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Current developments
and examples
of sustainable energy
technologies

Bundesministerium
Verkehr, Innovation
und Technologie

klima+ energie fonds

Strategies to reduce the Urban Heat Island effect

COOLING CITIES
Innovative solutions for liveable urban areas

Cities are particularly severely affected by the consequences of climate change. In Austria, numerous innovative solutions for dealing with urban overheating and for climate-resilient urban development are being researched and tested in Living Labs.

Green facade, 1060 Vienna
Photo: Waldhör KG

Strategies, tools and Living Labs for cooling cities

Cooling-optimised urban open space "Airship 01", photo: Waldhör KG

Proceeding urbanisation plays a major role in regional and global warming. New concepts, technologies and planning tools are required for sustainable, climate-sensitive urban development.

Climate change and the microclimate in urban areas are closely linked. Cities consume a great deal of energy and resources and emit high levels of CO_2. They are also amongst the critical areas where the effects of climate change are most noticeable. Alongside air pollution, dust and noise, there are also extreme weather events – occurring more frequently due to climate change – which all have a negative impact on the health of residents and their quality of life. Research and development activities for sustainable cities are targeted towards advancing Smart City solutions that protect the environment and resources and at the same time increase the capacity of urban systems to adapt to climate change, in order to improve the living conditions in urban spaces. User participation, for example through Living Labs, plays an important role in the development and implementation of new concepts and technologies for a better urban climate.

HEAT ISLANDS IN THE CITY

One of the key microclimatic problems in urban areas is the increase in temperature caused by the urban heat island (UHI) effect. Cities have climates that differ fundamentally from their surrounding areas. High-density construction and a high proportion of sealed ground surfaces mean that cities have a much larger surface area than less populated regions. During the day, roofs, facades and sealed surfaces absorb more solar radiation and thus heat, which is stored in the city's building structures and released again at night. The lack of vegetation and reduced air circulation gives rise to so-called heat islands. Due to the high level of impermeability, rainwater in the city is channelled away through networks of drains and sewers. Cooling through ground evaporation is therefore also greatly reduced. Temperature differences between the city and the surrounding area can be significant, especially at night.

For elderly people, the chronically ill, children and the socially disadvantaged, extreme heatwaves can cause serious health issues. Another problematic effect of urban overheating is the growing demand for energy to cool and ventilate buildings.

URBAN GREENING

Larger, linked green spaces in urban areas, such as parks, grassed areas, green corridors, community gardens, green roofs and facades, tree planting, rain gardens etc., counteract the consumption of land and soil sealing, improve the microclimate and effectively reduce the urban heat island effect. At the same time, they help to diminish air pollution, noise, dust and carbon dioxide emissions. Green public spaces are important for social interaction and enhance the quality of life for city dwellers.

Green infrastructure, Viertel Zwei, 1020 Vienna, photo: Waldhör KG

IMPROVING THE URBAN CLIMATE

When planning districts and urban infrastructure, city authorities now have to consider climate models in order to apply suitable strategies for adapting to anticipated changes in the climate. In Austria, there are numerous R&D projects under way to develop innovative concepts, tools and solutions for sustainable cities. Targeted measures – both high-tech and low-tech – can help to reduce the extreme heat stress in cities. An important aspect of climate-sensitive urban planning is the creation of cool oases, for example through green infrastructure, facade and rooftop greening, as well as integrating waterbodies. Another research focus is to improve the heat-radiating properties of buildings and surfaces through the use of reflective colours and suitable materials.

"City of Tomorrow" and "Smart Cities Demo – Living Urban Innovation" are programmes initiated by the Federal Ministry for Transport, Innovation and Technology and the Climate and Energy Fund, to support sustainable developments and integrated concepts for smart, resilient urban development and the implementation of "green" and "blue" infrastructure measures. Key elements are the involvement of city dwellers, and networking and cooperation between policymakers, business, research institutes and administrative bodies. ●

KLIMAFONDS DOSSIER URBANE KÜHLUNG

Background information, reports, interviews, expert commentaries etc. on the topic of "Urban cooling" can be found in the current dossier of the Climate and Energy Fund. (in German)

www.klimafonds.gv.at/dossier/urbane-kuehlung

Green facade, 1150 Vienna, photo: Waldhör KG

Rising temperatures in Austria

By 2050, average temperatures in Austria are forecast to be more than 2 °C higher than in the 1980s. Hot and very dry summers are expected. In 2018 several regions in Austria recorded three times more heat days (with temperatures of at least 30 °C) in comparison to the long-term average. The city centre of Vienna recorded 42 hot days.

