Conceptualising the urban transformative capacity of underprivileged neighbourhoods for realising just energy transitions

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Abstract

Positive Energy Districts (PEDs) are put forward as a building block to facilitate the transition towards climate-neutral cities and sustainable energy systems. While PEDs are pivotal for realising climate objectives, the concept is difficult to apply in existing, underprivileged neighbourhoods, because it underestimates social and political dimensions of neighbourhood energy transitions, and therefore risks to perpetuate or even exacerbate energy injustices. This research uses a spatially-sensitive approach to scrutinise energy injustices and rethink vulnerability stigmas. Drawing on the concept of urban transformative capacity, the paper develops a four-track approach focusing on collective-inclusive visioning, collective actions, institutional-community co-evolution and socio-technical innovation to foster collective agency. This framework serves as a basis for further case-study research aimed at achieving just urban transformations.

Keywords: underprivileged neighbourhoods, Positive Energy Districts, urban transformative capacity, place-based, collective agency.

1. Introduction

Transforming the energy system fairly and inclusively is a vital challenge in the face of the climate crisis. Positive Energy Districts (PEDs) are put forward to transition towards climate-neutral European cities and energy transitions. They are promoted as crucial building blocks to realise the UN Sustainable Development Goals, the European Green Deal objectives, the Mission on Carbon-Neutral and Smart Cities, and to implement the Renovation Wave

(European Commission, no date). Positive Energy Districts are defined as energy-efficient and energy-flexible urban areas or groups of connected buildings which produce net zero greenhouse gas emissions and actively manage an annual local or regional surplus production of renewable energy (JPI Urban Europe / SET Plan Action 3.2, 2020). However, this approach has predominantly been technical and infrastructural in nature, often overlooking the social and political challenges of the neighbourhoods it seeks to transform. Justice and wellbeing issues related to PEDs are missing (Truffer, Murphy and Raven, 2015), consequently, they fail to contribute to a just energy transition. This is particularly true in underprivileged neighbourhoods, where energy injustices become tangible and could be exacerbated by energy transitions, as a consequence of unequal distributions of burdens and benefits, non-inclusive decision-making processes, and a misrecognition of structural and historical inequalities (Jenkins *et al.*, 2016; Williams and Doyon, 2019).

It remains uncertain in theory as well as in practice in what ways PEDs can help achieve just transitions (Hearn, Sohre and Burger, 2021), and commonplace approaches to PEDs can even increase exclusion, energy poverty and other inequalities (Hearn, Sohre and Burger, 2021). In this paper we therefore explore the main challenges and resulting energy injustices, when dealing with energy transitions in underprivileged inner-city neighbourhoods and aim to identify a conceptual framework to foster the 'transformative capacity' of such neighbourhoods. Firstly, we theoretically explore the different injustices related to energy transitions faced in underprivileged neighbourhoods. Secondly, we argue that adopting a place-based approach is necessary to scrutinise these energy injustices and to connect energy transition strategies with a neighbourhood's socio-spatial realities. We emphasise how PED-strategies often fail in adapting their approaches to underprivileged, often dense inner-city neighbourhoods. Thirdly, we explore how fostering collective agency rather than strengthening the vulnerability stigma provides steps towards inclusive energy transitions. Fourthly, we explore how the concept of 'urban transformative capacity' can be applied to underprivileged neighbourhoods to address what we term the urban transformation paradox. We introduce this concept to emphasise how such neighbourhoods face injustices on the one hand, and display spatial, social and institutional transformative potential on the other hand. Lastly, the paper develops a four-track approach based on these dimensions of transformative potential, to foster the urban transformative capacity of underprivileged inner-city neighbourhoods, as an incentive for further case-study research.

2. Energy justice and underprivileged neighbourhoods

Energy justice addresses justice issues in energy access, use and policymaking to overcome inequality (Feenstra and Özerol, 2021). Sovacool and Dworkin (2015, p. 436) define the concept of 'energy justice' as 'a global energy system that fairly disseminates both the benefits and costs of energy services, and one that has representative and impartial energy decision-making'. Energy justice research typically deals with 'the triumvirate of tenets', including distributive justice, justice as recognition, and procedural justice (McCauley *et al.*, 2013). Respectively, these relate to fairness in the distribution of burdens and benefits, the recognition given to different socio-cultural identities, and fairness in the decision-making process (Schlosberg, 2007; Jenkins *et al.*, 2016; Bouzarovski and Simcock, 2017).

