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Are smart city projects catalyzing urban energy sustainability?

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ABSTRACT

The purpose of this paper is to investigate the links between smart cities and urban energy sustainability. Because achieving a "smart city" is a wide agenda rather than a specific set of interventions, smartness itself cannot easily be measured or quantifiably assessed. Instead, we understand smart cities to be a broad framework of strategies pursued by urban actors, and ask whether and how smart city projects catalyze urban energy sustainability. We use case studies of three cities (Nottingham, Stavanger, and Stockholm) funded by the Horizon 2020 Smart Cities and Communities program and examine how urban energy sustainability was advanced and realized through the smart city initiatives. We find first that while sustainability is not always a major objective of local implementation of smart city projects, the smartness agenda nevertheless increases the ambition to achieve energy sustainability targets. Second, the sustainability measures in smart cities are rarely driven by advanced technology, even though the smart city agenda is framed around such innovations. Third, there is significant sustainability potential in cross-sectoral integration, but there are unresolved challenges of accountability for and measurability of these gains.

1. Introduction

The idea of the "smart city" is increasingly central to debates on urban energy sustainability and a host of cities are now pursuing "smartness" to improve their energy efficiency, transport, and public services. Cities have been placed at the forefront of the sustainability transition and smartness is presented as a solution to urban challenges in both the global North and South. Urban smartness has become a major policy objective worldwide: e.g., one third of cities in the United Kingdom (UK) with a population of more than 100,000 have smart city ambitions, two thirds of US cities have invested in smart technology, and European governments and the European Union (EU) are both investing heavily in smart cities in Europe (Karvonen et al., 2019; Caprotti et al., 2016). The European Commission aims to facilitate one billion euros of investment in 300 smart cities by 2020 (EIP-SCC, 2018).

By integrating new technology into the management and operation of cities, smart cities are seen to offer innovative solutions to the challenges of sustainability, equity, and economic growth in cities and urban regions (Alawadhi et al., 2012; Calvillo et al., 2016; Kramers et al., 2014; Barresi and Pultrone, 2013; Rocco et al., 2013; Ramamurthy and Devadas, 2013; Neirotti et al., 2014). In other words, the smart city agenda is expected to solve a multiplicity of urban challenges – cities can increase rates of economic growth, competitiveness, and innovation while achieving sustainability goals, such as reduced emissions, increased energy efficiency, and improved quality of life (Ahvenniemi et al., 2017).

However, it is not clear how the smart city agenda contributes to sustainability. There is an increasing interest in links between smartness and sustainability (Bifulco et al., 2016). But while several studies point to the *potentials* of smart developments for increased efficiency and urban flow (Giffinger et al., 2007; Kramers et al., 2014), as well as the *discursive connection* between smartness and sustainability (Cowley and Caprotti, 2018; Trindade et al., 2017; Bifulco et al., 2016), few studies have actively engaged with the consequences for environmental concerns and urban energy sustainability as cities attempt to "go smart" (Gabrys, 2014; Martin et al., 2018). A broad bibliometric analysis conducted by de Jong et al. (2015) shows that the links between "smart city" and "sustainable city" in academic literature are relatively weak. And a review by Trindade et al. (2017) shows most of the research explores indicators, measures and tools for sustainability (i.e. Lazaroiu and Roscia, 2012; Lee et al., 2014) rather than empirical studies of implementation per se. In turn, few studies engage empirically with actually existing smart city projects (for a notable exception, see Karvonen et al., 2019). Those that do find little empirical evidence that smartness contributes to the sustainability of those cities (Yigitcanlar and Kamruzzaman, 2018). Therefore, we have limited insight into

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whether and how smartness is an appropriate agenda for cities and policy makers seeking to become more sustainable.

The purpose of this paper is to investigate the links between smart cities and urban energy sustainability. Yet in contrast to the existing literature, we see the "smart city" not as a specific set of interventions, but rather a loosely defined agenda. The agenda consists of both a technological aspect as well as a managerial side (Haarstad and Wathne, 2018; Cowley and Caprotti, 2018; Kitchin, 2014b) and can potentially include an infinite number of policies, innovations, and targets. Therefore, the appropriate analytical approach is not to attempt to measure its effects – it is more appropriate to understand smartness as a broad framing encompassing a wide range of interventions that are translated and reinterpreted by cities (Peck and Theodore, 2010; Stone, 2017). Thus, in this paper, we examine how smart city *framing* is used by local actors in cities, to answer *whether and how smart city projects catalyze urban energy sustainability*.

Taking this approach, we make significant advances on the current literature, which, as we elaborate below, tends to fall into two main camps. One is the *instrumental* camp, which highlights potentialities for specific technological solutions, but has little to say about the social integration of these solutions in cities. The other is the *critical* camp, which focuses on the socioeconomic interests and the implications of the smartness agenda itself rather than its practical application in projects. Instead, we examine the potential of the smart city framing for catalyzing sustainability by examining how it is used in specific cases.

Our empirical strategy is to use in-depth case studies of cities that have smart city status. We have conducted qualitative interviews (a total of 27), site visits and observations in three Lighthouse cities funded under the first generation of the Horizon 2020 Smart Cities and Communities (SCC) program: Stockholm, Nottingham, and Stavanger. Our interviewees were the chief project coordinators, planners, and project participants from the city municipalities, in addition to representatives of other organizations involved in the smart city initiatives. We also participated in key smart city events in the three cities.

2. Competing understandings of the smart city

The "smart" approach to urbanism and city development is debated in a sprawling body of literature and has emerged across the fields of engineering, innovation, and social science. Much of the research overlaps with related concepts such as intelligent cities, smart growth, information cities, or digitalization, and there is not necessarily a coherent literature on "smart cities" per se. Rather, the "smart city" is an umbrella concept that researchers use to discuss the use of technology in urban futures (de Jong et al., 2015). Drawing on Schaffers et al. (2011), we may say that the smartness approach has three key domains of application. First, the idea is applied in relation to an innovation economy, including interconnected business clusters involving different sectors, incubators, and research environments. Second, it is used in relation to urban infrastructures and utilities, such as transport, digital systems, and monitoring. Third, it refers to urban governance: i.e., cross-sectoral collaboration, integrated decision-making, and citizen participation (for a similar attempt at categorization, see Angelidou, 2015).

