ANNEX 70 – CASE STUDY FOR HOTSPOTS
MAY 20, 2019

- **Title of case study** – HOTSPOTS - Holistic thermographic screening of urban physical objects at transient scales, AUSTRIA
  Development of an 3D thermographic atlas to capture the condition of existing buildings in terms of energy efficiency and of providing a decision-making basis for improving this condition
- **Geography** – model city Gleisdorf, Austria
- **Scale / population** – The scale of the study is on local level at a town with a population of about 10.800 citizens.
- **Who was involved** – The project leader is Claudia Windisch from Siemens AG Österreich, Austria. Project partners are the Austrian Institute of Technology GmbH, Vienna, AUSTRIA, the AEE - Institute for Sustainable Technologies, Gleisdorf, AUSTRIA and Stadtwerke Gleisdorf, Gleisdorf, AUSTRIA.

- **Lead description of the case study** – The goal of the research project HOTSPOTS was the development and extension of a thermographic atlas for the model city Gleisdorf and providing periodic updates of the atlas. Furthermore, tools and scientific methods to gather information about the actual situation of the existing building stock concerning energy efficiency were the output of the project. The aim was to provide a basis for decision-making concerning optimization and retrofit measures. These targets shall contribute to climate protection and the improvement of the environmental quality.
  The method of the research project was to develop a procedure chain, which is validated with the model city Gleisdorf for detecting and validating potential for optimization. The criteria for the selection processes concerning construction measures is to be replicable and based on measured data to avoid ad-hoc decisions and “stranded” investments. The aim of the approach was to provide proof of concept of a continuous procedure chain, which shows potential for energetic optimization.
  Further on, a city-related knowledge base (3D thermal register, catalogue of weak spots, catalogue of retrofit -measures for buildings and neighborhoods, models and simulations) was developed. This shall by applied as assistance for decision-makers at large-scale thermal restorations and modernization of building services.

- **Datasets used**
  - The reference data of state, age, usage, heating system and fuel type (aggregated form, not building specific but grid-based) was taken from statistic departments (Statistics Austria) and the local building and apartment registry (GWR) of the municipality.
  - Data from external sources was used like De fault values of different construction-age typologies and cadastral data.
  - Air quality monitoring was done internal – from air pollution to laser scanning.
  - Public available information about the road network, building outlines and zoning plans was taken from the sources open street map – OSM, basemap.at, digital atlas /

GIS of Styria. Data of temperature and weather is online available – open access from the source: ZAMG – Zentralanstalt für Meteorologie und Geodynamik).
    - Energy performance certificates (EPC) of the buildings were provided by the municipality
    - ECOCITIES Tool
    - Stadtwerke Gleisdorf (utility): heated gross floor area, age of buildings, heating energy consumption (from EPC or derived from the year of construction), energy sources for heating and domestic hot water supply

- **Issues on access to the data**: Access to detailed cadastral and statistic data is difficult, because it is restricted. The publishing of the results is only possible, when anonymized data for the purpose of research is used.

- **Strength / Unique Selling Point**: The thermographic atlas is a tool enabling area-wide thermographic acquisition of the city with a specifically developed multi-sensorial measuring device and the usage of UVA (drones) and hot-air balloons for thermal data acquisition. The project uses a methodological approach for integration of thermal and statistic data.

- **Opportunities**: The research project shall provide a holistic energy related view of the building stock and enables a good basis for further investigation and planning for decision makers. Potentials for thermal renovation are analyzed and realistically implementable solutions for renewable and CO_2 neutral implementation of renovation strategies are identified. The generation of methods and evaluation metrics, which allow transferability of the findings to other small towns and districts enables a wide applicability.

- **Motivation / issues**: City-related data currently is only available in different quality, actuality and spatial resolution from different data holders. There is no common database of consolidated and harmonized data available. So the aim of the research project was to provide tools and scientific methods to gather information about the actual situation of the existing building stock concerning energy efficiency and to develop a basis for decision-making regarding optimization and retrofit measures.
  Issues during the project progression were challenges in the data collection with drones, because a request and permission from Austro Control is needed (think of leaflet-information for residents, weight limit below 5 kg or similar …). In addition, the usage of hot-air balloons provides difficulties because images can only be taken from bird's-eye view and not from the "façade-view". The procedure is hardly repeatable in an exact and time efficient way, when more iterations are necessary. The thermographic resolution also is not that good. Generally, there is a need to add ground truthing.

