Co-Creation of Positive Energy Blocks

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Abstract.

A main challenge in building carbon-neutral built environments is the ability to scale and replicate solutions. We examine how to develop low-carbon neighbourhoods and districts, while aiming at climate-friendly and sustainable livable urban environments. We take a view that not only scales up individual building solutions, but embraces the added complexities arising from the scale change and utilizes them for a novel approach. It includes a strong focus on co-creation and open innovation to develop sustainable solutions.

In this contribution, we present the approach of the +CityxChange project in implementing Positive Energy Blocks (PEB) through a European H2020 project from the topic of Smart Cities and Communities. A PEB comprises several connected buildings that have a averaged yearly positive energy balance between them. This definition excludes embodied emissions, but allows to focus on the infrastructure and systems between buildings as part of the built environment, and ways to implement and incorporate them within existing cities. The +CityxChange approach relies on co-creating Europe-wide deployment of Positive Energy Districts, with Integrated Planning and Design, Creation of a Common Energy Market, and CommunityxChange with all stakeholders of the city.

1. Introduction

A main challenge in carbon-neutral built environments is the ability to involve all stakeholders for sufficient buy-in and contributions to ensure well-aligned development and uptake of agreed solutions. The challenge goes hand in hand with the ability to scale up and replicate solutions out of successful small pilot deployments to become part of larger city developments. In short, successful design, development, and roll-out of smart city solutions requires cooperation of all involved stakeholders, for which we follow a quadruple helix ecosystem model. We follow this approach with a strong focus on cross-disciplinary collaboration and a co-creation approach that strongly includes cities and citizen.

In this contribution, we present the approach of the +CityxChange project in implementing Positive Energy Blocks (PEB) through a European H2020 project in the topic of Smart Cities and Communities. A PEB is a local neighbourhood-level implementation and is understood as a collection of at least 3 buildings in close proximity that have a averaged yearly positive energy balance between them achieved through a range of measures discussed in detail below. PEBs are supposed to be scaled up subsequently to net-Positive Energy Districts. The definition of PEBs so far excludes embodied emissions, but allows to focus on the infrastructure and systems between buildings as part of the built environment, and ways to implement and incorporate

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them within existing neighbourhoods and cities. In addition, the project aims to ensure that solutions are anchored and agreed by relevant stakeholders and citizens and thus engages them in all phases through open collaboration and co-creation processes. A PEB can thus be understood as an answer to the question of how to integrate current and future plus-energy buildings into the larger urban fabric.

We examine how to scale up from buildings to blocks, and further to low-carbon neighbourhoods and districts, while aiming at climate-friendly and sustainable livable urban environments. Our approach is part of emission reduction efforts and plus-energy building integration to reach the Paris Climate Goals. To this end, the project is piloting actionable, scaleable, and replicable solutions toward the local city-driven energy transition as part of the overall European Energy Transition by 2050.[1] Furthermore, the cities in the project have the ambition to achieve sustainable urban ecosystems that have zero emissions and to establish a 100% renewable energy city-region by 2050. The project is also contributing to the SET Plan[2] goal of 100 PEBs by 2025 in Europe[3], further supporting the ambition to replicability and scalability.

We aim for an approach that not only scales up individual building solutions, but embraces the added complexities arising from the scale change to districts or connected blocks and develops a novel approach for this challenge.

The +CityxChange vision is to enable the co-creation of the future we want to live in. To fill the slogan with life, it relies on co-creating Europe-wide deployment of Positive Energy Districts, with Integrated Planning and Design, Creation of a Common Energy Market, and CommunityxChange with all stakeholders of the city. It includes the development of frameworks, supporting tools, pilot deployments, and replication plans. This is reflected through 3 broad themes of the project:

Enabling a common energy market to translate the European Common Energy market to very local conditions, allow buildings to exchange and trade energy with their neighbours, and to integrate e-Mobility as a Service (eMaaS) to both combine the mobility and energy systems and to prototype new modes of transportation.

Creating connected communities that are enabled to be actors in the energy systems and markets, can directly benefit from the results, and both co-create the solutions and can act as market participants, democratising the energy system.

Recommendations for new policy interventions, market (de)regulations and business models to deliver positive energy communities to ensure learning can be shared and new framework conditions can be taken up. This also examines local regulations to achieve development within legal frameworks or special dispensation.