Sources: Central Institution for Meteorology and Geodynamics (ZAMG), 2018, www.oesterreich.gv.at/themen/bauen_wohnen_und_umwelt/klimaschutz/

Greened city district, photo: Waldhör KG

Green and resilient city

Control and planning instruments for climate-sensitive urban development

Many studies have already shown that properly considered building structures, together with green and blue urban infrastructure, can make a significant contribution to reducing the urban heat island (UHI) effect. Which measures are necessary at which locations, and what specific climatic effects these have, can only be demonstrated with (micro-) climatic simulations. In the project "Green and resilient city", led by the University of Natural Resources and Life Sciences, Vienna (BOKU)*, various climate simulation instruments are being combined and applied to landscape and urban planning. The goal of the project is to create a "proof of concept" for a control loop and toolset for regulating, optimising and evaluating green and climate-sensitive landscape and urban (district) planning. It comprises urban development and open-space planning tools as well as climate simulations on various levels.

REDUCING THE URBAN HEAT ISLAND EFFECT

Measures for reducing the urban heat island effect can be implemented on different levels – from greening individual buildings or roads to considering the climatic performance of various building typologies and housing structures in areas of urban expansion. A well-considered combination of measures can have an impact beyond the local area. For example, planting a tree has a positive microclimatic effect (shading, evapotranspiration) on its immediate surroundings. Greening several streets in a district has a more extensive effect.

TOOLSET FOR VARIOUS LEVELS

The first multi-scale toolset for green and climate-sensitive urban (district) planning will be created within the framework of the project. It comprises a green and open space factor (BOKU) as an urban measure as well as a control and planning tool at plot level, the GREENPASS® (green4cities GmbH) as a tool for optimising the microclimatic effects of green infrastructure at plot and district level, the urban climate model MUKLIMO_3 (ZAMG) as an evaluation tool for the mesoclimatic effect at city level, and Cosmo-CLM (AIT) as a regional climate simulation model.

USE IN PRACTICE

The practicality and effectiveness of the toolset for developing green and climate-resilient city districts are being tested in two Viennese districts – the urban renewal area of Innerfavoriten/Kretaviertel in Vienna's 10th district and the urban extension area of aspern Seestadt.

In Seestadt, the urban development competition "Quartier Seeterrassen" was supported by the research project and the joint use of the tools was successfully tested. A specified target value for the green and open space factor ensured an appropriate level of greening.

*** PROJECT PARTNERS:**
University of Natural Resources and Life Sciences/Institute for Landscape Planning (BOKU ILAP) and Institute for Landscape Development, Recreation and Nature Conservation Planning (BOKU ILEN), green4cities GmbH, ZAMG – Department of Model Applications, Vienna 3420 aspern Development AG – aspern Die Seestadt Wien, AIT – Austrian Institute of Technology GmbH, MA 22 – Environmental Protection

“The implementation of climate-resilient urban planning and development is being supported for the first time with the ‘Green and resilient city’ toolset. The research project will create fundamental principles to enable cities to implement sustainable urban planning in face of the challenges posed by climate change, from construction site level to the city as a whole. Comprehensive greening helps to overcome these challenges and creates value added for all residents.”

ASSOC. PROF. DORIS DAMYANOVIC
PROJECT DIRECTOR “GREEN AND RESILIENT CITY”