Several contributions have attempted to map and categorize the different perspectives that one can find in the literature on smart cities. For example, Meijer and Bolívar (2016) distinguish between those focusing on technology, human resources and governance aspects of the smart city, showing the technological focus to be most widespread alongside texts combining elements of the three. Similarly, Vanolo (2016) distinguishes between three categorizations of the smart city in urban studies and social sciences – firstly, a '*celebratory*' strand engaging with the smart city, analyzing and evaluating its potential positive and negative outcomes, secondly an '*always critical*' strand linking the smart city to neoliberal agendas and corporate interests and the new forms of power and control enacted through the smart city, and thirdly a newly emerging body of thought moving beyond these two to explore diverse employments of the smart city concept.

Building on the categorization by Vanolo (2016), we may point to two main strands within the smart city literature. Broadly, we see the smart city literature as divided into an *instrumentalist* strand, assessing how smart technologies can be improved and used to improve cities and a *critical strand*, fundamentally questioning the objectives of the smart city agenda.

Most of the research seems to fall into the instrumentalist category. Such instrumentalist approaches highlight the potential of information communication technology (ICT) solutions and ICT-enabled solutions to increase urban energy efficiency and improve urban infrastructure, which reduces emissions from cities (Alawadhi et al., 2012; Calvillo et al., 2016; Kramers et al., 2014; Barresi and Pultrone, 2013; Rocco et al., 2013; Ramamurthy and Devadas, 2013; Neirotti et al., 2014; Beatley and Collins, 2000). By integrating new technology into the management and operation of cities, it is widely considered that smart cities can revitalize issues of sustainability, equity, and economic growth in urban landscapes. Theorists claim that the complexity of the sustainability challenge can find its match in the complexity of ICT (Bibri and Krogstie, 2017; Kramers et al., 2014). Drawing on categories from Mitchell (1999), Kramers et al. (2014) identified five processes through which ICT solutions may reduce energy use in cities: Through processes of *dematerialization* (reducing the need for physical products such as DVDs or banks), *demobilization* (i.e., facilitating meetings online), *mass customization* (reducing resource use through streamlining adaptation, personalization, and demand management), *intelligent operation* (reducing the resources needed for various operations) and *soft transformation* (changes in the physical infrastructure because of technology and ICT advancements). Like many scholars, they outline *potential* areas where smart approaches may promote urban energy sustainability, rather than identifying clear linkages between smartness and sustainability.

In a similar vein, much of the literature describing ongoing trends points to potentials and proposes frameworks, rather than providing specific assessments of energy sustainability. This literature indicates that some isolated initiatives can yield positive sustainability effects, and it often attempts to identify areas where energy sustainability may be improved by policies to coordinate technological measures under the smart city approach (Barresi and Pultrone, 2013). For example, sustainability may be improved by promoting a triple-helix perspective (Deakin, 2014), improving smart city energy modelling (Calvillo et al., 2016), identifying hotspots (areas where cities could yield higher environmental returns from such technological investments) as loci for intervention (Kramers et al., 2014), or "gamifying" smart solutions to increase their uptake among smart city residents (Kazhamiakin et al., 2015; Di Dio et al., 2018). Others have discussed the role of governments and planners in implementing a smart city as a sustainability measure (Jepson and Edwards, 2010; Viale Pereira et al., 2017), and explored the shifting focus of smart city initiatives over time (Barresi and Pultrone, 2013; Mundoli et al., 2017a; Antrobus, 2011) and space (Neirotti et al., 2014). To understand the impacts of such developments, many question how such progress should be "monitored, understood, analyzed and planned to improve sustainability" (Bibri and Krogstie, 2017: 185).

Others have also pointed to the lack of evidence in this literature linking smartness to sustainability. Bibri and Krogstie (2017) argue that despite the vast potential of ICT in improving urban sustainability, there is "a lack of connection between smart cities and sustainable cities." Several authors have argued that the focus on isolated interventions makes it difficult to assess a coherent picture of smart city developments. Berkhout and Hertin (2004) argue that due to the pervasive effect of ICTs on economic activity, "their impacts on the environment are difficult to trace and measure." From a modelling perspective, Calvillo et al. (2016) hold that there is a need for a holistic and comprehensive smart city model, but that it is difficult to integrate all the necessary elements into a single model. In other words, despite a significant amount of research as part of what we call the instrumental perspective, it is difficult to reach definite conclusions about the conditions under which policy interventions should be used to achieve urban energy sustainability.

The other category of research is what call *critical*, which critiques the underlying premises of the smart city agenda. In this research, scholars do not focus primarily on the potential of technology or its incremental improvements, but on the socioeconomic interests and implications of the agenda itself. One criticism is that the agenda is driven by private and corporate economic interests, particularly the large companies that promote smart technologies (Hollands, 2008, 2015; McFarlane and Söderström, 2017; Viitanen and Kingston, 2014), or universalist and abstract ideas that fail to recognize the local contexts and nontechnological elements of cities (Viitanen and Kingston, 2014; Gabrys, 2014; Luque-Ayala and Marvin, 2015). Datta (2015) suggests that smartness is the new urban utopianism of the 21st century. These authors also highlight the lack of evidence that smart cities offer solutions for urban problems in areas such as social and environmental sustainability (Martin et al., 2018; Kramers et al., 2014). On the contrary, they suggest that smart agendas often prioritize economic growth agendas over environmental sustainability and promote ecological modernization rather than transformation towards sustainability (Martin et al., 2018, 2019; Mundoli et al., 2017b).

Some of this criticism is quite radical, with scholars arguing that the very approach of driving urban development through technological innovation fails to address the root causes of urban problems (Martin et al., 2018; Deakin, 2014; Hollands, 2008, 2015; Viitanen and Kingston, 2014; March, 2016; March and Ribera-Fumaz, 2016). It has even been suggested that smart city developments may exacerbate environmental sustainability challenges in cities, as well socioeconomic ones, by reducing urban problems to technical and apolitical issues and focusing primarily on issues that are solvable through ICT and technological advancements (March, 2016; Martin et al., 2018; Beatley and Collins, 2000). Intentionally or not, smart cities can be "mobilized in ways that serve to depoliticize urban redevelopment and environmental management" (March and Ribera-Fumaz, 2016: 816). Cities are also seen as using "disciplinary strategies" to impress a new moral order (Vanolo, 2014). Following such critiques, it has been argued that rather than quick technological "fixes," cities need more deep-seated transformations that address the underlying causes of urban unsustainability and inequality (March, 2016; Hollands, 2008, 2015; Viitanen and Kingston, 2014).

While some of this critique is grounded in an ideological debate, and the literature contributions are often theoretical rather than empirical, they raise some acute questions regarding the link between smartness and sustainability. In particular, they clearly articulate the problem that technological solutions may not be sufficient to meet sustainability targets and indicate that political and governance issues are important for promoting urban sustainability (Martin et al., 2018; Viitanen and Kingston, 2014). Martin et al. (2018) summarize the literature by pointing to some key tensions, which include reinforcing the growth paradigm, neglecting environmental protection, and failing to challenge consumerism.

