ENERGY LIVING LABS – AN INSTRUMENT TO DEVEOP A CLEAR PATH FOR INNOVATIONS IN THE CONTEXT OF SUSTAINABLE SMART CITY DEVELOPMENTS

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Overview

Advancements in 21st-century technologies offer cities new possibilities for their future. However, the rapid proliferation of disruptive technologies is outpacing the ability of city leaders to keep pace. Therefore, cities require a clear and comprehensive vision for shaping their energy future, which is ambitious, grounded in reality, and leverages unique local assets. Energy Living Labs are emerging as a promising instrument to support sustainable smart city developments by providing a collaborative framework for testing and developing innovative energy solutions. The conference contribution will focus on its potential to create a clear path for innovations in the context of sustainable smart city developments. The work discusses the key features of Energy Living Labs, including their participatory approach, the integration of different stakeholders, and the use of real-life environments for testing and validation. We also emphasize the importance of education and awareness campaigns to engage local communities and stakeholders in the transition to a net-zero carbon future. To structure the efficient implementation of smart energy technologies as a subsequent step of an Energy Living Lab, a roadmap needs to be developed for the realization of energy technology innovations. It is essential to identify the current barriers and challenges in deploying these technologies at scale to envisage a clearer view of the future's potential of the city as well as the today's city-specific challenges.

Methods

The paper introduces a practice-oriented systematic to guarantee a holistic and sustainable approach to decarbonize the energy system. The methodology consists of four action lines. The presentation will focus on Energy Living Labs (action line 1) and the subsequent scale-up energy roadmap development (action line 2). Networks to catalyze digital and energy innovation have to be established (action line 3) in the process to decarbonize the energy system in a city or region. As a conclusion it is illustrated how local strength with Energy Living Labs is created as one tool to support the government decision model (action line 4).

Within the framework of an Energy Living Lab (action line 1) valuable insights into the social, economic, and environmental impacts of these technologies can be achieved. Applying the methodology key technologies are identified, major development milestones are outlined, and technologies based on their CO_2-reduction potential are prioritize. To reach sustainability goals with consideration of city specific circumstances the potential to be implemented and upscaled in a particular city/region is in upmost importance.

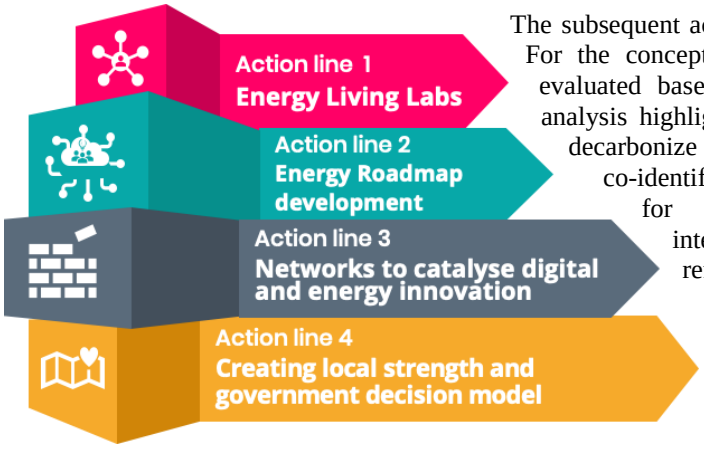

Figure 1: Four action lines of the BABLE decarbonization systematic

The subsequent action line 2 focusses on the roadmap development. For the concept of the scale-up roadmap, the technologies are evaluated based on a Multi-Criteria Assessment (MCA). This analysis highlights the city-specific potential for technologies to decarbonize the energy system considering several key criteria co-identified with the city. In the Roadmap technology sectors for energy solutions are differentiated and interdependencies and sector coupling effects are reflected. The five sectors are:

- Renewable and sustainable energy transition
- Digital & transmission infrastructure
- Balancing and storage
- Climate-neutral end use & energy efficiency
- Sustainable mobility

A cross-sectoral approach is applied to identify the sectors with highest decarbonization potential based on city/region specific circumstances. Novel approach of this paper is, that the concept of Energy Living Labs is extended by a methodology to map a roadmap to ensure the city specific landscape is considered – constituted by market leaders, best-practices, innovation networks and funding instruments.

Results

The methodology was applied in a major German city and executed together with city representatives. First, the work will present the results of the involvement of local communities and stakeholders in the development and deployment of clean energy technologies in Energy Living Labs (action line 1). Examples why this equitable and inclusive approach offers significant benefits for the transition to a net-zero carbon future are presented. In the subsequent roadmap development (action line 2) specific milestones and tipping-points are identified and illustrated until 2050 for each technology. Macro-economic consequences and market interaction effects between investigated technologies and sectors are stated. Networks to catalyze digital and energy innovation (action line 3) are mapped. Examples are given why investments in research, pilot projects, policy updates and infrastructure in the short and medium-term are decisive to have mass-market adoption of the technologies in the long-term in a city specific environment. However, city administration often indicates they have limited capacity and internal structure is not ready for increasingly rapid technologies cycles. To enable city leaders to keep up with disruptive and complex technology a government decision model (action line 4) is introduced. Using a comprehensive up-to-date platform an overview of the full market landscape of use-cases, solutions and products is given. The results will prove the accelerated decision making in city administration and illustrate how to distribute task to relevant departments overcoming silo thinking.

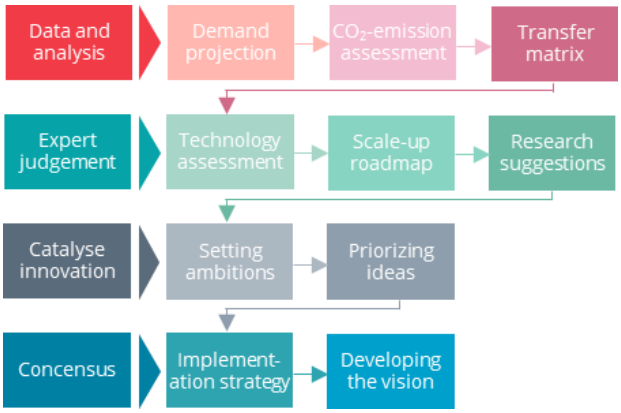

Figure 3: Multi-Criteria Assessment (MCA) for technology evaluation

Conclusions

To achieve the ambitious climate and carbon emission goals, in addition to major infrastructural investments, bottom-up innovations an early engagement of the local ecosystem are crucial. Energy Living Labs provide a collaborative and participatory framework for testing and developing innovative energy solutions in real-life environments, which can accelerate the adoption of these technologies. By involving different stakeholders, including energy providers, policymakers, researchers, and end-users, Energy Living Labs can ensure that the deployment of smart energy technologies meets the needs of all stakeholders.

The development of an energy roadmap as a subsequent step to Energy Living Labs and not only brings the citizens primary beneficiaries together, but is also relevant research and industry partners. A disruptive development can start, when crucial digital applications (e. g. ICT, open data, data platforms, security technologies, artificial intelligence, IoT) with relevance to the energy systems become standards.

References

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