2. Positive Energy Blocks and Districts

The initial definition of a PEB is as a collection of buildings in close proximity that have a averaged yearly positive energy balance between them. A Positive Energy Block is defined by the EU as several buildings (new, retro-fitted or a combination of both) that actively manage their energy consumption and the energy flow between them and the wider energy system. They achieve an averaged annual positive energy balance between them. This happens through use, optimization, and integration of advanced materials, energy reduction, local renewable energy production and storage, smart energy grids, demand-response, energy management of electricity, heating, and cooling, user involvement, and ICT. PEBs/PEDs are designed as an integral part of

[1] 2050 Energy Strategy, European Commission
`https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy`

[2] European Strategic Energy Technology Plan (SET-Plan) Action 3.2 on Smart Cities and Communities

[3] `https://setis.ec.europa.eu/system/files/setplan_smartcities_implementationplan.pdf`

the district energy system. They should be intrinsically scalable up to positive energy districts and cities and are well embedded in the spatial, economic, technical, environmental and social context, as defined by the EU call[4].

We are working to refine these definitions to be more actionable for the different cities we are working with and to take local conditions into account. Especially boundary and framework conditions and evaluation criteria are of interest.

The PEB definitions excludes embodied emissions and only focuses on energy (electricity and heating/cooling). This allows it to focus on the infrastructure and systems between buildings as part of the built environment, and ways to implement and incorporate them within existing neighbourhoods and cities. However, other definitions and buildings developed to other existing standards can be integrated, such as plus-energy buildings, low carbon buildings, zero energy buildings, etc. With the focus on the energy exchange, a PEB can be understood as a possibility to integrate the surplus energy from plus-energy buildings into the larger urban fabric.

To successfully establish a PEB, buildings with a high standards are preferred and can be an integral component. However, not all buildings in a block need to be energy-positive. An advantage of the PEB definition and development is that it can integrate existing building stock and both show an upgrade path and allow non-discriminatory integration.

As an example, within a local energy trading market or community grid, a first step is to upgrade buildings, reduce energy demand, and increase self-consumption, before balancing between buildings and energy sources and between different temporal load profiles. With increased local production, higher performing buildings can support lower performing ones, which may only be moderately upgraded. At one point, the yearly balance will turn positive and the block is on average making energy available to the larger grid. This can also be a trigger to expand the PEB. By integrating mobility aspects into the energy considerations, the energy surplus can also power local mobility needs.

3. Project Background

The +CityxChange project[5] is developing and deploying Positive Energy Blocks and Districts (PEB/PED) and scaling these out as part of the European Clean Energy Transition in cities. The project is funded by the EU H2020 Smart Cities and Communities topic SCC-1.[4] The call centers on the sustainable energy transition in cities that should realize Europe-wide deployment of Positive Energy Districts by 2050 through highly integrated and highly efficient innovative energy systems. Of interest are the direct technical solutions around PEBs, but also the interaction and integration between buildings, users, cities, the larger energy system, as well as the implications and impact on city planning, city systems, energy trading, citizen involvement, regulations, big data, digitalization, and socio-economic issues. [1]

32 partners, including 7 cities and industry and research partners will co-create these future energy systems within the 5 year project duration. It follows an integrative approach with a strong focus on city integration, open innovation and replication ability. Solutions and demonstration projects will be first piloted in the two Lighthouse Cities (Limerick, Ireland and Trondheim, Norway). They will later be replicated in five Follower Cities (Alba Iulia, Romania; Sestao, Spain; Písek, Czech Republic; Smolyan, Bulgaria and Võru, Estonia) throughout Europe to show replicability in different environments and to refine the solutions to local conditions.

Figure 1 describes the approach and framework that supports the project vision and goals through three integrated action areas:

[4] Smart Cities and Communities H2020-LC-SC3-2018-2019-2020,
`https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/lc-sc3-scc-1-2018-2019-2020`