The general message from both these strands of literature, we argue, is that the link between urban smartness and sustainability is unclear, and conditional upon perspective and point of departure. The instrumentalist strand focuses on isolated solutions and their potential for sustainability but says little about the social integration of these solutions in cities. Kitchin (2014a) held that most of the existing critical research takes more of a bird's-eye view on the sociopolitical implications of the smartness agenda and overlooks how this agenda shapes city strategies, and called for more empirical work on smart city implementation. And there are literature contributions beginning to address this, using empirical case studies to examine how smart city initiatives are unfolding on the ground (see for example Karvonen et al., 2019). These show how urban innovations are being negotiated and interpreted differently across a range of contexts. Yet even within this contextual work there has been less focus on implications for sustainability. In turn, it is difficult to draw clear lessons on whether and how smartness improves sustainability in cities.

3. Investigating the local implementation of smart city strategies

This article takes a different approach. Rather than seeing smartness as one or several specific technologies or interventions, we understand smartness to be the *framing* of particular urban interventions. In other words, we propose to assess smart cities not for what they *are*, but for what they *do* to urban development strategies in general, and to energy sustainability strategies specifically. This recognizes that being a "smart city" is not a singular agenda, so instead of attempting to analyze it as such we focus on the construction and use of the concept by actors that shape policy frameworks in cities.

There is a large literature on framing drawing upon contributions from many branches of the social sciences. A "frame" can be understood as the context or structure within which we make sense of our actions (see Benford and Snow, 2000: for a review of collective action frames). Among other topics, framing has been used to understand how the context of information influences people's attitudes towards climate change mitigation (Spence and Pidgeon, 2010) as well as sustainability aspects of energy (Van de Velde et al., 2010).

For our purposes, understanding smartness as a framing of action entails focusing on how the smart city agenda creates a context for urban sustainability interventions. This allows us to assess both the effects of smart city framing on a city's energy sustainability agenda and the ways urban-level actors reinterpret and translate the smart city agenda to the local context in which they work. The approach also affects how and where smart cities are studied. We focus on the local implementation of the smart city agenda, recognizing that this is its most specific realization. Such an approach assumes that local actors, contexts, and strategies have greater influence on the results of smart interventions, so we should strive to understand how these local variations play out as smart city strategies take form.

This localized approach does not mean that local implementation is understood in isolation from higher-level policy development. As the critical perspectives on smart city development have made clear (Hollands, 2015; Haarstad, 2016; Viitanen and Kingston, 2014), high-level institutions and actors play a significant role in shaping the smart city agenda. For example, the EU has been instrumental in setting the terms of the debate over smart city policy in Europe. Through its funding of Lighthouse cities, the Horizon 2020 SCC program, which we address through the case studies below, has put in place certain definitions and standards for what smart cities should achieve. The program defines eligible smart projects as those that demonstrate solutions on a district scale integrating smart buildings, grids, and infrastructure using ICT and renewable energy. The scalability of these solutions must be demonstrated through the testing of innovative business models and partnerships with various stakeholders within the cities as well as with follower cities in other countries (European Commission, 2016).

Thereby, smart cities are defined by the EU as oriented towards energy sustainability, mobility, new business models and partnerships, and the advanced use of big data. In other background documents and white papers, there is a strong emphasis on economic growth and technological innovation in the framing of the smart city policy discourse. Haarstad (2017) argues that the European Commission's discourse on smart cities connects it with fostering innovation and competitiveness in the emerging knowledge-based economy. This is the overarching framing, at least in Europe, that sets the parameters for smart city development. In other words, we would hold that the EU's SCC-program is of high relevance for understanding how the smart city agenda unfolds more broadly.

For the purposes of this article, the key issue is how this agenda is implemented and practiced on the ground and through the actors involved. The local room for maneuver in these projects is greater than smart city critics often assume (see Haarstad and Wathne, 2018). Even though the framing by Horizon 2020 is quite specific about the criteria for a smart city, there will always be opportunities for local actors to interpret and convert this framing during implementation. Put

Table 1
Overview of Lighthouse projects in the three case cities.

	Stavanger	Nottingham	Stockholm
H2020 Projects	Triangulum	REMOURBAN	GrowSmarter
Other Lighthouse cities (follower cities)	Eindhoven, Manchester (Leipzig, Prague, and Sabadell)	Tepebasi, Valladolid (Seraing and Miskolc)	Barcelona, Cologne (Graz, Porto, Suceava, Cork, and Valetta)
Demonstration area(s)	Hinna, Stavanger city center	Sneinton	Slakthus and Årstad
EU contribution	EUR 25,420,000	EUR 21,542,000	EUR 24,821,000
Main energy interventions	Building a new energy center based on a minimum of 75% renewable energy sources to supply three of Stavanger Municipality's administrative buildings with energy. Testing systems for energy management and innovative video solutions in private homes and public buildings.	Intensive retrofitting in Sneinton to achieve a low energy district. Extending existing district heating network with 4700 homes, combined with solar thermal installation. Fitting photovoltaic systems.	Efficient and smart climate shell refurbishment in Valla, including reducing hot water losses and waste water heat. Smart building logistics integrating multimodal transport for construction materials. Energy management systems integrated into retrofitted houses, including CO_2 signals
Contextual rationale	Regional innovation, competitiveness.	Advancing existing priorities in transportation and energy innovation.	Environmental profile, sustainable growth.
Dominant smart city vision	Economic sustainability fostered by knowledge intensive industries and innovation.	Socioenvironmental sustainability.	Sustainable urban growth.

differently, the high-level framing of urban smartness is negotiated in the cities that take on these projects. As research in other areas has emphasized, cities and urban actors act strategically in relation to discourses and policy prescriptions from above (Grandin et al., 2018). It should not be assumed that cities are passive receivers of smart city prescriptions.

To the contrary, we argue that analysis must accept the possibility that urban actors actively engage with the smart city framing during implementation and practice. As the literature on policy transfer and policy mobility make clear, the "localization" of policies from "above" is never an unmediated process – it involves interpretation and misinterpretation, mutation and resistance (Peck and Theodore, 2010; Stone, 2017). In light of these insights, the Horizon 2020 smart city concept should not be expected to be *adopted* by Lighthouse cities, it will rather be reinterpreted and incorporated into local "bricolages" of pre-existing policies, discourses, interests and infrastructures. And local actors are key in this process. They are faced not only with pressures to be smart, they also have to balance a host of overlapping and competing concerns, and they actively negotiate between these to shape the priorities of their cities (Robinson, 2015).

