals.

4.2.3 Modifications and Developments in Favour of Integrated Planning

To foster integrated planning, Narni implemented internal governance reforms, establishing interdepartmental working groups with clear goals, deadlines, and responsibilities. These groups were tasked with ensuring that various departments collaborated effectively, breaking down the silos that had previously impeded progress (Alessandrelli et al., 2024).

The process of integrating energy and climate considerations into spatial planning took shape with the roll out of the IN-PLAN project at the end of 2022 and could benefit from capacity-building activities, peer learning, and jointly developed guidelines for a data management plan.

4.2.4 Description of the Integrated Planning Process

The integrated planning process in Narni involved several key steps:

(1) Committing to the UN-Agenda 2030 standards as a reference framework for the update of the GUP.

(2) Creation of an interdepartmental working group: as the team encountered cross-sectoral complex issues, such as adhering to the Do No Significant Harm (DNSH) principle to implement also NRRP funded projects, the IN-PLAN Practice provided a practical common framework for facilitating knowledge transfer and collaboration among colleagues belonging to different departments.

(3) Developing distinct sets of strategic objectives in three key areas: land consumption, sustainable mobility, and air quality improvement. For each area, the municipality established metrics to ensure effective monitoring and integration of measures. For each strategic objective, Narni identified additional action plans already in place (e.g., for air quality improvement, the Air Quality Agreement for air pollution mitigation in the Terni Valley). This approach enhanced awareness for the regulatory context and ensured strong vertical, horizontal and territorial synergies between strategies and stakeholders.

(4) Adopting a data-driven approach for the definition of the knowledge framework and the spatial planning process to acquire more detailed and comprehensive data layers, enhancing the municipality's ability to analyse and plan for various environmental, climatic and urban factors and ensuring consistency and accuracy in the data used for planning.

(5) Signing an agreement with national, regional and local stakeholders for data-driven spatial and urban planning (AgID, Umbria Region, and Bastia Umbra municipality).

(6) Working on land cover data according to a 4-step methodology:

(a) Analysis of the EAGLE[1] matrices used for creating the Land Cover national Chart

(b) Definition of a "Land Cover" data model

[1] EAGLE is a concept aiming at providing a tool to address the ambiguity between different nomenclatures or their comparability. It is based on description and characterization of land units through Land Cover (LC), Land Use (LU) and Characteristics and Parameters (CH) rather than their classification (ARNOLD et al., 2018)

(c) A detailed mapping plan was created to relate the objects contained in the Geographic Database to the instances expected in the new "Land Cover" data model.

(d) Application of the mapping procedure: this procedure was verified first on an urban test area of the municipality of Narni and later on the whole territory of the municipality.

The process is aiming to create an integrated map database with land cover and national information sheets, ensuring interoperability. The first results show the advantage of a data quality increase without significant additional costs, but, on the other hand, the weakness consists in the input data update frequency, which is not yearly or regular but depends on the specific needs and resources of the single local public administrations. The updated knowledge framework, based on aerial images and detailed layers (built environment, infrastructures, hydrography, orography), supports more informed and effective spatial planning.

4.2.5 Influence of the Change Process through the IN-PLAN Project

The IN-PLAN project played a key role in Narni's transition to integrated planning by advocating for the formation of interdepartmental working groups. The development of a shared vision in the beginning of the process and the participation of all relevant stakeholders supported streamlining the process.

Due to the initiative of developing a data-driven approach and a data management plan with consulting expertise from the IN-PLAN team, the municipality also focused on adopting new methods and technologies, such as advanced GIS systems and data analytics, to enhance the accuracy and efficiency of their planning processes. An intersectional knowledge framework based on geospatial data is now being developed by means of an innovative methodology for Land Cover content derivation through a multi-level-governance collaboration. This framework is facilitating the integration of various cartographic themes. The approach emphasises the importance of high-quality geospatial data for optimising territorial governance and planning processes.

A focus was put on urban resilience and ensuring that planning processes remain adaptable to future challenges, particularly those related to climate change. Therefore, the updated knowledge framework also incorporates information on climate-related risks.

The focus on digitization and technological innovation positions the municipality as a front runner in utilizing new data sources and methods for integrated and resilient urban planning. Narni's experience serves as an example for other small and medium-sized municipalities, demonstrating the benefits of an integrated and holistic approach to sustainable urban planning, capable of providing comprehensive solutions to complex challenges. Narni will continue the development of its new GUP with a strong focus on urban resilience baes on the updated and more detailed cartography as a solid foundation.

