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Energy planning in the urban context: challenges and perspectives

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Abstract

Cities are responsible for roughly two-thirds of global primary energy consumption, and are therefore expected to play an essential role in reaching European climate change targets. Innovative urban planning methods are in particular needed to benefit from energy efficient measures beyond the building scale. The aim of this paper is thus to explore the challenge of energy planning in cities, with the goal of providing a framework to better understand the problems and identify perspectives to tackle them.

First, the evolution of urban planning is briefly described, with a focus on its progressive widening to include energetic issues. Then, European guidelines and perspectives on the subject are highlighted based on key policy documents. Finally, a systematic framework is proposed to describe the various and complex aspects of energy planning in cities. A few practical examples from two cities are presented to illustrate possible actions in line with the problem definition and European recommendations.

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1. Introduction

In the context of the current rapid urbanization, recent trends indicate that more than a million people will be added to our cities every week until 2050. In this scenario, urbanization could reach over 80% of the global population [1]. Such a drastic increase in urban population accentuates sustainability challenges, in particular that of climate change. In order to efficiently reduce greenhouse gas emissions, cities should focus on the building sector, which represents 40% of final energy use [2]. These global changes influence cities, and thus impact urban planning.

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As Barnett [3] pointed out, "urban design and planning techniques have to change because cities and suburbs are changing. What was true about cities as recently as ten years ago is true no longer, and the process of evolution goes on." In this sense, it is expected of urban planning to undergo adaptations to address the recent urban challenges of sustainability. A growing consensus indicates that one of these adaptations is for urban planning to integrate energy planning in early stages [4][5][6][7]. Recent research shows that suitable urban forms can positively affect energy demand and production, for example by controlling urban sprawl, improving solar exposure of buildings, or promoting mixed-use districts [5][8]. However, the consideration of energy as a central aspect of urban planning is a fairly recent concept, which still lacks a proper framework and clearly defined methodologies. The authors believe that a better understanding of these frameworks and interactions between urban planning and energy issues is useful not only for the planners themselves, but also for the scientific community who may develop appropriate decision and planning support systems, or for other private actors who may benefit from related economic and social added values.

This paper thus explores the context of urban planning and energy integration. Section 2 aims to describe urban planning and its context in Europe. First, focus is given to the progressive widening of its scope to include –beyond the mere pursuit of economic efficiency– social, and more recently, environmental and energetic issues. Then, a review of the main European documents (both legal and strategic) and projects which play a role in shaping current trends in energy and urban planning is provided. In Section 3, the complex challenge of energy planning in cities is framed by viewing it as a "wicked problem". This approach offers a formal, standardized way to describe a problem which is inherently difficult to grasp. Finally, the discussion in Section 4 offers illustrations of how frontrunner cities tackle the problem and implement practical actions in the direction of integrated urban planning.

2. The widening of urban planning towards energy issues

Before discussing urban planning, a few words on planning theory may provide a useful context. According to Friedmann [9], at the most basic level, planning is the attempt to connect scientific knowledge to actions in the public domain. Methodological approaches to planning have continuously evolved, with specific concerns regarding planning models in urban planning beginning in the 1950s [10][11]. One of these approaches, *rational planning*, is believed to have played an influential part in shaping current urban planning practices. The process of rational planning was first formally described by Banfield [12] as four main steps: (a) analyze the situation, (b) establish goals,
(c) formulate possible actions, and (d) compare and evaluate consequences of actions. This model has been praised for its simplicity, adaptability, logic, and is believed to offer psychological reassurance to planners by clearly defining their role as expert advisors. Conversely, it has been criticized for the lack and difficulty of accounting for multiple stakeholder's opinions and interests, being autocratic, with a few dominating experts and little public participation.

These main critiques allowed its progression towards more participative and holistic approaches discussed in depth by Lawrence [11] and Schoenwandt [10]. Today, rational planning has essentially shifted towards *collaborative planning* [11][13][14]. This model improves on the autocratic rational approach by favoring dialogue and communication between all stakeholders, leading to consensus building, as well as to a new mediating role for planners [5][15], previously viewed as technical experts. In this general context of planning theory, we can begin to address the specific case of urban planning, and how it followed a similar trend towards a more integrative approach.