[5] Positive City exChange `http://cityxchange.eu/`

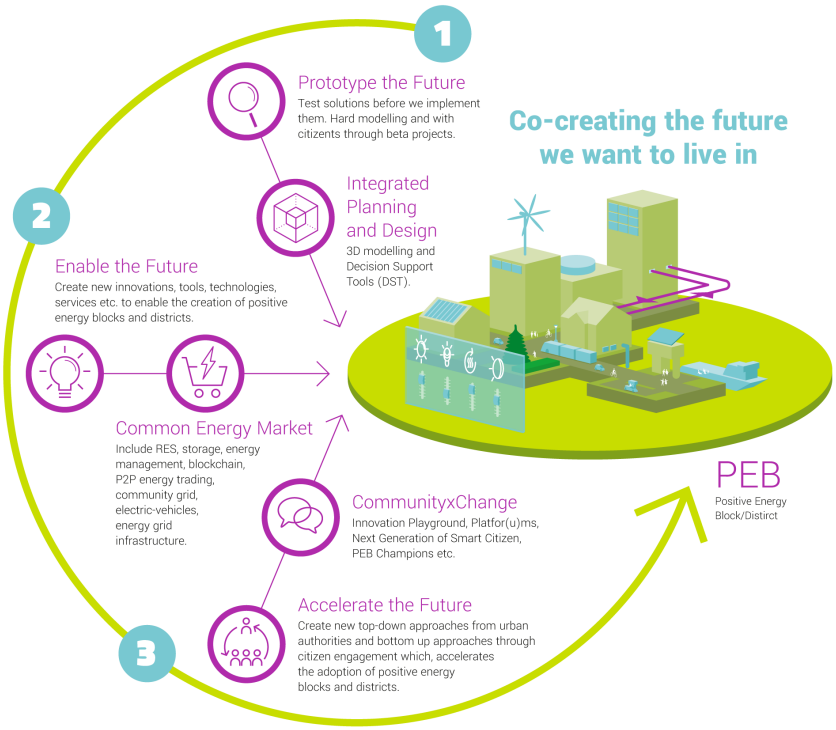

Figure 1. +CityxChange integrative approach and framework for the development of Positive Energy Blocks

- Prototype the Future – Integrated Planning and Design of Cities;
- Enable the Future – Creation and Enabling of a Common Energy Market;
- Accelerate the Future – CommunityxChange with all stakeholders of the city to create connected and engaged communities.

Within these, 11 demonstration projects in climate-friendly and sustainable urban environments are developed:

- Integrated Modeling
- Bold City Vision
- Co-Creation and Citizen Engagement
- Regulatory mechanisms and sandboxes
- Innovation Playgrounds
- Distributed Positive Energy Blocks (DPEBs)
- Micro-Grid Optimisation
- e-Mobility as a Servide
- Local Energy Trading Market
- Local Flexibility Market
- Business, Investment, and Risk Models

+CityxChange implements these 11 Demo Project in its 2 Lighthouse Cities and 5 Follower Cities. They are designed to enable the co-creation and development of Positive Energy Blocks.

The project structure mandates to take the local conditions of the different cities into account for the development, increasing broad applicability, replicability, and knowledge transfer.

We believe that citizens can and have to play a central role in the energy transition. Enabling local co-creation and collaboration for the PEBs is thus an important goal. There is a strong collaborative and strategic anchoring within the cities and participating partners through internal processes. However, reaching to stakeholders and citizens outside the project is a challenge. Experimental approaches as well as established mechanisms need to be followed to understand better local needs, and develop tailored mechanisms for engagement of citizens and stakeholders. Aspects to be trialled include citizen observatories, innovation playgrounds, hackathons, and regulatory sandboxes linked to urban living labs [2], and strategic Bold City Visions to engage civil society, local authorities, industry, and RTOs to scale up from PEBs to PEDs in an open innovation process.

4. Co-Creation and Open Innovation

Smart cities projects are understood as inherently complex and smart city evolution as an ongoing process. Based on insights around organisational and governance complexity, it is considered vital to open up processes to stakeholders in and around the city. To translate this into action, we follow an open innovation approach [3, 4, 5] and employ a quadruple helix participation model of collaboration [6]. Partners in the quadruple helix case are cities and public bodies, industry and business, research and academia, and citizens and civic society as the four main pillars. The addition of civil society is a major change from previous double or triple helix approaches. In addition, approaches of integrated innovation ecosystems move the focus from individual stakeholders to the ecosystem as a whole.

Within our framework, we aim to balance between these communities, between private and professional stakeholders, and to enable all to participate and build upon the ecosystem of smart city projects with lower entry barriers, as well as to benefit from open systems and processes. This is achieved through a range of measures, from co-creation of the project proposal, over citizen and stakeholder participation in the project, open innovation frameworks, open data architectures, and opening up large amounts of information and results, both for transfer of knowledge and experiences between cities and solutions providers within the project, and with external stakeholders. To facilitate dissemination and replication, the project assumes an "open by default" approach in line with the Open Innovation ambition. Almost all Deliverables are public and as much material, documentation, systems, and data as possible will be made available through respective channels.