5 INNOVATIVE LEARNING APPROACHES FOR INTEGRATED PLANNING

Besides the direct support of cities and municipalities through the regional partners of the IN-PLAN project, another important pillar to enhance an integrated planning practice was capacity building amongst professionals from the planning and energy sector. The two activities of course benefited from each other with local practitioners from lighthouse and pilot cities participating in the trainings and successful pilot projects serving as best practices being presented within the capacity building programme.

Capacity building describes a range of activities aimed at strengthening the abilities, knowledge, and resources of individuals, organisations, and communities. It involves equipping key actors with necessary skills, knowledge, and resources to achieve goals and improve effectiveness. In the long-term, building capacity among policy makers – crucial decision makers in advancing integrated spatial planning – can support the sustainable development of appropriate policy measures. Effective capacity building requires an approach that involves identifying needs, setting clear goals and objectives, providing appropriate training and resources, and monitoring progress and impact. To be truly comprehensive, capacity building also requires the involvement of engaged stakeholders, including community members, civil society organisations, government bodies and statutory agencies, to ensure that efforts are tailored to the specific needs and contexts of the communities they serve.

Capacity building in the IN-PLAN context, of course, focused on integrated spatial planning. As this type of planning lends a holistic approach to land use planning and seeks to organise and integrate the various

aspects of spatial development, including social, economic, and environmental considerations, the capacity building was delivered as a multi-disciplinary approach that aims to address complex spatial problems and challenges, such as urban sprawl, environmental degradation, and social inequality.

As training is subject to time constraints, it is important that each session was utilised as effectively as possible. Based on these considerations, the Activity, Discussion, Input, Deepening and Synthesis (ADIDS) method was identified as being most adequate as adults learn most effectively when they are presented with information in a series of stages and using a variety of different formats and methods, such as relevant and thought-provoking case study presentation, group activities and breakout sessions, slide and audio-visual presentations, as well as hands-on practice, discussion and reflection. In particular, peer-to-peer exchanges created an integral part of the training experience, as it recognises the variety of experiences and range of expertise, whilst allowing participants to share their own perspectives and real life, lived experiences on the associated topics. ADIDS refers to the five main activities of a session including:

- Activity and Discussion – focusing on interaction, such as a poll or case study reading, followed by discussion. In the IN-PLAN training, participants first engaged in interactive introductions, which enabled them to share basic information like geographic background and areas of interest
- Input – Interactive expert lecture or presentation thus building capacity to act as multipliers of the IN-PLAN practice.
- Deepening and Synthesis – Hands-on activity to apply the input by completing a template analysis, policy framework, or guideline in small groups. Group work reinforced trust and mutual recognition building networks for sustainable local and regional application of the IN-PLAN practice.

Participants had to frame, understand and develop the skills and knowledge they were gaining within the IN-PLAN capacity building programme and apply them in real time. As the trainings were held online, it was vital that they were formatted around activities and interactive sessions while building on assignments and thus constructing strong knowledge bases and adding value to the work already carried out by participants. The methodology employed ensured that pertinent questions could be posed to carefully curated break out groups of likeminded peers. Over the course of three weeks, participants worked towards a final assignment using structured templates. Each group was asked to provide a real-world local example or case study regarding the integration of climate targets in urban planning within a local municipality. Using online break out rooms, online tools (e.g., mural workspace, expert capacity building facilitators, guest speaker involvement, peer-to-peer-learning and practical applications of new knowledge) participants built a solid, considered response to the posed query in collaboration with peers. These discussions allowed participants to hear outside perspectives and take away new ideas and concepts.

The two step capacity building measures as part of the IN-PLAN project, have to date (March 2025), resulted in more than 45 multidisciplinary participants from diverse European regions, having successfully completed the programme.

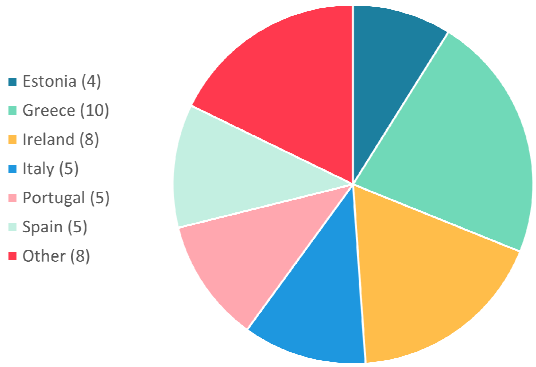

Fig. 3: Participation in the capacity building programme by country of origin.

