Introduction to Panel 5 Sustainable communities

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Introduction

Currently, 57 % of the world's and 77 % of Europe's population already live in urban areas, and by 2050 the numbers are expected to increase to 68 % and 85 %, respectively. The last few years (and especially 2020) have shown us that the way we live in cities will change. At the same time, we see already large cities growing rapidly and small rural municipalities shrinking. For this reason, a transition towards more sustainable and resilient cities and communities poses large challenges.

Cities hold great opportunities for simultaneous climate protection and economic development, employment, and wealth generation. However, in order to realize these opportunities, the risks and the conflicts of interest have to be handled very carefully. Although cities worldwide only occupy 2 % of the land area, they consume 75 % of global energy and generate 80 % of the greenhouse gas emissions. Thus, sustainable development of urban areas and multidisciplinary planning is a challenge of key importance.

In order to be able to manage urban areas in a sustainable manner, the local governments in partnership with the local business life and civil society and other stakeholders need to work closely together on making cities smarter. Furthermore, planning and development of cities are of utmost importance for both growing and shrinking cities, as this decides today how we will live in cities in the future. In this context, new innovative systems can be used to enhance the typical provider-consumer model, leading to higher energy consumption awareness on both sides, with consumers being able to assist the energy service providers in their processes of integration of renewable generation.

Smart urban technologies can provide an important contribution to the sustainable development of cities, with Information and Communication Technologies (ICT) offering new interdisciplinary opportunities to improve services while reducing energy consumption and emissions. ICT is also key for implementing new roles along the energy value chain, where traditional business models are rapidly becoming outdated, with more demanding consumers and sustainability policies and practices. However, it is of utmost importance to design smart solutions, so that their benefit exceeds the resources necessary for implementing these measures. Sustainable is always smart, but smart is not necessarily sustainable.

Panel 5 submissions have been grouped into two themes:

- Sustainable communities and urban planning – the papers on this theme are focused on aspects such as urban districts, barriers and progress in communities, sufficiency, and human perspectives.
- Integration of renewable energy sources and demand flexibility – the papers on this theme are focused on the integration of renewable energy generation sources at the community level, as well as the control of demand to provide demand flexibility, including heating systems.

Sustainable communities and urban planning

Urban planning and governance are crucial elements in achieving sustainable communities, whether the cities are growing or shrinking, and the visions and goals of different stakeholders

should be considered in the planning of urban districts. Calvén et al. (peer-reviewed paper 5-152-24) provide insights into how energy-related visions and goals, in a new urban district in Sweden, are formulated and further translated into instruments employed by the municipality. Bankert and Taranu (peer-reviewed paper 5-148-24) employ a combination of policy analysis, desk research, and focus groups with key enablers in projects located in Belgium, Spain, and Estonia. van der Horst (peer-reviewed paper 5-328-24) explores the energy efficiency potential of the x-minute neighborhoods.

In such a context, sustainable communities should consider the human perspectives. Löfström and Santandrea (peer-reviewed paper 5-229-24) used different eco-visualizations as interventions as a starting point for reflections on the current and potential future role as humans in the eco-system. Vadovics et al. (extended abstract 5-285-24) evaluate the conditions conducive to active energy citizenship. Nyström et al. (extended abstract 5-221-24) describe preliminary results from interviews with stakeholders in the formation of energy communities in Sweden, focusing on the expectations of households and the conceptualization of energy. Verbeeck et al. (extended abstract 5-108-24) investigate how we can envision a radical and positive future and what the impact of this envisioning can be. Costanzo (peer-reviewed paper 5-063-24) presents some exemplary initiatives on cultural audience engagement and citizen science for the clean energy transition. Doguc et al. (peer-reviewed paper 5-061-24) detail the implementation and outcomes of an Analytical Hierarchy Process approach to engaging stakeholders in the decision-making process for the formulation of refurbishment strategies. Lohmann and Schakib-Ekbatan (extended abstract 5-105-24) offer a snapshot of citizen views about hydrogen at the onset of the hydrogen economy.