- **Implementation / Method**: The data basis of the project is the 3D thermal register, which is generated with aerial imagery. The task is the area-wide acquisition of thermal data in urban area, where single frames are linked to a holistic, city-wide database and are extended to the third dimension by deriving a 3D building model from the image data. By using the thermal atlas the identification of "critical spots" with high potential for

optimization or retrofit is enabled. The “critical spots” are further analyzed in the following project modules in detail; therefore, a close-range mobile data acquisition with a UAV for detailed thermal analysis and to generate 3D building models is done.
A selective acquisition and densification of data in terms of a 3D gas layer model is implemented. Based on this data a cell-wide but focused analysis of weak points of the implicit infrastructure is done.
Then, a catalogue for measures on “critical spots” with high potential for optimization, including influencing factors is developed. This catalogue shall provide a decision support tool for interactive selection, localization of energy efficiency measures and simulation of the resulting effects with a calculation of optimal combinations of measures.

- **Benefits**: The benefits from the project are the area-wide thermographic acquisition of the city and the generation of a 3D gas layer model. The methodic approach for integration of thermal and statistic data can be used in future projects.
  The monitoring of the effects of energy efficiency and optimization measures concerning heating systems by further aerial photography can contribute to reach the aims of a smart city. The individual energy-saving measures depending on the building state can be simulated and realistically viable solutions for renewable and CO_2 neutral implementation of renovation strategies can be identified.
  Furthermore, the development of specific scenarios for implementation in terms of short-, medium- and long-term action plans contribute to energy efficiency measures of the city. The finding of methods and valuation numbers enables the applicability of the results to other small towns or districts.

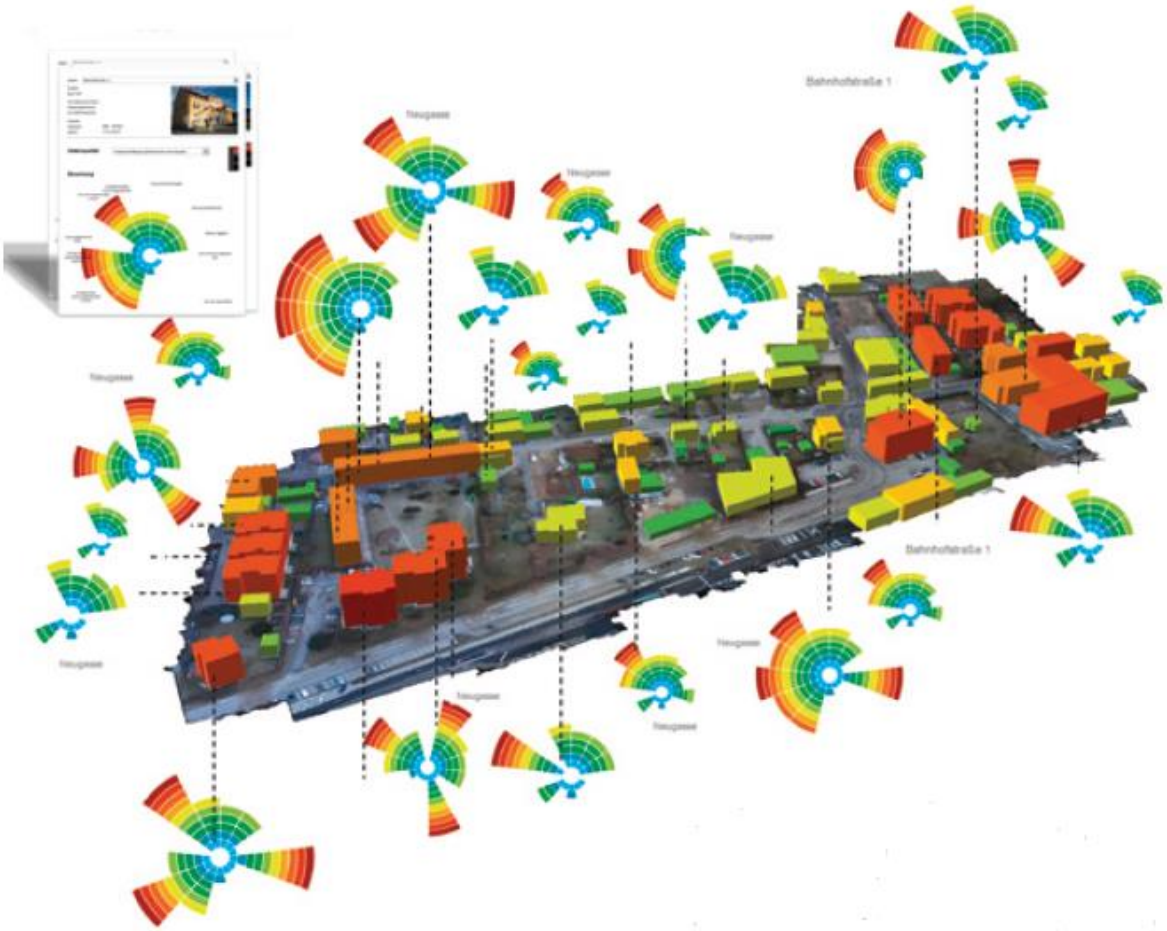

Figure 1: Analysis of weak points with spatial visualization of results (AEE Intec)