The urban poor living in underprivileged neighbourhoods are confronted with distributional, recognition and procedural energy injustices (Bouzarovski and Simcock, 2017). The socio-spatial characteristics of these neighbourhoods, such as the quality and energy efficiency of the built environment, public and collective infrastructure, demographics, income, class and

ownerships structures, social networks, cultural and behavioural factors etc., influence both the barriers and opportunities for sustainable transformation (Dietz, 2002; Boardman, 2010; Robinson, Bouzarovski and Lindley, 2018; Knox, 2019). These factors play a role in shaping the context for sustainable development initiatives. Using the concept of energy justice, the next paragraphs highlight how underprivileged neighbourhoods face disproportionate challenges in realizing an energy transition.

Distributional energy injustices are inequalities in how the burdens and benefits of energy systems and energy transitions are distributed, and therefore 'who wins and who loses from transitions' (Bouzarovski and Simcock, 2017). Distributional injustice is strongly related to socio-spatial inequalities (re)producing energy deprivation in particular spaces and social groups (Bouzarovski and Simcock, 2017; Simcock and Petrova, 2018).

As argued by Walker (2009), distributional inequalities have a spatial expression and constitution. Inhabitants of underprivileged neighbourhoods face disproportionate burdens as a consequence of enhanced energy insecurity related to the energy transition (Carley and Konisky, 2020).

Concentrations of low-income households contribute to higher levels of energy poverty in underprivileged neighbourhoods (Bouzarovski and Simcock, 2017). A low income typically serves as a fundamental factor associated with energy deprivation. However, it overlaps with several other social and political identities that may deepen the state of deprivation, such as education, race, ethnicity, religion, gender, age, class, disability and health status. The burdens of rising energy prices disproportionately affect individuals at the intersections of these characteristics (Großmann and Kahlheber, 2018; März, 2018). For instance, because energy costs represent a larger proportion of their income, these individuals are not only more vulnerable to rising energy prices, but also have limited capacity to adapt to climate change impacts, such as affording cooling systems (Knox, 2019).

Uneven distributions of economic resources intersect with material deprivation, particularly evident in underprivileged neighbourhoods characterised by low-quality housing (Bouzarovski and Simcock, 2017; März, 2018). Low-income households typically live in the worst quality housing (Boardman, 2010; Bouzarovski and Simcock, 2017). Emergency buyers[1] or (social) renters here face heightened vulnerability, lacking the financial resources to invest in energy efficiency measures or access renewables (Carley & Konisky, 2020; Vanderstraeten & Ryckewaert, 2019).

Inhabitants of underprivileged neighbourhoods often lack access to energy transition opportunities. Mainly higher incomes can utilise low-carbon and efficient technologies (Carley and Konisky, 2020), which can be explained by the high upfront costs of these technologies (Angel, 2016; Carley and Konisky, 2020). Living conditions in underprivileged neighbourhoods can restrain access to climate-friendly energy solutions as well (Carley and Konisky, 2020). The dense morphology in underprivileged neighbourhoods, limited open public space (Knox, 2019), and higher concentrations of (social) renters may limit opportunities to integrate renewable energy systems, such as photovoltaics (Middlemiss and Gillard, 2015; Knox, 2019; Derkenbaeva *et al.*, 2022).