Therefore, since local actors have a large room for maneuver during implementation and translation, the smart city agenda should be understood as a *means* to achieve urban change, rather than as a *goal* in itself. The smart city can be employed locally to promote a variety of agendas and pursue a variety of goals. To understand the relationship between this framing on the one hand and urban sustainability on the other, we need to examine smart cities "on the ground" and to explore the ways in which the smart city agenda is used to reshape conditions for action at the local level. The potential of the smart city as an agent for urban sustainability depends on how it enables the specific sustainability strategies of cities.

3.1. Methodology

To understand the local application of smart city framing, we conducted case studies of three Lighthouse cities funded under the first generation of the Horizon 2020 SCC program: Stockholm, Nottingham, and Stavanger. The methodology and fieldwork consisted of in-depth interviews, observations, and document analyses. We interviewed a total of 27 informants across the three cities. The interviewees were planners and project participants from the city municipalities, as well as representatives of other organizations involved in the smart city initiatives. The interviewees in each city included the chief project coordinators. We also participated in relevant smart city events in the three cities: the Nordic Edge Expo in Stavanger (2015–2018), the LEVEL conference on electric vehicle charging point infrastructure in Nottingham (2017), and a demonstration event at Valla Torg, Stockholm städ (2018). Several demonstrations by informants of the smart city initiatives (participant observation), as well as seminars and meetings on the smart projects also formed part of our research. In addition, we analyzed strategic documents of the city projects.

4. Smart cities on the ground: Nottingham, Stockholm, and Stavanger

The EU began launching smart city initiatives in 2012, with the European Innovation Partnership on SCC. The objectives were to stimulate knowledge-based economic competitiveness, as well as to improve the quality of life of Europe's urbanizing population (Haarstad, 2017). The first generation of Horizon 2020 SCC program in 2015 included three projects, each containing three Lighthouse cities and several "follower" cities. The duration of the projects was five years, with approximately 20–25 million euros in funding for each. Nottingham, together with Lighthouse cities Valladolid and Tepebasi, comprise the project network of REMOURBAN. Stavanger is part of the Triangulum network, together with Eindhoven and Manchester (UK), and Stockholm is part of the GrowSmarter network, also encompassing Cologne and Barcelona (see Table 1).

The overarching project profiles appeared to be fairly similar in all three smart cities, with minor contextual differences. In line with the SCC program, all Lighthouse cities developed solutions in the areas of energy, ICT, and mobility. Energy initiatives in the three cities typically involved retrofitting buildings and reducing waste from water, stores, and building mass.

For Nottingham's part, the main focus of the energy strand of the project was retrofitting buildings to increase energy efficiency, coupled with the expansion of a low-temperature district heating network, enabling Nottingham to "cope with climate change and build resilience to external energy price pressures" (Remourban, n.d.). Most of the houses chosen for this retrofitting were old apartment buildings with poor building structures, which would have had to be either improved or torn down regardless of the REMOURBAN project and accompanying funding. These were houses where marginalized social groups were residing. The retrofitting thus both addressed energy consumption and energy poverty (environmental and social sustainability).

Similarly, Stockholm's energy strand of the project also focused heavily on retrofitting, involving 300 high-rise building apartments in the Årstad area. By installing more energy-efficient solutions for water usage, heating, and lighting, the project aimed to reduce emissions and upgrade living standards in public housing apartments. The renovations

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also included digital solutions for home energy management and visualization of energy consumption to alter citizen behavior patterns (GrowSmarter, n.d.).

In Stavanger, the energy strand of the project looked different from those in the other cities. Without major issues with poor building structures and energy loss from building mass, the energy strand there focused on securing renewable energy sources for municipal buildings, as well as integrating smart solutions into private homes to make consumers more conscious energy consumers. A major part of the project involved building a renewable energy plant for three municipal buildings, using a minimum of 75% renewable energy sources to provide municipal office buildings with power (Triangulum, n.d.; Stavanger Municipality, 2017). In private homes, energy usage was connected to a digital wall panel and a smartphone app; therefore, residents were given the opportunity to make more conscious choices about their energy use. However, as one informant stated, the initiative was not expected to yield reductions in energy usage. Electricity in Stavanger was fairly cheap and living standards high; therefore, it was expected that when residents had greater control over their electricity use, residents would choose comfort over cost and increase their electricity usage. However, it is known that new technology to reduce ecological impact can often have the opposite effect (Carvalho, 2015).

While the projects may appear relatively similar across the three cities, they vary greatly in motivation, design, and implementation. All the following facets of the projects were greatly influenced by the local context:

Nottingham, with a history as a successful testing ground for innovations in the transport and energy sectors, sought to strengthen this image through the smart city program. Combining these priority areas for urban development with planned revitalization projects for the city, such as the upgrading of poor housing, made it possible to kill two birds with one stone. The project has a clear social aspect because it is intended to improve living conditions for some of the most disadvantaged groups in the city through reduced energy loss from housing and reduced energy prices.

In Stockholm, the smart city agenda became embedded in a strong tradition of climate and environmental policy. As a capital city with high socioeconomic standards and a brand as one of Europe's most environmentally friendly cities, Stockholm sought to use the smart city agenda to maintain quality of life and its environmental profile in a rapidly growing city. In contrast to the other two cases, the branding of Stockholm's smart city project had a clear goal of sustainability.

In Stavanger, which is known as Norway's “oil city,” the smart city agenda was largely seen as filling a void left by the declining oil industry, and they were to ensure that Stavanger had “more than one leg to stand on” in its industrial future. Here the smart city agenda was focused heavily on facilitating the emergence of new technology entrepreneurs, many of them branching off from the oil sector. Capitalizing on its Horizon 2020 smart city project, Stavanger sought to rebrand itself as the leading smart city in the Nordic countries.

Just like the local contexts in which the smart city projects were embedded, the priorities and outcomes of the projects varied. The smart city agenda in Nottingham was largely concerned with social sustainability. It used various resources from the Horizon 2020 project to renew public housing, often by surprisingly low-tech means. In attempting to prepare for a post-oil future, Stavanger emphasized local innovation, entrepreneurship, and economic competitiveness. Stockholm's smart city project was led by the environmental section of the municipality and selected interventions consistent with its long-term goal of becoming carbon-neutral. “Sustainable urban growth” permeated the branding of the project (Stockholm städ, 2018) and the city aimed to improve urban flow and life whilst simultaneously cutting carbon emissions by 60%. This was sought through improvement of waste handling and waste heat recovery in both public and private areas. Such initiatives were coupled with attempts to alter citizen behavior through smart home systems allowing tenants to regulate their own energy usage.