2.1. Theoretical retrospective on urban planning

The UN-Habitat report on sustainable city planning [4] makes it clear that defining urban planning is a difficult, if not an impossible task, because of its varying role, form and perception through time and around the world. Hopkins [16] nonetheless attempts to define it as follows: *"Urban planning is used loosely to refer to intentional interventions in the urban development process, usually by local government. The term "planning" thus subsumes a variety of mechanisms that are in fact quite distinct: regulation, collective choice, organizational design, market correction, citizen participation, and public sector action."* Definitions however generally avoid attributing specific

aims to urban planning, as they systematically evolve. According to Knox [17], these aims have ranged from "mythology and religion to geopolitics, military strategy, national identity, egalitarianism, public health, economic efficiency, profitability and sustainability". Though elements of sustainability and energy issues have been present in early forms of urban planning, their centrality in motivating current urban planning is fairly recent. We will discuss hereafter the progressive widening of urban planning's missions, and how such broad topics came to enter its context.

In the mid-1800s, "modern" urban planning originated in the hands of local public authority to manage sanitary and social crises [15][17]. This approach was generally top-down, expert-led, and produced master-plans and land-use regulations [4], leading to low-density, single-use districts. This was convenient up until after World War II to implement quick *urban expansion* to recover from the damage. In the following decades, urban planning's goal shifted to *urban regeneration*, where focus was rather on improving existing urban areas [18]. With rising critiques of modern *rational planning*, viewed as rigid and technocratic, developed countries shifted in the late 1900s to *strategic spatial planning* [4], which conferred cities and local actors more space to act. Strategic spatial planning identifies and gathers major stakeholders, develops long-term strategies, and is oriented towards actions and implementation in short, medium and long terms [19]. With growing complexity of urban problems, a range of urban actors tend to replace mono-oriented and linear approaches with iterative, global and spatial ones [18]. It is in this context, further influenced by variability in fossil fuels costs since the 1970s and concerns for climate change and sustainability in the 1990s [4], that energy planning issues and experts began to enter typical urban planning environments. This idea of breaking down barriers to achieve an integrated and holistic form of urban planning is further developed by Gallez and Maksim [20], who argue that urban planning aims to improve coherence in public action by transcending spatial scales (considering functional rather than administrative limits), sectoral boundaries (coordinating intersectoral policies), and new temporal boundaries (anticipating future needs, including long-term implications). The awareness rising since the 1970s regarding sustainability has converged to its widespread acceptance, and today we face the need to rethink and implement new urban planning procedures to meet these expectations. Teriman et al. [15] developed a framework for integrated and sustainable urban planning, building on the planning models discussed above. They advocate the consideration of goals from all aspects of sustainability, the participation of relevant stakeholders along both planning and implementation steps, as well the systematic assessment of the plans' and outcomes' sustainability.

The integration of energy planning in such a vast framework is however a highly complex matter. First of all, there is no common agreement on what energy planning actually represents. Many authors define it in various ways, but fail to converge towards a single definition because of the wide applications, perspectives and multi-scale aspects it involves [21]. Thery et al. [22] underline the general challenges: "*Energy planning consists in determining the optimal mix of energy sources to satisfy a given energy demand. The major difficulties of this issue lies in its multi scales aspect (temporal and geographical), but also in the necessity to take into account the quantitative (economic, technical) but also qualitative (environmental impact, social criterion) criteria*". If there is no consensus on how to define energy planning in cities, a clear consensus does seem to exist on its complex nature. Section 3 will provide a systematic methodology to attempt to address this problem.

2.2. EU framework and perspectives on energy and urban planning

The EU has contributed in guiding and harmonizing urban planning towards the more holistic, integrated and sustainable planning models presented above. If the subsidiarity principle lets cities in Europe operate as best fits their local contexts and traditions, urban planning is, to some extent at least, influenced by the European context to integrate energy issues. Two main sources of influence are EU directives, and other non-legally binding documents (Table 1). The analysis of this framework shows that there is in fact no legal competence directly defining urban and energy planning procedures. However, the documents listed below do impinge on the topic. Roughly synthetizing their main outcomes, we can observe that the EU promotes the four following aspects in urban planning regarding energy issues: (a) encouragement of public participation and societal consensus, (b) horizontal "intersectoral" coordination between disciplines and regions, (c) vertical "multi-level" coordination following the reciprocity principle between cities, regions, countries and the EU, and (d) the sustainable consumption of natural resources.

