

# TOPVIEW: CLOSING DATA GAPS IN URBAN ENERGY AND CLIMATE PLANNING WITH REMOTE SENSING AND AI

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## 1 SUMMARY

This paper highlights the potential of remote sensing as a catalyst for integrated spatial energy planning and climate adaptation. Building on the Austrian national project TopView, it demonstrates how automated, data-driven methods enhance existing geospatial datasets and generate new information layers for municipal and regional decision-making. By combining Very High Resolution (VHR) thermal imagery, orthophotos, Geographic Object-Based Image Analysis (GEOBIA), and artificial intelligence, the project delivers scalable workflows to address critical data gaps in urban-scale planning. Five use cases illustrate the approach: (1) automated roof form classification for solar potential analysis, (2) rooftop object detection to improve energy modelling, (3) time-series analysis of urban heat islands (UHI), (4) detection of unheated buildings to refine energy datasets, and (5) integrated rooftop performance assessment combining thermal, RGB, and vegetation data. These harmonized datasets expand the scope of spatial energy planning and strengthen evidence-based climate-resilient strategies at local and regional levels.

**Keywords:** Remote sensing, climate adaptation, spatial energy planning, urban heat island, thermal imagery, GEOBIA, artificial intelligence, rooftop analysis

## 2 INTRODUCTION

The *TopView* project addresses the urgent need for precise, up-to-date, and integrated data to support decision-makers in the transition towards decarbonization and climate resilience. Conventional modelling methods often fail to capture the spatial and temporal complexity of urban change and thus cannot adequately support energy policy targets or climate adaptation strategies.

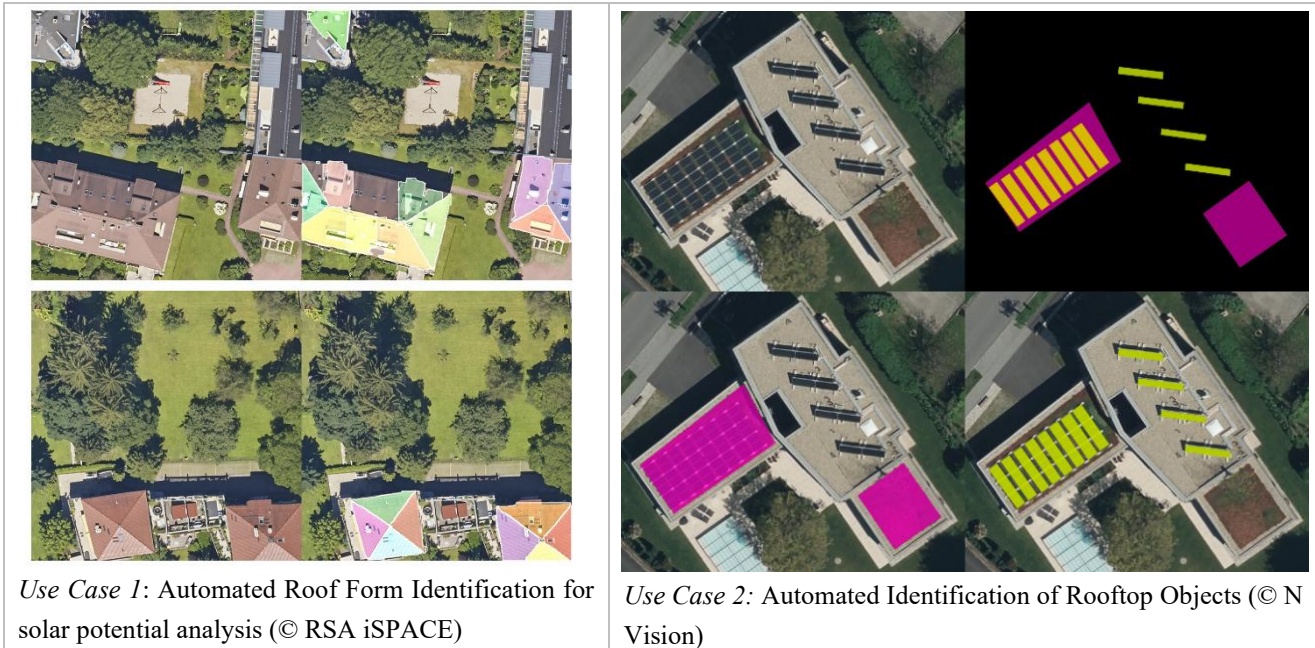
Remote sensing and artificial intelligence offer a transformative alternative: they enable the systematic processing of large volumes of high-resolution imagery, extraction of relevant features with minimal human intervention, and continuous updates at a pace that reflects real-world urban dynamics.

The overarching objective of *TopView* is to enhance and extend existing spatial data foundations for energy planning and climate adaptation. By combining Geographic Object-Based Image Analysis (GEOBIA), Very High Resolution (VHR) thermal imagery, and advanced AI algorithms, the project reduces the cost and time of data acquisition while expanding the scope of measurable indicators. This results in robust, scalable workflows that empower municipal and regional authorities to develop evidence-based strategies for sustainable and climate-resilient urban development.