The three city cases share a common framing in the overarching smart city agenda, emphasizing technological solutions in urban development, and in the specific parameters set by the Horizon 2020 SCC program. Bound by this framework, the case projects have clear similarities. They all offer solutions that are implemented on a district scale, integrating buildings, grids, and infrastructure using ICT and renewable energy. They all emphasize scalable solutions and promising potentials for reduction of CO_2 emissions. However, seen from a local perspective, the framing also allows wide room for maneuver. Local actors use the smart city framing to conduct projects that existed well before the smart city projects were realized and are not necessarily dependent upon advanced technology. The smart city framing provides resources for preexisting local projects and initiatives. As we explain in the following section, we find little evidence of blueprint implementation or a technology-driven agenda.

4.1. Smart urban sustainability in the three cases

From our case studies in the three Lighthouse cities, we find that smart agendas are to a significant extent adapted to local priorities and concerns. Therefore, the relationship between what is smart and what is sustainable is largely dependent upon the local context. This section explores how the smart agenda can promote urban sustainability, and we draw three main conclusions about its potential to do so: (1) While the potential of the smart city depends on how it is contextualized locally, *a high-level agenda can push for sustainability achievements in cities*. (2) Even though the smart city agenda is framed around technology, the sustainability-related measures in smart cities are *rarely driven by advanced technology*. (3) There is significant sustainability potential in cross-sectoral integration, but there are also unresolved challenges of accountability and measurability.

4.1.1. Smart sustainability is prescribed locally, yet a high-level agenda matters

As the smart cities visited for this study and their areas of focus and main priorities show, the direction a smart city project takes is contingent on preexisting local factors. These factors can be both institutionalized (e.g., preexisting plans, approved budgets, priority areas), and noninstitutionalized (e.g., the people who assume responsibilities within the project and their personal attributes, such as affiliations and learned smart ideas). Many of these were plans and practices that had developed over long periods of time and had been integrated into the smart city framework as part of the cities' applications to become Lighthouses.

An example of this incorporation of preexisting plans is seen in the case of retrofitting homes in Nottingham: dealing with these houses in one way or another was the next step planned by Nottingham City Council (according to interviews with planning officials). Integrating the retrofitting into the smart city agenda was an easy way to combine the planned project with an investment in smart city development. “[Renovating the houses] was something that we were going to do anyway,” said a representative for the Nottingham City Homes, adding that if nothing were done, the houses would ultimately have to be torn down. The EU also promoted the integration of already planned and budgeted elements into the smart project proposals, thus facilitating institutionalized local negotiations. Several non-institutionalized factors also informed local negotiations of the smart agenda. This was perhaps most evident in the types of departments and people that were given responsibilities in the projects and their connections to ideas and networks. For example, the site manager of the Lighthouse project in Stockholm was trained in environmental protection and was primarily concerned with social and ecological issues. In comparison, the two key people involved in the Stavanger smart city were an architect from the city planning division and a person who had a background in technical college and innovation. It was apparent that these seemingly minor factors shaped the emphasis of the smart city projects in practice.

Even when projects were prescribed locally, we see that when such negotiated smart cities were formulated according to broader ideas of sustainability, the cities were able to access funding and other resources that heightened the ambitions of the smart agenda. Stockholm included the retrofitting of 400 high-rise building apartments as part of the energy strand of the smart agenda of the city. EU funding added to the city council's budget allowed more ambitious retrofitting than the initial plans. Having calculated that a 50% reduction of energy consumption from the apartments would be an economically viable goal, the additional funding received through the EU enabled an increase of this goal to a 70% energy reduction. As the local site manager said:

In terms of cost, a halving of energy consumption had been profitable without any contribution. […] We are now talking about 70% reduction … So, the last 20% gets very expensive.

The smart agenda of Stockholm, resonating with wider ideas of sustainability and innovation in the EU program, triggered additional funding from the EU, allowing the aspirations for the project to be raised.

Similarly, in Nottingham, additional EU funding made it possible to expand the local district heating scheme to include the demonstration area of Sneinton. Nottingham has the oldest and one of the largest district heating schemes in the UK, but this had mostly been employed in the west of Nottingham. It was relatively easily expandable by connecting it to gas tanks near the pipeline, and the REMOURBAN took this opportunity in the Sneinton district. Thus, the project built on local preconditions and plans, and used EU funding to draw on these to obtain the development considered most suitable by local stakeholders.

4.1.2. Smart sustainability interventions are not necessarily high tech

Smartness is typically associated with advanced technological innovation. However, in our case cities, we found that these solutions were rarely driven by cutting-edge technologies or advanced technological innovation per se. Innovation was certainly important. However, requirements for high levels of innovation can be overcome by quite incremental advances, as Stavanger found in its project. To gain Horizon 2020 funding for smart investments in the city, the Lighthouse cities were required to demonstrate innovative first-of-a-kind solutions. Thus, if a smart initiative did not have an element of innovativeness, it would not comply with the project requirements. When they included the roll-out of electric buses, as part of their smart city agenda, Stavanger municipality employees were concerned about failing to meet EU requirements for innovation, as electric buses in themselves are no longer particularly innovative. However, as the buses needed double-glazed windows owing to the Nordic climate, the EV buses had an innovative edge, and were accepted as innovative by the EU requirements (interview).

Other smart initiatives also demonstrated the relative simplicity of the smart innovations. As mentioned above, all of the Lighthouse projects included the retrofitting of buildings. This was mostly mere building adjustments to existing buildings, with the addition of incremental innovations in the process. In Stavanger, the retrofitting included the integration of smart wall panels with the ability to display various forms of information that could help improve urban flows, increase livability, and promote sustainable lifestyles. One goal was to integrate real-time data on weather and transport into such panels; thus, citizens could make informed choices on the routes and modes of transportation they used for their daily commutes and leisure trips. Such innovations are not necessarily radical, nor do they in themselves reduce emissions greatly. However, the projects assume that even incremental innovations can potentially affect behavior and social practice. For example, during demonstrations of the Stockholm project, the panels showing electricity consumption were projected to make consumers more aware of their consumption levels and thereby likely to reduce consumption through nudging. They do not primarily constitute a radical technological innovation, but rather an incremental socio-behavioral innovation.

In general, then, when examined “on the ground,” smart projects are not necessarily highly technological or radically innovative (Fernandez-Anez et al. (2018) make a similar point with regard to Vienna). Rather, they draw on existing and often quite basic technology or organizational innovations to create apparently minor changes. We can simultaneously rule out the potential outcome of such changes in catalyzing wider changes in urban systems, although these are difficult to measure, which is our final point.