Recognition injustice manifests itself as a failure to recognise different perspectives rooted in social, cultural, ethnic, racial, and gender differences (Jenkins *et al.*, 2016). Central to

[1] An emergency buyer is someone that purchased a lower-quality property out of necessity, lacking the financial means to invest in bringing the property to a satisfactory standard

misrecognition are cultural and institutional processes of disrespect, denigration, insult and stigmatization (Walker, 2009). The devaluation of certain groups is intertwined with and manifests itself through the misrecognition of places (Walker, 2009). Place stigmatization and misrecognition may lead to certain spaces to be chosen for development before others. As a consequence, certain places in the daily life of poor individuals, or certain ethnic groups, are neglected and poorly served (Hastings *et al.*, 2005; Hastings, 2009; Walker, 2009). Local governments' lacking willingness or ability to provide resources contribute to a non-prioritised status for energy and infrastructure development (Golubchikov and O'Sullivan, 2020), reproducing vulnerabilities of different places even more (Bouzarovski *et al.*, 2017).

For instance, in the European context, Renewable Energy Communities (RECs) have been introduced as a key tool for citizen-led energy transition (Hanke, Guyet and Feenstra, 2021). These communities enable citizens to actively engage in local and collective energy systems (Caramizaru and Uihlein, 2020; Hanke, Guyet and Feenstra, 2021). While empowering consumers to joing RECs has potential to contribute to energy justice, vulnerable consumers remain underrepresented (Hanke and Lowitzsch, 2020). Multiple studies have highlighted that these initiatives often take place in affluent communities (Goedkoop and Devine-Wright, 2016; Caramizaru and Uihlein, 2020; Hanke and Lowitzsch, 2020; Kaandorp *et al.*, 2024). Moreover, REC members are mostly middle-aged men with higher incomes and educational backgrounds (Radtke and Ohlhorst, 2021; Kaandorp *et al.*, 2024).

Injustice arises as a consequence of the limited recognition of underprivileged groups to take advantage of these kind of energy initiatives. Agenda's targeting environmental issues are prone to remain 'socially blind' and policies that stimulate the energy transition, such as incentives for renovating or the uptake of renewables, mainly benefit middle-income households. The misrecognition of the daily life of households in energy poverty widens social inequalities and may even lead to a reduced public support for climate policies (Juwet, 2020; Carrosio and De Vidovich, 2023; Fransolet and Vanhille, 2023).

Misrecognition in energy transitions also plays a role in terms of the types of knowledge and the disciplinary perspectives that are represented in transition processes. Already in the 1980s, Laura Nader sharply analysed the dominance of technical perspectives in energy transition debates, underestimating the social, behavioural and political dimensions of energy transitions (Nader, 1980, 1981, 2010). More recently, for example, Juwet and Deruytter unravelled how the implicit planning processes of the Flemish network operator, and its positioning as a 'neutral', 'apolitical', technocratic and operational actor, misrecognise the territorial and societal dimensions of infrastructure planning and energy tariff structures (Juwet and Deruytter, 2021).

Procedural injustices are a consequence of lacking public participation and deliberation (Newell and Mulvaney, 2013). Decisions regarding the allocation, utilization, and the consumption of energy for specific purposes often occur out of the public eye and seldom within democratic forums (Newell & Mulvaney, 2013). For instance, 'strategic planning exercises' leave no room for responding directly to both climate change and social justice imperatives because they occur at a scale that is too broad for local residents to identify the local impacts and their implications (Steele *et al.*, 2019). Moreover, the technocratic nature of the energy sector, characterised by secrecy and arcane technical knowledge makes public involvement even more challenging (Szulecki, 2018). As a consequence, underprivileged groups are confronted with unfair decision-making processes (Bickerstaff, Walker and Bulkeley, 2013). Decisions related to energy systems often occur 'over the heads' of marginalised groups,

exacerbating social and economic inequalities. Addressing energy injustices and holding accountable the responsible parties is often challenging because they are frequently powerful elites or multinational corporations (Newell and Mulvaney, 2013).

At the same time, and importantly, research on energy transitions itself also usually fails to involve citizens and even participatory research approaches rather focus on professional stakeholders and only involve citizens to a very limited extent (Huttunen *et al.*, 2022). Participatory action research offers interesting potential for energy transition research that aims to contribute to more just urban transitions. It places the researcher next to the practitioner as 'expert', fostering emancipatory and collaborative goals.

3. Place-based approaches to district level energy transitions

Previously we have discussed the interconnection between injustices in underprivileged neighbourhoods and energy transitions, highlighting the relationship with their socio-spatial and socio-political characteristics. This calls for a spatially-sensitive approach that enables to tailor PEDs to unique needs, aspirations and dynamics to different specific contexts.

