HEXAGON

Case study

Achieving ambitious climate goals with a digital twin

City of Klagenfurt | *Austria*

Klagenfurt may not be the biggest city in Austria – in fact it is the sixth largest – but the Carinthian capital is definitely a city on a mission: Mission 2030. Klagenfurt is the only city in Austria to be part of the EU Cities Mission 2030. Alongside Rome, Barcelona, Ljubljana and other European cities, it has set a goal of being climate neutral by 2030 – a project that may seem utopian but is indeed quite realistic.

Klagenfurt's Smart City strategy sets out how it can achieve climate neutrality in nine fields of action (mobility, energy, infrastructure, economy, nature & living space, urban development, governance, digitalization and generations) with more than 200 measures planned to ensure a sustainable, resilient living space for future generations.

An essential component of this mission is the digital twin the City developed with the help of Hexagon.

Creation of the digital twin

A digital twin is a dynamic, virtual representation of the real world. For cities, this involves creating a comprehensive digital model that mimics all aspects of a city's environment and infrastructure.

To create the digital twin of Klagenfurt, aerial images and LiDAR data from a four-and-a-half-hour flight were fed into Hexagon's AI technology. Based on 23,000 individual images, a high-resolution 3D model (mesh) was created using Hexagon's HxDR and M.App Enterprise software. The data represents the 3D geometry of the entire city and was supplemented with additional data from the cadastral survey.

The result is several data products: a photorealistic 3D mesh, a digital surface model (DSM), a digital terrain model (DTM) and an image of land use directly on the ground and from an orthogonal view. The digital twin is the result of close collaboration between City authorities and the Hexagon project team, which enabled seamless integration of data into a user-friendly web application.

Versatile 3D model

The digital twin is accessible to everyone and displays the total area of urban properties with different land use categories. The 3D model provides an easily accessible and complete geoinformation system that allows users to measure distances and visualize shading depending on the time of year and day. It is also possible to analyze land use, soil sealing, the volume of green space, shading and the maximum height of trees.

The system displays percentage of land use categories and the degree of sealing for each property. Based on factors such as exact dimensions of a building, potential energy generation from solar cells on roofs, effects of concrete surfaces on the urban climate and which areas could benefit from green development, users can make informed construction and planning decisions.

Klagenfurt's digital twin is a dynamic, virtual representation of the city.

A big step into the future

“This project is an important step into the future of our city. It demonstrates how we are using digital technologies to make Klagenfurt smarter, more efficient and more livable,” summarized Klagenfurt City Planning Officer and City Councillor Constance Mochar.

Her colleague Günter Koren, head of surveying and geoinformation at the City of Klagenfurt, uses the digital twin for fact-based simulation studies when planning scenarios to evaluate the benefits of a measure in advance of its realization.

“We use the new technology not just for new construction projects, but also for the historical part of Klagenfurt to provide the basis the protection and preservation of historical monuments,” he added. “The digital twin has helped us communicate the topic of sustainability and climate adaption strategies very well to the public.”