4.1.3. There is significant sustainability potential in cross-sectoral integration, but unresolved challenges of accountability and measurability

The sustainability effects of smart approaches are not always easily identifiable and measurable, as seen from the literature seeking a link between the two. However, based on our case studies, we conclude that this difficulty may stem from processes intrinsic to the very nature of smart city initiatives. More explicitly, the integrated nature of the smart city approach to urban planning might make it difficult to single out and measure certain elements and objectives of a smart city.

The organizational side of the smart city agenda is to promote an integrated approach towards urban planning, breaking down silos, crossing barriers, and working dynamically and reflexively to address various urban challenges. Such integration is seen as essential for the successful adaptation of a smart city in the literature (Bibri and Krogstie, 2017), in the framing of the EU SCC program, and by many of the informants in the three case cities. In Nottingham, a city council representative stated her belief that:

If we had not been a part of this project, [urban developments] would have been very separate, very segregated. The transport team would be doing their thing, the energy team would be doing their thing, housing would be doing their thing, and you wouldn't be getting the coordinated overview over what difference it makes to do all of this together.

An informant from the Stockholm energy company Stokab also highlighted the integral role of coordination in smart projects. In Stockholm, all fiber-based solutions were integrated into one common fiber network managed by a daughter company of Stokab called *ST Erik* to avoid duplication of services and data collection. Taking over services commonly managed by external companies prior to the smart initiative, the common fiber network now incorporated Internet cables and wires for lighting and ventilation in addition to city functions such as public cameras, locks, and the operation of bridges and traffic signals. The smart agenda was the motivation for joining these services. “Rather than laying cables next to each other, you share them,” the Stokab informant explained, arguing that this would simplify the collection and common use of big data in addition to reducing the number of duplicate datasets produced by different actors as all data communication was via the same network.

Thus, the interconnection of services, management and organization is a vital aspect of the smart city agenda. However, this interconnection may also create difficulties in identifying and measuring the outcomes of specific smart interventions or the goals achieved in specific target areas. Qualities such as sustainability are rendered hard to observe and measure in isolation because there is no longer one strand of a project, but rather projects implemented across many smart initiatives. This may be the reason for the smart city agenda in Stockholm being described as hard to label a success or a failure, as the program manager wrote in a blog post:

When we look at the first set of evaluation data collected, we can see promising results, no results at all and negative results at the same time. In many cases, we simply do not have enough data to give an accurate answer. Also in many cases the systems have not been fully optimized and/or are running on partial capacity, so it is too early to determine whether they are working well (Hakosalo, 2018).

Across the cases, interviewees say that they seek clearer measurements and data to evaluate the achievements of the projects. Despite smart cities being described as abundant with data, it is problematic to identify parameters for sustainability per se. At the same time, the sustainability achievement of smartness may lie within the more complex processes of integration, connectivity and synergies that are hard to measure.

For example, one of the smart initiatives in Stavanger was "Blink," an electronic health service by which residents could communicate with medical personnel through an application connected to their television. Although it was not implemented as a sustainability measure per se, the implementation promoted more sustainable lifestyles by reducing the need for urban transport required for trips to the doctor. This was highlighted by the Stavanger municipality when they described the smart video and video-enabled solutions that formed part of their smart agenda:

Reducing demand for travel to meetings or medical consultations can make a difference. In addition, increased telecommuting may reduce carbon-emitting mobility, and the energy and time consumed during transport. Thus, the impact of innovative video would also fall within the realm of energy and transportation (Stavanger Municipality, 2017).

In organizational terms, smart reorganization serves to weave sustainability interventions into other sectors. While the state-mandated Climate and Energy Action Plans were assigned to one low-resourced department, a smart city office was established directly under the Mayor. The job of its "Smart City Czar" is to coordinate smart action across the city departments (interview with the head of Stavanger smart city section). He described his job as to identify synergies and improve the usability of big data both outside and inside the municipality. However, he argued that the integration could also facilitate "pushes" towards more sustainable projects and processes. This can be seen as a way of mainstreaming urban smartness and its sustainability potential, but it may serve equally well to diffuse responsibilities for climate action.

In turn, smartness embeds sustainability in cross-sectorial policies, which makes them difficult to account for and measure. It has been pointed out by others that measuring sustainability involves complex epistemological challenges (Miller, 2005; Boyko et al., 2012). In smart cities as well, numbers properly capturing the sustainability achievements may be evasive. Cross-sectorial integration may lead to significant sustainability achievements across sectors. At the same time, such integration may also cause sustainability concerns to fall between the cracks in existing governance structures. With no climate division or city council employees designated to work on these issues, implementation of policies may have modest impact. From this, we argue that interweaving sustainability into the smart agenda is potent, but it has potential pitfalls. It may lead to cross-sectorial integration of sustainability into all fields of urban development, but it also has the potential to obscure sustainability efforts as they are blended in to a wider agenda driven by other local concerns. This interweaving of climate goals into wider urban development requires new approaches by researchers exploring the sustainability of smart measures.

5. Conclusions and policy implications

In this paper we advance understanding of the links between smart city initiatives on the one hand and sustainability on the other: Do smart city projects catalyze urban energy sustainability? We argue that we need to analyze smartness as a frame for action that is employed and negotiated locally by actors seeking to promote sustainability alongside other policy objectives. This contributes significantly to the existing literature related to smart cities and sustainability, which tends to fall into two main categories. The *instrumental* literature has little to say about the social integration of smart solutions into cities, while the *critical* literature addresses socioeconomic interests and implications of the smartness agenda rather than how it is applied in actual projects. Our empirical contribution is to shed light on the sustainability potential for smart city solutions by examining their implementation in specific cases. The article has provided an empirical examination of three Lighthouse cities funded by the Horizon 2020 SCC program. In each of the cases we considered how urban energy sustainability was promoted through the smart city projects.