On the IT side, Open data models and API specifications (Application Programming Interface, a set of functions, protocols and tools for interconnected software) have been agreed by partners where possible, not only for the internal purpose of the project, but also for replicability and portability of the services beyond the project. An API-driven approach helps ensuring interoperability and independence between existing solutions by keeping individual systems sufficiently distributed and focusing on the structured interaction between them. Privacy and GDPR issues are considered throughout the project. This is integrated through an open ICT ecosystem architecture that supports openness, access, and stakeholders' awareness [1].

During the proposal stage, the +CityxChange consortium already adopted an Open Innovation 2.0 framework [3] to secure involvement and co-creation of the partners and key stakeholders in different sectors for a joint and integrated project approach, including cities, citizens, industry partners, academia as part of the mentioned quadruple helix approach. The framework is being continued and further developed into the operational activities of the +CityxChange project and beyond [7].

To give some background, the term "open innovation" was originally defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand

the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology" [4, p.vii]. As a next step, Open Innovation 2.0 is then based on the principles of "integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and rapid adoption due to network effects" [3, p.1]. It is used by the European Commission, amongst others, as a policy that contributes to the EU digital single market[6]. Its five key points are Networking; Collaboration by involving partners, competitors, universities, and users; Corporate Entrepreneurship by enhancing corporate venturing, start-ups and spin-offs; Proactive Intellectual Property Management by creating new markets for technology; Research and Development (R&D) for achieving competitive advantages in the market.

These are also integrated as key factors in our framework. In addition, +CityxChange is centred around agile, rapid and multidisciplinary experimentation by the quadruple helix ecosystem. This type of experimentation is firmly embedded within Open Innovation 2.0 and is considered a main success factor [7]. It helps to work with cases of participatory processes, where the outcome is not set yet, by being able to perform and evaluate experiments, and integrate the results of these with the broader project scope.

In addition to the overall integrated approach, a number of particular interventions and actions are built into the project to support this. A main part is a Bold City Vision, to enable each city to bridge global and local strategies with local interventions and developments. Derived from that, individual actions such as Citizen Observatories, Innovation Playgrounds, Investment Models perform tasks of citizen engagement and participation, connect local citizens and existing innovation actors, build different publicly available observatories as physical and virtual platforms and spaces for exchange, and make systems and data available through for example hackathons and open data portals to ensure a variety of technical and community-oriented interactions.

Along with agile experimentation, mechanisms need to be in place to keep open to new solutions in a fast changing research and industry environment such as smart cities. Engagement with external stakeholders as discussed above can tap into knowledge and innovation that can and will happen outside of the project and combine internal and external ideas. This links to creating a balance between exploratory and exploitative innovation [8]. While exploitative innovation typically builds on existing knowledge and activities in more structured processes, such as a project framework, explorative innovation, is close to innovation processes, such as were happening during the development of the project. Bridging this gap is an interesting challenge, which will be addressed by creating spaces and opportunity for elements of serendipity and supporting activities along the overall collaboration.

Technological innovation is a necessary condition to make a city smart. However, the challenge of smart city innovation is not only on technology, but on service transformation, integration, and improvement. A strong involvement of citizens and non-governmental associations, and the diffusion of innovative models of cooperation and social relationships are necessary [7]. The discussed methods and measures enable this involvement and will be further evaluated and refined as the project progresses.

5. Conclusion

In this contribution, we have given an overview of the +CityxChange project and of Positive Energy Blocks and Districts as a way to enable a city-driven energy transition within smart cities. Based on the PEB development needs we have discussed our framework and approach for co-creation and open innovation as a key success factor in reaching complex project goals

[6] https://ec.europa.eu/digital-single-market/en/open-innovation-20

through multi-actor collaboration.

Successful development and deployment of Positive Energy Blocks/Districts requires open innovation, combining knowledge and experience of a wide range of different actors in a quadruple helix ecosystem. Furthermore, managing and facilitating complex PEB/PED and other smart cities projects requires new forms of governance integrating the collaboration of various actors as a key principle. We have chosen open innovation as a relevant pathway for cities to become smarter, solve various societal challenges and improve the quality of life of its citizens by stimulating and facilitating the synergistic contribution and participation of business, university, public sector, non-for-profit partners and citizens to innovation processes.

In our ongoing work, we will refine the frameworks and processes of co-creation and collaboration as well as support the detailing out of the actual development towards the deployment of Positive Energy Blocks. All project partners are currently working on all these tasks and are showing promising initial results.

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