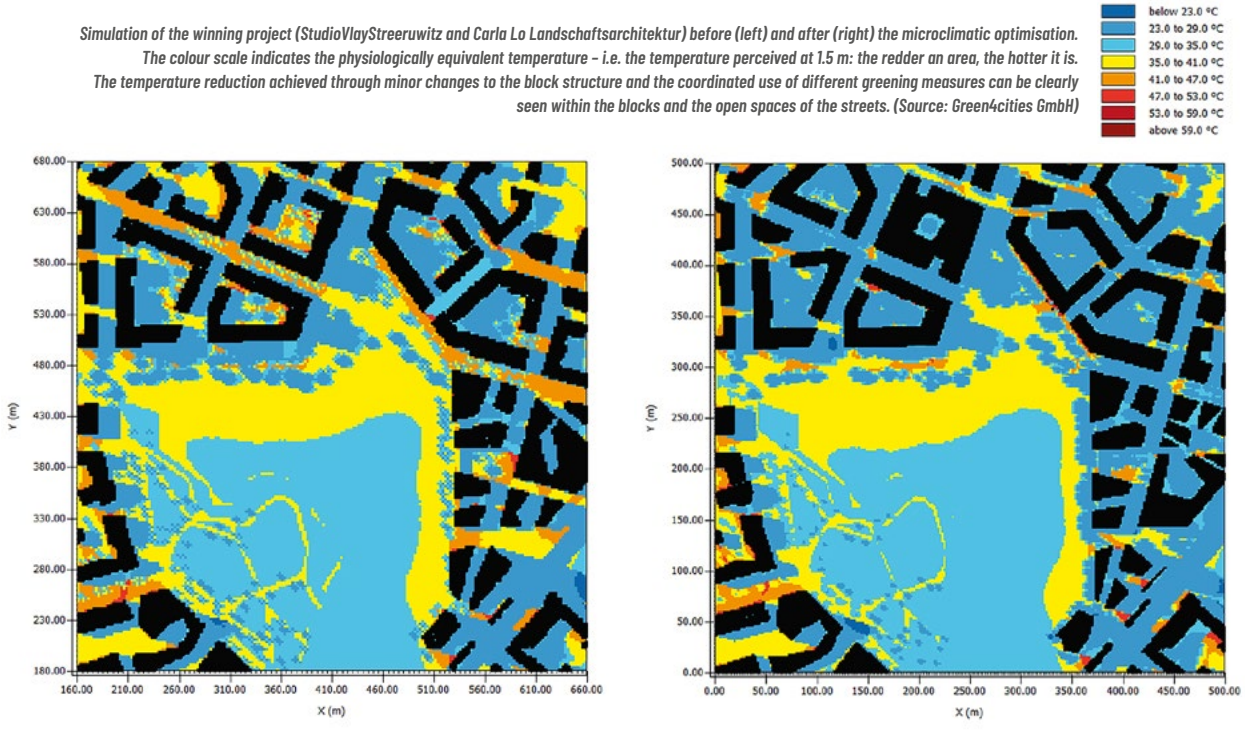
Photo: University of Natural Resources and Life Sciences (BOKU)

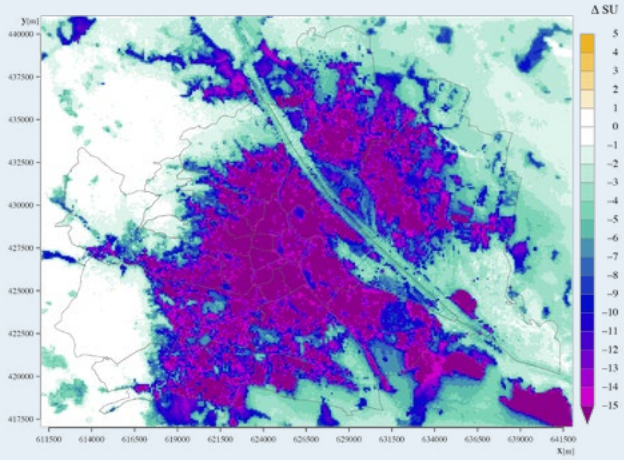
The GREENPASS® allowed simulation, comparison and analysis of the effectiveness of green infrastructure and the effects of the built structures proposed in the various competition submissions.

However, this scientific support did not end with the announcement of the winning project. Building on the results of the simulation, adaptations were formulated for the winning project and optimisations made by introducing various targeted measures. With the green and open space factor, the necessary extent of greening was embedded in the urban development mission statement for further planning and implementation processes. The planning area was additionally simulated with MUKLIMO_3 in order to demonstrate the climatic effects on the district as a whole. ●

aspern Seestadt, photo: Waldhör KG

Simulation of the winning project (StudioVlayStreeruwitz and Carla Lo Landschaftsarchitektur) before (left) and after (right) the microclimatic optimisation. The colour scale indicates the physiologically equivalent temperature – i.e. the temperature perceived at 1.5 m: the redder an area, the hotter it is. The temperature reduction achieved through minor changes to the block structure and the coordinated use of different greening measures can be clearly seen within the blocks and the open spaces of the streets. (Source: Green4cities GmbH)





Microclimatic simulation for Vienna – theoretical overall potential, change in average annual number of hot days compared to the reference simulation based on the normal climatic period 1981-2010, source: ZAMG

KELVIN

Potentials of activities to reduce the urban heat island

The KELVIN project, led by the JOANNEUM RESEARCH Forschungsgesellschaft mbH*, analysed various concepts for the reduction of urban heat islands. One of the central questions concerned the effect that a change in the surface albedo, i.e. the reflectivity of roofs, roads and parks, has on the microclimate in densely developed urban areas. The influence of green roofs on the urban heat island effect was also investigated. Using the city of Vienna as an example, possible consequences were quantified, such as energy savings from a reduced demand for building cooling, and reductions in carbon dioxide emissions.