The concept of Positive Energy Districts explicitly draws attention to the scale of the district or neighbourhood as a promising scale to realise systemic transformation of the energy system and the built environment. However, the discourse around PEDs often remains placeless and many early PED cases involved greenfield development rather than the transformation of complex, existing inner-city neighbourhoods. While a strict interpretation of PED ambitions focused on energy efficiency, renewable energy and flexibility (JPI Urban Europe / SET Plan Action 3.2, 2020) is more aligned with new-build developments, recent discussions about the PED framework challenge this limited technological perspective. In order to be able to apply the PED framework to existing urban contexts, it requires a broader view emphasizing key considerations such as governance, awareness, stakeholder ecosystems, participation, and context sensitivity (DUT, 2024)

Indeed, the specific spatial, social, cultural, historical, governance and political characteristics of a neighbourhood shape the barriers, obduracies and opportunities for transformation. Understanding this context is therefore key to develop not only more effective but also more qualitative and inclusive transition strategies and solutions. Geographers have emphasised the need to understand how transitions play out differently in different geographical, socio-political and institutional contexts (Coenen and Truffer, 2012; Bridge *et al.*, 2013; Rutherford and Coutard, 2014; Binz *et al.*, 2020). Spatial planners and designers have shown how energy system transformation is, and historically was, connected to transformations in landscape, urban morphology and spatial quality (Owens, 1986; Sijmons *et al.*, 2014; Sijmons, 2017; Asarpota and Nadin, 2020; Juwet, 2022), and have visualised how energy system transformation at the neighbourhood scale can be linked with densification, urban renewal, introducing collective infrastructures, greening or soft mobility modes (van Bolhuis *et al.*, 2016; Hubrecht *et al.*, 2020; Juwet, 2020). Moreover, our discussion on energy justice illustrates how inequalities in energy poverty or access to sustainable energy solutions are strongly connected with social and spatial neighbourhood characteristics (Bouzarovski and Simcock, 2017) such as building morphology and energy efficiency, ownership structure, demographics, public neighbourhood infrastructures, etc. Using a spatially-sensitive lens is then crucial to address 'place-based deprivation' (Robinson, Bouzarovski and Lindley, 2018). Moreover, it helps to recognise the unique realities and contexts of different areas, and to address the needs and aspirations of inhabitants of underprivileged neighbourhoods. A place-based approach may moreover

emphasise the value of local knowledge to address community-specific needs (Elmallah, Reames and Spurlock, 2022).

Context-specific dimensions of energy transitions are particularly tangible at the neighbourhood scale, where socio-spatial barriers and opportunities become visible, and where initiating transformation and developing alternative solutions requires multi-scalar collaboration between different levels of government, civil society organizations and citizens. Neighbourhood energy strategies then involve shifting power relations and new coalitions between public, private and civil society stakeholders and citizens, new energy governance and new business models (Avelino and Wittmayer, 2016; Wolfram, 2016; Köhler *et al.*, 2019). These strategies need to respond to the specific morphological, institutional, legal, social and behavioural conditions

4. From a vulnerability stigma to urban transformative capacity and collective agency

Underprivileged neighbourhoods are often characterised as 'vulnerable' and deprived of quality, agency and opportunities for change. We argue it is vital to challenge this idea of 'vulnerability' as 'inevitable' in underprivileged neighbourhoods by focusing on opportunities and capacity for transformation (Weatherill, 2023). While such neighbourhoods indeed face overwhelming challenges for transformation, overemphasizing 'vulnerability' risks to limit possibilities for transformative change and increase stigmatization. On the contrary, concepts such as 'empowerment', 'agency' or 'collective action' may allow to resist 'vulnerability' and understand transitions as transformative processes involving a disruption of current pathways, and radically altering existing urban structures, cultures and practices (Wolfram, Borgström and Farrelly, 2019).