A third lever used by the EU is to support research projects and initiatives. These mainly aim at developing new methods and tools to integrate energy issues in urban planning, and to disseminate results and best practices between cities. A few notable examples which contribute to the topic are the "Covenant of Mayors" initiative, the CONCERTO initiative, soon to be continued under the "Smart Cities Information System" (SCIS) appellation, the EnSURE project, or the Reference Framework for European Sustainable Cities (RFSC).

Table 1. Key directives and documents influencing EU energy planning in cities

EU Directives	Date	Guiding documents	Date
Environmental Impact Assessments Dir. (EIA)	1985, 2011	European Spatial Development Perspective (EU Ministers for Spatial planning)	1999
Strategic Environmental Assessment Directive (SEA)	2001	Guiding Principles for Sustainable Spatial Development of the European Continent (Council of Europe)	2000
Renewable Energy Directive	2009	Leipzig Charter on Sustainable Urban Cities (EU Ministers for Urban Development)	2007
Energy Performance in Buildings Directive Recast (EPBD)	2010	White Paper on Adapting Climate Change (Commission of the European Communities)	2009
Energy Efficiency Directive	2012	Toledo Declaration (EU Ministers for Urban Development)	2010
		Barcelona Charter of European Planning, (European Council of Spatial Planners)	2013

3. Framing the problem of energy planning in cities

The complexity of energy planning in cities has been introduced through the description of urban planning in Section 2. There appears to be no single best way to address the problem of energy planning in cities, or even to merely define it. Such problems have been referred to as "wicked", a notion which has been used to discuss social and environmental problems, such as renewable energies or climate change [23][24][25]. In the scope of this paper, we shall rely on its definition to methodologically frame the problem of energy planning cities.

The expression was coined in 1973 by Rittel and Webber [26] in regard to the complex economic and social issues in planning. The authors' following quote is of particular interest: "*The kinds of problems that planners deal with – societal problems– are inherently different from the problems that scientists and perhaps some classes of engineers deal with. Planning problems are inherently wicked.*" The fact that today's planners must deal with recent energy issues on top of these societal problems only increases the relevance of our approach. A "wicked problem" is essentially characterized by the involvement of many actors with different interests, the difficulty to state the problem explicitly, and the lack of immediate or ultimate solution [24]. More specifically, a wicked problem will fit some or all of the conditions in Table 2 [23][27]. These conditions are useful to provide a better insight of the key challenges of energy planning in cities, and can help actors better understand the key issues at stake and focus their efforts. The second column of Table 2 thus identifies how these conditions might apply to energy planning. This overview is loosely based on results from [23][24][28].

Table 2. Conditions for identifying wicked problems (adapted from [23])

Condition	Application to energy planning
1. Lack of a unique problem statement *Different stakeholder perspectives result in an unclear nature of the problem.*	Multiple key stakeholders at different levels view the problem differently (architects and planners must rethink buildings and spaces; public authorities need to adapt organization and procedures; lawyers need to adapt legal and policy adaptation, etc.)
2. Conflicting objectives *Ambiguity in purpose leads to a lack of clarity about successful outcomes.*	Various valid objectives possibly conflicting on short to medium terms require prioritizing (carbon-free cities; cheap affordable energy for all; regional energy self-sufficiency; job-promoting energy system; fully renewable energy sources; etc.)
3. Conflicting values *Ambiguity in values prevents the clear assessment of outcomes.*	Urban actors will value sustainability criteria differently depending on their objective (societal benefits of clean energy opposed to the need for low investment costs, the "landlord- tenant" dilemma; top-down planning or bottom-up collaborative planning; etc.)