It is important to evaluate the progress in the development of energy communities, but also to analyze the existing barriers. Geary et al. (extended abstract 5-078-24) examine the patterns behind the establishment of sustainable energy communities, their progression along the Learn-Plan-Do pathway, and the degree of grant application activity that follows the initial establishment. Exintaveloni and Flamos (extended abstract 5-107-24) employ a novel framework that uses the frequency of existence and the level of importance to empirically investigate the factors affecting the implementation of energy efficiency and sustainable actions in public and private buildings, public lighting, transport, and cross-sectoral areas across the EU. Elgendy et al. (peer-reviewed paper 5-013-24) investigate barriers, incentives, and possible solutions that motivate homeowner associations to undertake deep energy renovation projects. Klöckner et al. (extended abstract 5-023-24) take a multi-perspective approach to understanding drivers and barriers of climate action on the neighborhood level in a selection of European neighborhoods.

In the context of communities, it is important to go beyond energy efficiency and ensure the implementation of sufficiency strategies. Zimmermann and Firat (extended abstract 5-097-24) define the sufficiency strategy, more specifically for the building sector by suggesting five specific building sufficiency measures. Hock (peer-reviewed paper 5-183-24) approaches sufficiency for buildings and their spatial relation, outlining eight sufficiency parameters for neighborhood planning. Taranu et al. (peer-reviewed paper 5-188-24) quantify and monetize the social welfare, micro-economic, and environmental benefits of projects, by considering the added values of the sustainable plus energy neighborhoods approach.

Integration of Renewable Energy Sources and Demand Flexibility

The integration of renewable generation in energy communities is crucial to provide local and clean energy, while ensuring lower electricity costs and greater energy independence. Lingfors et al. (peer-reviewed paper 5-065-24) investigate the gap between the property-optimized and the community-optimized deployment of solar photovoltaics systems. Sarraf et al. (extended abstract 5-172-24) explore synergies in co-optimizing India's electric grid and affordable housing, addressing challenges such as grid stability, clean energy adoption, and increasing energy demands due to economic mobility and climate events. Peng and Klöckner (peer-reviewed paper 5-109-24) identify the key socio-demographic, dwelling, household contextual, and psychological factors that have a significant impact on household energy efficiency behaviors in different categories, including private PV installation, flexible electricity use, and dwelling energy efficiency upgrading.

Demand flexibility will have a fundamental role in the grid integration of intermittent renewable generation, ensuring the matching between local generation and consumption, guaranteeing a better use of generation resources at the local level, and ensuring positive impacts for grid management. Lopes et al. (extended abstract 5-223-24) evaluate the flexibility potential for the agriculture sector, namely in energy intensive activities such as intensive horticulture and fruit farming, considering the technical potential, productive and organizational restrictions, and behavioral preferences. Sørensen et al. (peer-reviewed paper 5-024-24) present the innovative and sustainable technologies implemented in Campus Evenstad, a Norwegian university campus, namely vehicle-to-grid (V2G), biomass-based combined heat and power (CHP), solar energy, energy storage, energy efficiency measures, and a zero-emission building. Passey and Zapata (extended abstract 5-038-24) report the outcomes for demand flexibility in the context of saturation levels of uptake and operation of residential distributed energy resources.

The impacts of new loads associated with electrification efforts must be considered. Hong et al. (extended abstract 5-009-24) present a study to quantify and inform building electrification impacts at the district scale using detailed building energy modeling based on public records datasets. In the context of electrification, heating systems can have a strong impact on ensuring decarbonization goals and ensuring demand flexibility. Gupta et al. (peer-reviewed paper 5-115-24) applied an online and interactive local area energy mapping tool (LEMAP) to assess air source heat pump (ASHP) suitability for 865 dwellings in a suburban area of Oxford, UK. Banks (peer-reviewed paper 5-323-24) developed a conceptual framework and then road tested it on two major place-based projects aiming to build smart energy communities in the UK to catalyze the adoption of heat pumps. Leutgöb et al. (peer-reviewed paper 5-271-24) demonstrate that cooperatives are a promising implementation model to coordinate and balance different legal frameworks,

financing conditions, and interests that challenge the implementation of cross-property projects. Kooger et al. (extended abstract 5-316-24) discuss the involvement of residents in municipal heat transition plans in order to avoid a mismatch between the needs of residents and the efforts of the municipality. Åberg (peer-reviewed paper 5-159-24) designed an analytical method that enables adequate evaluation of resource utilization, partly by defining a measure of exergy matching that enables adequate analyses of integrating thermal systems with electrical systems in residential areas.