Reframing underprivileged neighbourhoods in transitions then requires to recognise the inherently political character of transitions, involving diverging and often conflicting interests and ideas, and producing 'losers' as well as 'winners' (Coutard and Guy, 2007; Shove and Walker, 2007; Meadowcroft, 2009; Rutherford and Coutard, 2014; Healy and Barry, 2017; Köhler *et al.*, 2019; Williams and Doyon, 2019). However, energy transitions research and transition management approaches have been criticised for underestimating and obscuring these politics of transitions (Shove and Walker, 2007; Kenis, Bono and Mathijs, 2016). Sierhuis et al. (2023), voice similar concerns about PEDs as experimental hubs for renewable energy solutions and as transformation areas towards more sustainable urban futures but failing to clearly address their political dimension. In particular, Shove and Walker (2007), and Kenis et al. (2016), raise fundamental questions about whether societal transformations can be 'managed' and about the framing, legitimacy and inclusivity of transition management approaches. For example, its focus on 'frontrunners' in transitions risks to create exclusionary processes where the voice of underprivileged or non-hegemonic citizens is not heard. They call for an explicit acknowledgement of power relations, conflict and contingency as constitutive in processes of societal change (Kenis, Bono and Mathijs, 2016). From a similar 'power' perspective, Avelino and Wittmayer (2016) conceptualise transitions as involving shifting power relations between state, market, community and third sector actors. Moreover, Avelino and Rotmans distinguish different types of power in transitions and different power relations, specifying power 'over', 'more' power than, and 'different' power (Avelino and Rotmans, 2009). Adopting this perspective, and articulating the politics of transitions, allows to shift the focus away from 'vulnerability' or 'lack of capacity' or 'limited agency' to questions of power and politics; it allows excluded voices, discourses or visions from outside the hegemonic social order to be heard; and it opens up opportunities to challenge the status quo and facilitate social

transformation (Kenis, Bono and Mathijs, 2016; Mikulewicz, 2018; Sierhuis, Bertolini and Van Winden, 2023).
We argue that highlighting the potentiality, agency, and capacity of underprivileged neighbourhoods, instead of addressing 'vulnerability' as inevitable or intrinsic, is a step towards energy justice. We use 'urban transformative capacity' (UTC) (Wolfram, 2016) as a critical concept in addressing the challenges faced by underprivileged communities, positioning itself as a counterbalance to vulnerable conceptions. This approach shifts the narrative, it underscores the inherent capacities of underprivileged neighbourhoods to initiate and sustain change.

Urban transformative capacity is always and necessarily political since it strives for deep and holistic urban change, shaped by agency and interactions within certain spatial-material settings (Wolfram, Borgström and Farrelly, 2019). It is invariably marked by contestation and social struggle: the determination of which urban future will materialise is influenced by the dynamics of urban transformation (Wolfram, Borgström and Farrelly, 2019). Developing urban transformative capacity should aim to nurture and harness diversity and contestation in order to enable justice (Wolfram, Borgström and Farrelly, 2019).

Urban transformative capacity identifies what enables cities and urban stakeholders to initiate and perform transitions by identifying the required abilities to forge new system arrangements (Wolfram, 2016). Developing agency and empowerment are key for developing urban transformative capacity. Instead of an all-encompassing approach, opportunities and strategic priority interventions need to be identified. In line with our argumentation above, this implies a place-based approach. As Wolfram (2016) argues, "place strongly conditions the characteristics of e.g. social needs, communities, institutional thickness, leadership and practical experiments, while providing an essential frame for the cognitive processes related to system awareness and foresight (Wolfram, 2016, p. 129)". Therefore, the development of urban transformative capacity must depend on strategies and interactions that are specific to the place (Wolfram, Borgström and Farrelly, 2019). However, as the author underlines, it cannot be developed locally alone.

While the framework of urban transformative capacity refers to the transformative capacity of stakeholders, places and processes – both as a capacity source, and as a subject of transformation, the 'spatial' or 'place'-dimension of this transformation remains underconceptualised. By adopting a place-based approach, we can identify the types of capacities and characteristics of underprivileged neighbourhoods that can drive urban transformative change, i.e. "disrupting current pathways by deeply and radically altering existing urban structures, cultures, and practices (Wolfram et al., 2019, p. 437). Such a perspective reveals an 'urban transformation paradox': while underprivileged neighbourhoods are indeed confronted with many interrelated characteristics that complicate energy transitions, they also offer opportunities for transformation that can be linked for example with morphology, ownership structure, stakeholder landscape, spatial qualities, social networks or infrastructure projects.