The overarching conclusions we draw from our study are threefold. First, while sustainability is not always a major objective of local implementation of smart city, the smartness agenda nevertheless increases levels of ambition in energy sustainability targets. Second, the sustainability-related measures in smart cities are rarely driven by advanced technology, even though the smart city agenda is framed around such innovations. Third, there is significant sustainability potential in cross-sectoral integration, but there are unresolved challenges of accountability for and measurability of these gains. As the third conclusion underlines, the sustainability effects of a smart city are difficult to isolate and measure, because of processes intrinsic to the smart city itself. When a smart city project aims to integrate solutions, processes and actors and counter inefficiencies associated with silo-oriented organization, it becomes nearly impossible to measure energy sustainability as a discrete target. In smart city initiatives, sustainability becomes interwoven into a set of other goals and agendas, all interfering with and influencing each other, creating possible feedback loops and unpredictable outcomes. The level to which sustainability is evident in this smart city fabric seems to be influenced not only by institutionalized factors such as preexisting plans and budgets as well as requirements in the Horizon 2020 SCC program, but also by non-institutionalized factors, with perhaps most noteworthy factor being the unpredictability of the people and departments that eventually assume leadership in the smart projects. Arguably, the sustainability outcomes also depend on citizens' uptake of the smart agendas, and may involve continuance and worsening of existing habits.

Whereas the effects of traditional climate planning were more easily measurable by traditional means (output from transportation and energy use of buildings), the sustainability effects of smart cities are more ambiguous. The way we understand and measure energy sustainability in a smart city needs reconsideration. We have suggested that sustainability profiles are influenced largely by preexisting plans, budgets, and EU requirements, as well by as the people and departments who assume responsibility for the smart agendas in the cities. At the urban level, the smart city agenda is still at an early stage. Rapid technological development, uptake and upscaling is likely to shape further developments and the embeddedness of smart city sustainability. One may expect the integration of services and the development of big data to lead to sustainable solutions of yet unknown scope. Simultaneously, such city developments may obscure sustainability issues and disguise smart measures to promote economic growth and innovation as energy sustainability measures. By and large, these outcomes are highly contingent, and to a significant extent determined by the implementation of the smart city agenda by policy makers on the ground.

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References

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., et al., 2017. What are the differences between sustainable and smart cities? Cities 60, 234–245.
Alawadhi, S., Aldama-Nalda, A., Chourabi, H., et al., 2012. Building understanding of smart city initiatives. In: Scholl, H.J., Janssen, M., Wimmer, M.A. (Eds.), Electronic Government: 11th IFIP WG 8.5 International Conference, EGOV 2012, Kristiansand, Norway, September 3-6, 2012. Proceedings. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 40–53.
Angelidou, M., 2015. Smart cities: a conjuncture of four forces. Cities 47, 95–106.
Antrobus, D., 2011. Smart green cities: from modernization to resilience? Urban Res. Pract. 4, 207–214.
Barresi, A., Pultrone, G., 2013. European strategies for smarter cities. TeMA J. Land Use 6, 61–72.