4. Dynamic context *Static solutions do not work well in a dynamic context.*	Energy planning in cities dependent on highly time-bound and volatile parameters (energy price fluctuation; evolving new technologies; population growth; high urbanization rates; changing political actors and agendas; etc.)
5. Scientific complexity / uncertainty *Uncertain or incomplete knowledge impedes adequate decision-making.*	Different scales and actors induce scarce, dispersed and low quality physical data, often hindered by privacy or measurability issues; vast set of technological options, constantly evolving; scientific uncertainty on consequences and intensity of climate change; etc.
6. Political complexity / uncertainty *Ambiguity in political power results in unclear prevailing values.*	No single body can take all decisions (horizontal and vertical shared responsibilities); unclear policy responses to appropriately address climate change; disagreement on estimating social costs and benefits of global warming policy; etc.
7. Administrative complexity / uncertainty *Ambiguity about budgets and procedural continuity results in inadequate implementation.*	Public investment is often low or unavailable, and private investments are difficult to guarantee; responsibilities are often defined historically, and interaction is difficult or delayed; no standard way to describe key energy information (floor area calculation, primary and final energy metrics, …), causing exchange and monitoring difficulties; etc.
8. Multiple tactics to address problems *Unclear objectives values result in lack of clarity about how best to proceed.*	No preferred optimal solution type (technological, behavioral, political, economic, …); solutions and measures are sometimes conflicting (e.g. insulating buildings may render district heating infrastructure obsolete); etc.
9. Multiple stakeholders with the power to assert their values *Multiple value sets and power structures lead to conflicting definitions of success.*	Many stakeholders have a say in urban planning and/or energy issues. Governments need to reach sustainability targets and safeguard public interest; energy providers need to make benefit; individuals need to reduce expenses; etc.

4. Case-study examples addressing energy in urban planning

A systematic assessment of solutions to the challenges listed in Table 2 is beyond the scope of this paper. Instead, a few practical examples are provided to demonstrate how such a framework could be useful for generalizing and disseminating best practices among cities. The Canton of Geneva, in Switzerland, has taken strong institutional, methodological and legislative measures addressing the challenges identified in Table 2. Administratively, the Canton regroups in one department the services Town and Country planning, as well as those of Housing and Energy policies. Energy issues and spatial planning are thus tightly gathered, facilitating horizontal coordination. Vertical coordination is enforced by the Cantonal energy law which requires relevant actors to collaborate with the Canton when dealing with energy planning, e.g. by providing energy demand and supply data. The same law requires informing the population on energy planning matters. Local spatial planning must systematically include a "territorial energy concept", which aims at promoting energy efficiency and local renewable energy. Geneva Canton also follows long-term visions, such as the 2000 Watt Society without nuclear, described in the General Energy Conception and an Energy Master Plan. In 2014, the European Energy Award as well as the European Council of Spatial Planners (ECTP-CEU) awarded the Canton of Geneva for their contributions in combining energy and urban planning described above.

With similar high sustainability ambitions, the City of Vienna adopted in 2011 a long-term framework strategy entitled Smart City Wien, which lays down the values and global objectives, i.e. reducing CO_2 emissions by sparing resource use. It recently updated its urban development plan (STEP2025), which serves as a guideline to coordinate the city's spatial issues. In particular, the document states that spatial and energy planning shall be merged into a single process at the neighborhood level. Vienna seeks therefore to partner with technical experts, companies and researchers in the fields of urban planning, energy and transport. Most energy questions and urban planning issues, such as urban development and planning, architecture and urban design, energy planning, district planning and land use, are gathered in one policy group. This allows synergies and facilitates coordination between the different sectors. Both Vienna and Geneva became signatories of the Covenant of Mayors initiative, aiming to reach or exceed the 2020 targets, by engaging all local actors in the implementation of actions.

5. Discussion and conclusion

The goal of this article was to frame the difficulties of integrating energy issues in urban planning, and identify possible ways to tackle them. A brief retrospective first emphasized the intrinsic complexity of modern urban

planning, by pointing out its requirement to meet recent sustainability goals. This implies the integration of a variety of conflicting objectives, stakeholders and interests, while considering multiple geographical and temporal scales. Merging these urban planning processes with energy planning, itself similarly complex, is thus far from trivial, and there seems to be no single optimal procedure or methodology to solve the problem. Part of the solution can be found on the EU level, which provides means to harmonize and develop urban planning towards more sustainable approaches. Another part of the solution arises from the following understanding: if the challenges are multiple and interconnected, then so should be the solutions. Drawing from the challenges outlined above, and from the different solutions proposed by the case-studies, the interconnectedness between the solutions can be better understood. What is needed is not *just* better planning procedures, reformed administrative structures, more stakeholder involvement, nor even *just* cleaner technologies or sophisticated tools. Rather, what is needed is a *combination* of interconnected solutions, which reinforce each other to tackle the issues in a comprehensive and dynamic way.

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