5. Towards a four-track approach to urban transformation for PED's

As we have argued, addressing energy justice in PEDs requires a place-based approach which is based on identifying the transformative capacities that can cultivate inclusive opportunities for collective agency. However, while recent work has conceptually outlined the different interdependent components of what transformative capacity can entail, as well as its targeted outcomes (Wolfram, 2016; Wolfram, Borgström and Farrelly, 2019), we aim to respond here

to the need for an operational framework to address challenges of collective agency and institutional change in a place-based way. In order to do so we have developed a four-track approach to foster the urban transformative capacity of underprivileged inner-city neighbourhoods, which focuses on diverse yet interrelated components.

The proposed four tracks all respond to the outlined issues regarding energy justice and are specifically oriented at the challenges of fostering place-based transformative capacities of underprivileged neighbourhoods. Firstly, we emphasise the importance of engaging local residents as well as institutional stakeholders in collective visioning (track 1). Secondly, bottom-up actions can instigate behavioural change and tie in with everyday needs and concerns (track 2). Thirdly, this framework argues how lasting and inclusive transitions require the co-evolution between public and community stakeholders (track 3) as well as between social and technological innovations (track 4).

The tracks can be read as conceptual perspectives but also be developed into participatory methodological approaches to research collective agency in neighbourhood energy transitions. They are an incentive for further case-study research, for practical application and further operationalization. Each of these four tracks is (theoretically) elaborated below.

5.1 Collective visioning

The development and implementation of PEDs relies heavily on visions and visioning processes to inspire both policy programs and local action towards sustainable systems change and just energy futures (Kantabutra, 2020). Visioning processes can both articulate long-term goals and guiding principles for urban planning as well as align policies and stakeholders collaborations towards achieving sustainable energy futures (McPhearson, Iwaniec and Bai, 2016).

Visions can provide a framework for monitoring progress and adjusting strategies to stay on track towards realizing sustainability goals or PED targets, reflecting the specific requirement and opportunities of a particular context (Späth and Rohracher, 2010; Trutnevyte, 2014). However, visions and visioning processes can come with justice concerns when structural inequalities are not fully recognised. Therefore, they need to take into account the contextualised and unequally distributed agency of people to both act upon and change such visions. Collective and inclusive visioning processes are vital to ensure critical examination of existing transitions, in order to emphasise energy justice as a fundamental criterion and strive for equality and equity, both formal and substantive, within energy systems (McCauley *et al.*, 2013; Revez *et al.*, 2020).

Visioning processes can foster transformative capacity by translating abstract concepts of sustainable energy futures into more concrete agendas, reflecting the specific requirements and opportunities of a particular context, in terms of energy potentials, actor constellations etc. (Späth and Rohracher, 2010). Doing so, collective-inclusive visions can outline a radical departure from the current path and develop urban transformative capacity in underprivileged neighbourhoods (Wolfram, 2016). When a community shares a vision, it can give them a sense of capability, endurance, commonalty, and agreed-upon objectives (Parkhill *et al.*, 2015) and clear reasons for engaging in social action (Parkhill *et al.*, 2015). A shared vision is grounded in a sense of the common good, shared experiences, culture, and perspectives on the world and collective action (Silk, 1999).

5.2 Collective actions

The second track researches how bottom-up and collective PED actions can mobilise collective agency and behaviour change. In line with Horvath's (Horvath, 1999, p.221) definition of social action, we define bottom-up and collective PED action as the 'participation of local communities and stakeholders in PED initiatives to influence the outcome for the benefit of the people and the community. Developing participatory methods to identify and set up bottom-up and collective PED actions requires a place-based approach, as context is significant to foster collective social action (Parkhill *et al.*, 2015).