Beatley, T., Collins, R., 2000. Smart growth and beyond: transitioning to a sustainable society.(managing growth in the twenty-first century: philosophies, strategies, institutions.). Va. Environ. Law J. 19, 287–322.
Benford, R.D., Snow, D.A., 2000. Framing processes and social movements: an overview and assessment. Annu. Rev. Sociol. 26, 611–639.
Berkhout, F., Hertin, J., 2004. De-materialising and re-materialising: digital technologies and the environment. Futures 36, 903–920.
Bibri, S.E., Krogstie, J., 2017. Smart sustainable cities of the future: an extensive interdisciplinary literature review. Sustain. Cities Soc. 31, 183–212.
Bifulco, F., Tregua, M., Amitrano, C.C., et al., 2016. ICT and sustainability in smart cities management. Int. J. Public Sect. Manag. 29, 132–147.
Boyko, C.T., Gaterell, M.R., Barber, A.R.G., et al., 2012. Benchmarking sustainability in cities: the role of indicators and future scenarios. Glob. Environ. Chang. 22.
Calvillo, C.F., Sánchez-Miralles, A., Villar, J., 2016. Energy management and planning in smart cities. Renew. Sustain. Energy Rev. 55, 273–287.
Caprotti, F., Cowley, R., Flynn, A., et al., 2016. Smart-eco Cities in the UK: Trends and City Profiles 2016. Exeter: University of Exeter (SMART-ECO Project).
Carvalho, L., 2015. Smart cities from scratch? A socio-technical perspective. Camb. J. Reg. Econ. Soc. 8, 43–60.
Cowley, R., Caprotti, F., 2018. Smart City as Anti-planning in the UK. Environment and Planning D: Society and Space.
Datta, A., 2015. New urban utopias of postcolonial India:'Entrepreneurial urbanization' in Dholera smart city, Gujarat. Dialogues Human Geogr. 5, 3–22.
de Jong, M., Joss, S., Schraven, D., et al., 2015. Sustainable–smart–resilient–low carbon–eco–knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. J. Clean. Prod. 109, 25–38.
Deakin, M., 2014. Smart cities: the state-of-the-art and governance challenge. J. Univ. Ind. Gov. Innov. Entrep. 1, 1–16.
Di Dio, S., La Gennusa, M., Peri, G., et al., 2018. Involving people in the building up of smart and sustainable cities: how to influence commuters' behaviors through a mobile app game. Sustain. Cities Soc. 42, 325–336.
EIP-SCC, 2018. General Assembly 2018 Summary Report. European Innovation Partnership on Smart Cities and Communities, Sofia, Bulgaria.
European Commission, 2016. Horizon 2020 - Work Programme 2016 - 2017. European Commission European Commission Decision C (2016) 4614 of 25 July 2016. [Internet] Available from: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-focus_en.pdf, Accessed date: 8 September 2017.
Fernandez-Anez, V., Fernández-Güell, J.M., Giffinger, R., 2018. Smart City implementation and discourses: an integrated conceptual model. The case of Vienna. Cities 78, 4–16.
Gabrys, J., 2014. Programming environments: environmentality and citizen sensing in the smart city. Environ. Plan. D Soc. Space 32, 30–48.
Giffinger, R., Fertner, C., Kramar, H., et al., 2007. City-ranking of European Medium-Sized Cities.
Grandin, J., Haarstad, H., Kjærås, K., et al., 2018. The politics of rapid urban transformation. Curr. Opin. Environ. Sustain. 31, 16–22.
GrowSmarter. (n.d.) Lighthouse City: Stockholm.
Haarstad, H., 2016. Where are urban energy transitions governed? Conceptualizing the complex governance arrangements for low-carbon mobility in Europe. Cities 54, 4–10.
Haarstad, H., 2017. Constructing the sustainable city: examining the role of sustainability in the 'smart city' discourse. J. Environ. Policy Plan. 19, 423–437.
Haarstad, H., Wathne, M.W., 2018. Smart cities as strategic actors: insights from EU Lighthouse projects in Stavanger, Stockholm, and Nottingham. In: Karvonen, A., Cugurullo, F., Caprotti, F. (Eds.), Inside Smart Cities: Place, Politics and Urban Innovation. Routledge.
Hakosalo, M., 2018. Stockholm Blog #9: looking at first evaluation results. In: GrowSmarter. GrowSmarter [Internet] Available from: http://www.grow-smarter.eu/inform/blog-updates/blog-archive/?c=search&keyword=stockholm_blog, Accessed date: August 2018.
Hollands, R.G., 2008. Will the real smart city please stand up?: intelligent, progressive or entrepreneurial? City 12, 303–320.
Hollands, R.G., 2015. Critical interventions into the corporate smart city. Camb. J. Reg. Econ. Soc. 8, 61–77.
Jepson, E.J., Edwards, M.M., 2010. How possible is sustainable urban development? An analysis of planners' perceptions about new urbanism, smart growth and the ecological city. Plann. Pract. Res. 25, 417–437.
Karvonen, A., Cugurullo, F., Caprotti, F., 2019. Inside Smart Cities: Place, Politics and Urban Innovation. Routledge, London.
Kazhamiakin, R., Marconi, A., Perillo, M., et al., 2015. Using Gamification to Incentivize Sustainable Urban Mobility.
Kitchin, R., 2014a. Making sense of smart cities: addressing present shortcomings. Camb. J. Reg. Econ. Soc. 8, 131–136.
Kitchin, R., 2014b. The real-time city? Big data and smart urbanism. Geojournal 79, 1–14.
Kramers, A., Höjer, M., Lövehagen, N., et al., 2014. Smart sustainable cities – exploring ICT solutions for reduced energy use in cities. Environ. Model. Softw. 56, 52–62.
Lazaroiu, G.C., Roscia, M., 2012. Definition methodology for the smart cities model. Energy 47, 326–332.
Lee, J.H., Hancock, M.G., Hu, M.-C., 2014. Towards an effective framework for building smart cities: lessons from Seoul and San Francisco. Technol. Forecast. Soc. Change 89, 80–99.
Luque-Ayala, A., Marvin, S., 2015. Developing a critical understanding of smart urbanism? Urban Stud. 52, 2105–2116.
March, H., 2016. The smart city and other ICT-led techno-imaginaries: any room for dialogue with degrowth? J. Clean. Prod. 197, 1694–1703.
March, H., Ribera-Fumaz, R., 2016. Smart contradictions: the politics of making Barcelona a Self-sufficient city. Eur. Urban Reg. Stud. 23, 816–830.
Martin, C., Evans, J., Karvonen, A., et al., 2019. Smart-sustainability: a new urban fix? Sustain. Cities Soc. 45, 640–648.
Martin, C.J., Evans, J., Karvonen, A., 2018. Smart and sustainable?: five tensions in the visions and practices of the smart-sustainable city in Europe and North America. Technol. Forecast. Soc. Change 133, 269–278.
McFarlane, C., Söderström, O., 2017. On Alternative Smart Cities: from a Technology-Intensive to a Knowledge-Intensive Smart Urbanism. City. pp. 1–17.
Meijer, A., Bolívar, M.P.R., 2016. Governing the smart city: a review of the literature on smart urban governance. Int. Rev. Adm. Sci. 82, 392–408.
Miller, C., 2005. New civic epistemologies of quantification: making sense of indicators of local and global sustainability. Sci. Technol. Hum. Val. 30, 403–432.
Mitchell, W.J., 1999. e-topia: Urban Life, Jim–But Not As We Know It. Mit Press, United States.
Mundoli, S., Unnikrishnan, H., Nagendra, H., 2017a. The "Sustainable" in smart cities: ignoring the importance of urban ecosystems. Decision 44, 103–120.
Mundoli, S., Unnikrishnan, H., Nagendra, H., 2017b. The "Sustainable" in smart cities: ignoring the importance of urban ecosystems. Offic. J. Indian Inst. Manag. Calcutta 44, 103–120.
Neirotti, P., De Marco, A., Cagliano, A.C., et al., 2014. Current trends in Smart City initiatives: some stylised facts. Cities 38, 25–36.
Peck, J., Theodore, N., 2010. Mobilizing policy: models, methods, and mutations. Geoforum 41, 169–174.
Ramamurthy, A., Devadas, M., 2013. Smart Sustainable Cities: an Integrated Planning Approach towards Sustainable. Urban Energy Systems, India.
Remourban. (n.d.) Low Temperature District Heating (LTDH).
Robinson, J., 2015. 'Arriving at' urban policies: the topological spaces of urban policy mobility. Int. J. Urban Reg. Res. 39, 831–834.
Rocco, P., Carmela, G., Adriana, G., 2013. Towards an urban planners' perspective on Smart City. TeMA J. Land Use 6, 5–17.
Schaffers, H., Komninos, N., Pallot, M., et al., 2011. Smart Cities and the Future Internet: towards Cooperation Frameworks for Open Innovation. Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 431–446.
Spence, A., Pidgeon, N., 2010. Framing and communicating climate change: the effects of distance and outcome frame manipulations. Glob. Environ. Chang. 20, 656–667.
Stavanger Municipality, 2017. Triangulum. Available at: https://www.stavanger.kommune.no/samfunnsutvikling/prosjekter/triangulum/.
Stockholm städ, 2018. GrowSmarter – Smarta Urbana Lösningar.
Stone, D., 2017. Understanding the transfer of policy failure: bricolage, experimentalism and translation. Pol. Polit. 45, 55–70.
Triangulum. (n.d.) City of Stavanger, Norway.
Trindade, E.P., Hinnig, M.P.F., da Costa, E.M., et al., 2017. Sustainable development of smart cities: a systematic review of the literature. J. Open Innov. Technol. Market Complex. 3, 11.
Van de Velde, L., Verbeke, W., Popp, M., et al., 2010. The importance of message framing for providing information about sustainability and environmental aspects of energy. Energy Policy 38, 5541–5549.
Vanolo, A., 2014. Smartmentality: the smart city as disciplinary strategy. Urban Stud. 51, 883–898.
Vanolo, A., 2016. Is there anybody out there? The place and role of citizens in tomorrow's smart cities. Futures 82, 26.
Viale Pereira, G., Cunha, M.A., Lampoltshammer, T.J., et al., 2017. Increasing collaboration and participation in smart city governance: a cross-case analysis of smart city initiatives. Inf. Technol. Dev. 23, 526–553.
Viitanen, J., Kingston, R., 2014. Smart cities and green growth: outsourcing democratic and environmental resilience to the global technology sector. Environ. Plan. A 46, 803–819.
Yigitcanlar, T., Kamruzzaman, M., 2018. Does smart city policy lead to sustainability of cities? Land Use Pol. 73, 49–58.