

How digital tools can engage stakeholders: Munich's digital twin and an interactive 3D print model

Andreas Baernreuther ⁽¹⁾ - Stefan Dr. Synek ⁽¹⁾

⁽¹⁾ City Of Munich, Department Of Labor And Economic Development, Munich, Germany

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Abstract Urban areas play a pivotal role in achieving climate neutrality, yet the transformation of existing districts into energy-positive environments remains a complex challenge. The ASCEND project, funded by Horizon Europe, addresses this by establishing one of Munich's first Positive Clean Energy Districts (PCED) in Harthof. The project responds to the urgent need for innovative, and replicable strategies to achieve district-level energy positivity.

Harthof, home to 6,000 residents and mainly developed between the 1950s and 1970s, represents a typical residential area setting where most buildings are owned either by the city's social housing company or private owners. These buildings require significant energy retrofitting. ASCEND aims to demonstrate how the combination of digital innovation, stakeholder engagement, and integrated energy planning can transform such a district into an energy-positive one. Implementation actions include high-efficiency retrofits (e.g. upgrades toward Nearly Zero Energy Building standards), serial renovations, photovoltaic installations on roofs and façades, improvements to district heating and e-car charging stations.

In Munich, more than 20 solutions are being co-designed with municipal departments, scientific institutions, local businesses, and residents. Importantly, the implementation of PCED solutions is accompanied by a strategic roadmap for upscaling and replication. Stakeholder engagement is central to ASCEND's success: tenants and property owners have been activated through a variety of formats—information events, online surveys, counselling services, and on-site engagement—to foster their participation in energy communities, refurbishment initiatives, and a district energy council.

Digitalisation plays a critical role through the development of a local monitoring framework that combines real-time data collection and simulation tools to assess key performance indicators. These indicators track progress toward PCED targets and measure impacts in terms of energy efficiency, cost savings, and social acceptance. Additionally, innovative communication tools— e.g. a VR implementation of the semantic 3D model and an interactive 3D printed model—are proving valuable for engaging both citizens and decision-makers. ASCEND developed a transparent 3D print model of the district where one can select different layers from a touch screen. The results are immediately displayed so that the affected buildings are highlighted from underneath. Those representations of the Urban Digital Twin of the district enables the project to visualise data and objectives, thereby bridging the gap between technical detail and public understanding, thus embedding the ASCEND's results

in Munich's urban policy and planning.