Bottom-up and collective PED actions seek to respond to the structural injustices that constrain the agency of individuals and communities in underprivileged neighbourhoods (Lennon, Dunphy and Sanvicente, 2019; Gaupp, Constantino and Pereira, 2023). They aim to empower local communities to actively participate in more meaningful and democratic low-carbon energy transitions. This can foster a sense of ownership, develop capacity, and increase responsibility among local residents (Hoffman and High-Pippert, 2010; Parkhill *et al.*, 2015). Not only does this lead to more sustainable solutions, it also garners widespread support (Musall and Kuik, 2011; Lennon, Dunphy and Sanvicente, 2019), crucial to achieving sustainable transformation towards low carbon systems (Coy *et al.*, 2021). In addition, collective participatory PED actions can mobilise behavioural change. By strengthening community engagement and social networks among neighbours, positive behaviours can spread more easily through peer influence (Gaupp, Constantino and Pereira, 2023).

Bottom-up and collective PED actions foster transformative capacity precisely by centring on inhabitants' everyday lives (Ortiz Escalante and Gutiérrez Valdivia, 2015) and focusing on meeting social needs (Wolfram, 2016). To transform sensitive living environments whilst addressing social needs, community participation, and empowerment, it is crucial to leverage commonly held community values and beliefs (Hoffman and High-Pippert, 2010), as well as connect and amplify local social and spatial assets and initiatives (Kretzmann and McKnight, 1993). This collective effort builds transformative capacity within communities towards sustainable development.

5.3 Institutional-community co-evolution

This track responds to the insight that energy transitions benefit from the co-evolution of institutional, material and relational change (Sareen and Haarstad, 2018). We argue that in order to address the complexities of equitable energy access, distribution and justice, public institutions and community stakeholders need to engage in a dynamic reciprocal relationship where both influence and permanently adapt to each other's actions and needs over time. In order for government-shaped energy policies and resource allocation to be equitable and effective, they have to be informed by the needs, experiences, and input of the communities they serve. Community stakeholders, including residents, local organizations, and advocacy groups, possess valuable knowledge about their unique energy challenges, priorities, and aspirations. By actively engaging with these stakeholders, public institutions can gain a deeper understanding of the specific issues faced in underprivileged neighbourhoods and co-create solutions that are responsive to local contexts and concerns (Burke and Stephens, 2017).

In underprivileged neighbourhoods, where energy injustices are often most pronounced, the co-evolution of public institutions and community stakeholders is particularly critical. Transition issues are frequently addressed in a fragmented manner, focussing on separate issues, without

taking into account the advantage of other agendas (Huntjens and Kemp, 2022). Energy transitions in underprivileged neighbourhoods requires the rethinking of institutional and community structure in a more integrated way. By working together, co-evolutionary partnerships can help address the intersecting challenges of (energy) poverty, environmental degradation, and social exclusion, while at the same time building more resilient and empowered communities (Baker, 2019). The co-evolution of community and public stakeholders directly respond to the imperative of procedural and recognition justice, involving the active participation, and the recognition of the voices of diverse stakeholders, eventually contributing to more distributional justice as well.

A collaborative approach to energy governance not only fosters trust and accountability between public institutions and local communities but also enhances the transformative capacity of both parties. For public institutions, it enables them to develop more inclusive and effective policies and programs to address systemic inequalities and promote social justice. By centring on the voices and experiences of marginalised communities, public institutions can better identify and dismantle barriers to energy access and affordability, increasing energy justice (Elmallah, Reames and Spurlock, 2022). Similarly, community stakeholders benefit from this co-evolution process by gaining increased influence and agency in shaping energy decision-making processes and outcomes. By actively participating in policy development, planning processes, and resource allocation, communities can advocate for their own interests and priorities, ultimately leading to more equitable and sustainable energy systems.