### 3 APPLICATIONS FOR REMOTE SENSING IN CLIMATE-RESILIENT ENERGY PLANNING

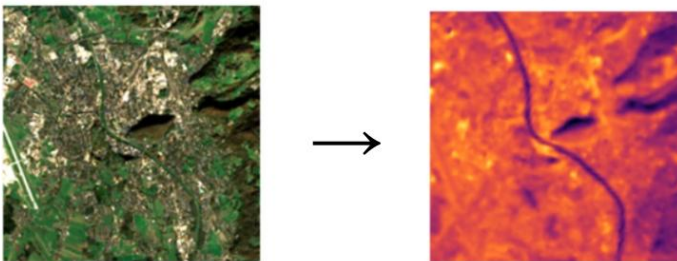
Municipal and regional databases often contain static or incomplete information on building characteristics, rooftop infrastructure, and urban thermal conditions. Remote sensing can address these shortcomings by providing spatially explicit, up-to-date, and comprehensive datasets that enhance the accuracy and effectiveness of spatial energy planning and climate adaptation (Manapragada, 2025).

Within *TopView*, five use cases demonstrate how high-resolution imagery and automated processing create reliable, scalable data products that support planning authorities in developing evidence-based, resilient strategies. Each use case targets a specific data gap, thereby updating, refining, and extending the geospatial foundations for urban energy and climate planning.

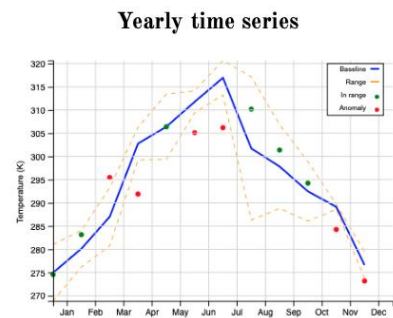
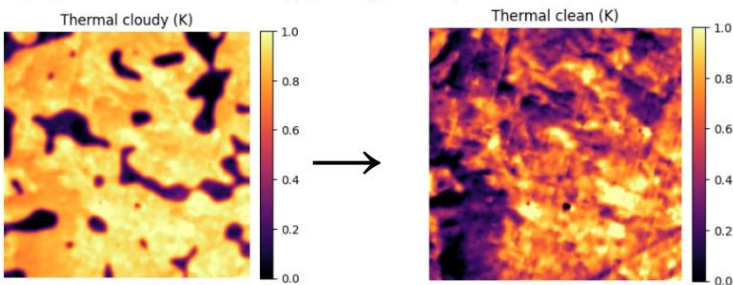


#### Satellite land surface temperature gap filling for enhanced time series analysis

a) **Time:** multi-spectral to thermal data driven modelling



b) **Space:** data-driven cloud gap filling with synthetic clouds



Use Case 3: Time-series analysis of UHI for cities and regions (© Termatics)

Fig. 1: Overview over TopView use cases 1-3 (use case 4 and 5 in progress)

### **Use Case 1 – Automated Roof Form Identification for Solar Potential Analysis**

Current methods in Salzburg and Styria struggle to distinguish roof geometries with sufficient accuracy, limiting solar energy calculations. By applying Geographic Object-Based Image Analysis (GEOBIA) to orthophotos and Digital Surface Models, *TopView* enables precise segmentation and classification of roof structures. These results improve photovoltaic (PV) potential mapping, urban energy planning, and the creation of digital building twins.

### **Use Case 2 – Automated Detection of Rooftop Objects**

Reliable information on existing rooftop installations (e.g., PV, solar thermal, cooling units, green roofs) is often missing from urban energy datasets (Abraham Noah Wu, 2021). Using AI-based computer vision, this use case detects and classifies such rooftop objects automatically. Combined with UC1, it allows for more accurate assessments of installed PV capacity and remaining potential at building, district, and municipal level.

### **Use Case 3 – Time-Series Analysis of Urban Heat Islands (UHI)**

Thermal datasets with adequate resolution and frequency are essential for understanding UHI dynamics but are rarely available. *TopView* applies generative AI to close cloud gaps and merge multiple thermal data sources including the Harmonized Landsat and Sentinel-2 dataset (Junchang Ju, 2025), producing continuous land surface temperature maps. When combined with climate data, these reveal persistent hot spots that inform municipal heat mitigation strategies.

### **Use Case 4 – Identification of Unheated or Poorly Insulated Buildings**

High-resolution winter thermal imagery is used to detect unheated or insufficiently insulated buildings. This information refines existing building and energy datasets, enabling municipalities to prioritize renovation programs, district heating expansion, and targeted efficiency measures

### **Use Case 5 – Integrated Rooftop Performance Assessment**

Green roofs and PV systems provide both energy and cooling benefits, but their combined performance is rarely measured at scale. By combining thermal, RGB, and vegetation data, this use case evaluates the temperature-reducing effects of rooftop greening. The results support evidence-based decisions on where to invest in green infrastructure for maximum energy savings and adaptation benefits

## **4 REFERENCES**

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