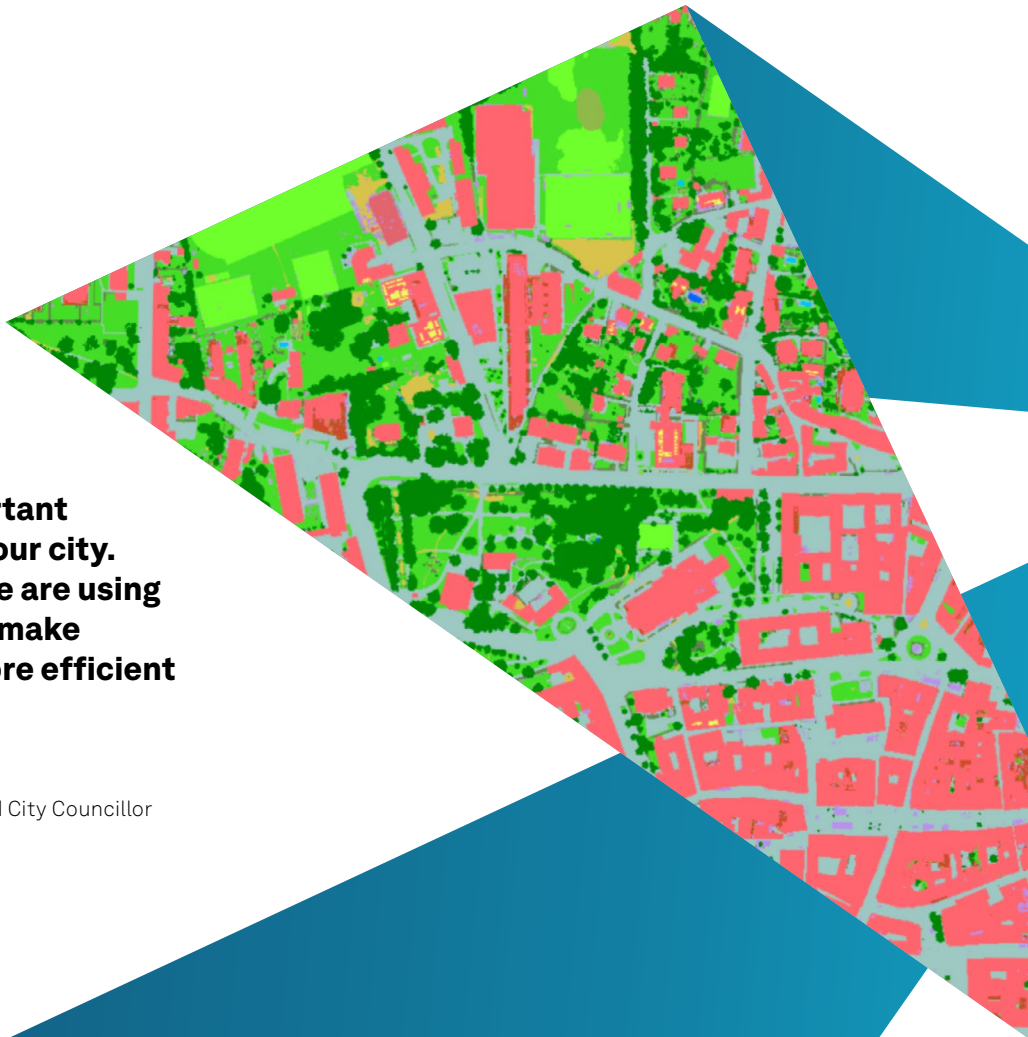
The digital twin offers a hands-on tool that helps residents save energy and costs and at the same time links them with the City’s ambitious development. It also helps city planners and administrative staff in their daily work and is an excellent way to show that the city is close to its residents.

Unlocking the potential of solar energy

One of the biggest advantages of the digital twin is that it shows the solar energy potential of every single building in Klagenfurt. It is able to identify possible locations for solar thermal and photovoltaic systems on roofs. The photovoltaic energy potential is calculated and the system predicts the yield depending on the orientation, inclination and possible shading of solar modules.

Proactive climate protection

The digital twin was made publicly available on the City’s website in April 2023. Right from the start, City representatives and Hexagon were sure the introduction of the digital twin would have a positive impact on the installation of solar energy generation in Klagenfurt – but they could only guess at the extent of the effect. Supported by massive public funding of solar technology, all cities in Austria experienced an accelerated installation of renewable energies to reduce fossil fuel power generation. It was interesting to see, in a nationwide comparison, the extent to which the digital twin provided an additional boost in solar energy generation.



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Roofs generate substantial solar yields from incoming solar energy. In the digital twin they are shown in 3D with color representation indicating the level of energy yield.

14,000 tons of avoided CO2 emissions per year

In September 2024, Hexagon completed a study quantifying the impact on carbon dioxide (CO2) emissions for Klagenfurt. The study takes into account a large number of factors, including the calculated emissions from the flights required to take the aerial photographs. The calculations were carried out in accordance with the "Guidance on Avoided Emissions" of the World Business Council for Sustainable Development.

The aim of the study was to quantify the CO2 savings made possible by the digital twin. It focused on determining the solar potential on roofs and compared the increase in installed PV capacity and solar thermal energy calculated from the increase in area with the increase at the national level. The above-average increase in actual installations (solution scenario) compared to a scenario in which the Klagenfurt photovoltaic installations between 2021 and 2023 would have only corresponded to the state average (reference scenario) was attributed to the use of the digital twin of Klagenfurt. In short, the avoided emissions are the difference between the reference and the solution scenarios.

The results of the study prove that the installation of the digital twin led to CO2 savings. The digital twin accelerated the installation of photovoltaic systems by around 50% compared to the Austrian average, which is reflected in an above-average installation of around 3,350 kWp. The operational area of solar thermal energy between 2021 and 2023 was 120%, or 32,000 m² above the national average.

All this means a savings of 14,000 tons of CO2 emissions in each of the two years the digital twin has been in operation. Every year, the Klagenfurt digital twin saves CO2 emissions equivalent to taking 330 internal combustion engine vehicles off the road or compensating for the annual carbon footprint of more than 2,000 Austrian citizens. The system is a small but important contribution to achieving the goal of being climate-neutral by 2030.