5.4 Social and technical innovation

Decarbonization is a multidimensional challenge that requires co-evolutionary interactions between technologies and societal groups (Geels *et al.*, 2017). As energy transitions in particular are socio-technical challenges (Geels *et al.*, 2017), we need to move beyond the dominant technology-driven conceptions of these processes (Suitner, Haider and Philipp, 2023). This track puts forward the necessity to intertwine social and technological innovation in order to overcome systemic lock-ins and to support late adopters towards positive energy district. A social innovation perspective distinguishes itself from traditional (technological) innovation through its iterative alignment with concrete societal needs, inclusive practices and its embeddedness in local capacities by creating new (social) business models, actor networks, governance modes, policy interventions or organizational entities, p. 1500). Moreover, social innovation can help to embed new practices in a specific spatial context by aligning the transition process to regional capacities (Suitner, Haider and Philipp, 2023).

Low carbon technological innovations can come with justice tensions in underprivileged neighbourhoods. The lack in access to and information on decarbonisation technologies (Sovacool et al., 2019) can lead to disparities in agency, where underprivileged inhabitants are being pushed into more passive roles (Sovacool et al., 2019). Additionally, initiatives solely focused on technological innovation overlook the reality that certain neighborhoods may not be ready to integrate these innovations into their dwellings (Halleck Vega, Van Leeuwen and Van Twillert, 2022). This oversight is compounded by the failure to recognise the need for behavioral adaptation alongside innovative technologies, further widening existing injustices, particularly among marginalised communities. It is noteworthy that individuals in energy poverty often already use energy efficiently, without innovative technologies (Paone & Bacher, 2018).

In order to strengthen transformative capacity on the neighbourhood scale, socio-technical innovation processes need to foster local agency and be embedded in a place-based institutional context. Doing so, 'opportunity spaces' for innovation can be created that build on regionally specific preconditions, temporally specific configurations of knowledge, institutions and resources, and specific local capabilities (Suitner, Haider and Philipp, 2023).

6. Conclusion

Transforming the energy system inclusively is critical in the face of the climate crisis. Positive Energy Districts (PEDs) are put forwards as a building block for climate-neutral urban transitions. In this research paper we address how applying PED approaches in underprivileged neighbourhoods requires better recognition of spatial, social and political energy transition dimensions. So far, the PED framework falls short to address the complex and interrelated injustices related to energy transition in underprivileged neighbourhoods. There is a risk that PEDs can increase exclusion of energy vulnerable people, exacerbate energy poverty, and potentially even stigmatise the energy poor (Hearn, Sohre and Burger, 2021), rather than contribute to inclusive and just energy transitions. This paper foregrounds the concept of urban transformative capacity in an effort to theorise more inclusive and just PED strategies. It proposes a four-track conceptual approach that responds to energy justice challenges in underprivileged neighbourhoods.

The concept of energy justice provides a useful lens to unravel energy transition challenges in underprivileged neighbourhoods and unravels how distributional, recognition and procedural injustices are related to socio-spatial neighbourhood characteristics. We argue in order to contribute to just transitions, PED strategies should be place-based approaches that acknowledge and leverage the socio-spatial and socio-political contexts of underprivileged neighbourhoods. We introduce the 'urban transformation paradox' as a way to challenge vulnerability stigmas by focusing on collective agency and empowerment, and by recognising social, spatial and institutional neighbourhood characteristics that offer opportunities for transformative change.

We respond to this problem statement by introducing a four-track approach to foster urban transformative capacity and address energy injustices in underprivileged neighbourhoods through different points of departure: (1) collective visioning, (2) collective actions, (3) institutional-community co-evolution and (4) socio-technical innovation. This four-track approach aims to foster the urban transformative capacity of underprivileged neighbourhoods.

Further research should translate these theoretical 'tracks' into practice in different case study neighbourhoods, as four components of fostering urban transformative capacity in underprivileged neighbourhoods. Firstly, such case study research can produce valuable insights to refine the PED framework and inform just energy transition policies. Secondly, the four tracks can also be interpreted as different methodological approaches to research and foster neighbourhood transitions in a participatory way. They can be developed into concrete participatory research methods, tested and critically evaluated in different case study contexts, and contribute to more inclusive energy transition research. Thirdly, the four-track approach can be used to co-produce, test and implement concrete governance tools for neighbourhood energy transitions, such as collective actions, new coalitions, governance structures or business models and use comparative case study research to evaluate whether and how such tools could be translated, expanded or upscaled to other neighourhood contexts.

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