5.1 Layout of the educational format

The four training modules included valuable and specific learning outcomes and are devised as follows:

5.1.1 Module 1 Spatial Planning an Introduction

The First Module aims to introduce participants to Spatial Planning and Integrated Planning. While participants may have a perception of what spatial planning is, this module addresses the topic from a novel perspective. Even seasoned spatial planners benefited from the conceptual overview.

5.1.2 Module 2 IN-PLAN Practice

The finalised IN-PLAN practice has been developed within the IN-PLAN project. This methodology was used to develop a presentation specifically tailored to the participants of each capacity building programme. This module consists of how to use the IN-PLAN practice and specifically highlight the most relevant areas and case studies to the participants of the capacity building.

5.1.3 Module 3 Case Study examples

Understanding what Integrated Planning looks like in practice is key to developing the capacity of participants and over the 4 sessions run to date, diverse European cities such as Karlovac, Galway, Vienna and Tipperary have been profiled by guest speakers.

5.1.4 Module 4 Module 4: Leadership and Communication

The final module aims to take the understanding of what needs to be done to examine different strategies and how this will be communicated through leadership. This module is a lively mix of activities and interactions primarily led by the main training facilitator.

5.2 Reflections on the IN-PLAN Training Experience

Evaluations have been conducted with all participants in the capacity building process resulting in generally positive feedback. The only criticism was related to the online delivery of the training programme as an in-person exchange would be more engaging. Participants appreciate the extra time to learn, reflect and consider spatial planning and energy and climate issues in a context of integration. The idea of fostering an "integrated planning mindset" amongst all stakeholders is gaining traction but some member states expressed this more than others. For example, participants from Croatia expressed greater optimism regarding the integration of different planning spheres within their regions, whereas in Ireland, further progress is needed before this approach becomes a well-established practice.

IN-PLAN regularly welcomes two types of stakeholders in its two-step capacity-building programme: local and regional authorities, and energy, climate, or development agencies. Step 1 aims at empowering energy, climate and/or development agencies from across Europe to become IN-PLAN Multipliers. Step 2 aims at passing on knowledge to local and regional authorities, which will be tutored either by the project partners or by the trained multipliers. Local and regional authorities as well as energy, climate, and development agencies will become increasingly important to spread the connected methodologies and tools of integrated planning as they are working together with spatial planners and technical energy and climate planners.

6 CONCLUSION

The IN-PLAN project demonstrates the value of a participatory approach to integrated spatial, energy, and climate planning. By fostering collaboration across different levels of governance and disciplines, the project has contributed to embedding integrated planning processes in municipalities such as Narni and Karlovac. However, further efforts are needed to achieve broader implementation. Improving the accessibility and applicability of the IN-PLAN Practice is a key step in this direction. Translating the IN-PLAN Practice into local languages and developing an interactive online version would significantly enhance its usability, facilitating its wider adoption.

Institutionalizing integrated planning remains a central challenge, as seen in Narni, where consolidating a transdisciplinary team proved to be essential. Addressing data gaps is also crucial – municipalities need reliable knowledge frameworks to make informed decisions, particularly in the context of climate change, where large amounts of data are being generated, yet many datasets and their applications are to present relatively unknown or untested but are gradually being explored and integrated into planning processes. A key challenge in this regard is that while data availability is increasing, institutional capacities for processing and utilizing this data remain limited.

Furthermore, municipalities often struggle to implement integrated planning due to limited resources and reliance on external consultants. This highlights the importance of equipping municipal staff with the necessary expertise in integrated planning to ensure they can provide the right guidance and oversight. Additionally, integrating learning formats such as the capacity building programme into professional education could further strengthen the efforts to build long-term institutional capacity. For example, incorporating integrated planning into academic curricula in the fields of energy, planning, and climate change could help prepare future consultants and civil servants more effectively.

Experiences from Karlovac underscore the need to equip spatial planners with knowledge about the energy sector and reinforce the value of localized training modules that reflect regional planning contexts and governance structures. This can be achieved by adapting the IN-PLAN Practice to align with regional planning systems and administrative structures in different European regional contexts, as well as by making insights from municipalities that have implemented the IN-PLAN Practice widely accessible.

To ensure the long-term sustainability of the IN-PLAN project and to enhance the integration of climate adaptation, energy and mobility policies and spatial planning, national and European coalitions will be established to support policy development and provide additional resources for capacity building. Strengthening these collaborative efforts will help secure the future of integrated planning and promote its widespread adoption across municipalities.

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