REDUCING URBAN HEAT ISLANDS

Solar energy is absorbed and stored more and for longer in urban areas than in rural landscapes. The type and colour of the surfaces of roofs, roads, parking spaces, etc. as well as the thermal storage capacity of the materials used play an important role in this effect. Based on high-resolution topographical and land use data, reference values for the albedo of the existing buildings in Vienna were collected from satellite data for the period 2000 to 2014. With the help of microclimatic simulations, the project team was able to estimate how the urban heat could be reduced by changing the surface albedo of different urban structures and through increasing rates of evaporation from green areas (e.g. by using highly reflective roof coverings, green roofs and facade greening).

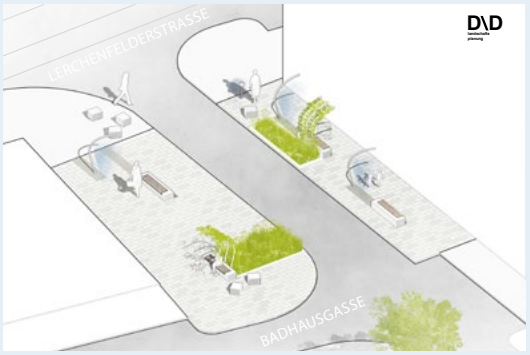
ESTIMATING POTENTIALS FOR VIENNA

The project results show that the comprehensive use of highly reflective roof coverings with a reflective capacity of approx. 70%, combined with fully exploiting the potential for roof greening in Vienna, would lead to a sharp decline in the number of hot days (maximum temperatures ≥ 30 °C). Based on climate values for the years 1981 to 2010, these actions could give a maximum reduction in the number of hot days for the Vienna city centre (Innere Stadt district) of 29%, and of up to 20% for areas away from the centre. If highly reflective building facades and sealed surfaces are also included in the model (as a theoretical overall potential), then a maximum reduction in the number of hot days of up to 53% could be achieved, e.g. for the Innere Stadt district. The energy-saving potential in these scenarios – for the same cooling performance – is approx. 5,000 to 20,000 MWh per year. This would save between 600 and 2,000 tonnes CO_2 equivalent of greenhouse emissions.

Subsequent projects will aim to develop methods for low-cost transfer of this model to other cities. Plans are also in place to implement case studies, e.g. measurements on installed roof surfaces with a higher albedo or roof greening, planting in pedestrian zones, etc. in selected Austrian cities. ●

*** PROJECT PARTNERS:**
JOANNEUM RESEARCH Forschungsges. mbH, DIGITAL – Institut für Digitale Bildverarbeitung (Institute for Digital Image Processing), LIFE – Institut für Klima, Energie und Gesellschaft (Institute for Climate, Energy and Society), ZAMG – Zentralanstalt für Meteorolgie und Geodynamik (Central Institute for Meteorology and Geodynamics)

Vienna, photo: Climate and Energy Fund/Hans Ringhofer



PLATZSITUATION BADHAUSGASSE

Light reflecting surface, greenings and water mist systems, „Kühle Meile" project, Zieglergasse, 1070 Vienna; Copyright: D/D Landschaftsplanung, www.dnd.at

The 50 green-facade modules are mounted on the street-facing side. They are suitable for both existing and new buildings. Installation is also possible on insulated facades. The 100 x 40 cm stable troughs are made from fibre-reinforced cement.
Both illustrations: Gs6_Isabel Muehlbauer

Owing to high demand, the greening system will be available to residents throughout Vienna in the future. It will be supported by the City of Vienna's green facade programme.

GREENING 50 HOUSES

Low-tech green facade systems undergoing testing

Greened facades have a positive impact on the microclimate in the city. On hot summer days, they provide cooling, improve the air quality and contribute to the greater well-being of residents. There are many options for greening building facades in Vienna, but in the past these have not included low-cost, simple solutions for retrofitting on existing buildings. Complicated application and approval processes with the relevant authorities and within tenant groups make it more difficult to realise green facades in urban environment.

The research project "50 Green Houses"* was developed, in collaboration with the City of Vienna, as an integrated solution for simple greening of building facades in the city. The system consists of the BeRTA module, i.e. a low-cost planter system with supports for climbing plants and corresponding maintenance concept. The approval process is handled by an innovative submission tool with a quick-check function for the relevant authorities. This links the city administration, owners and residents and provides support during implementation of the project. An online manual leads applicants through the submission process step by step and requests all the necessary data on the planned project in a quick and straightforward manner. All requirements of the relevant municipal departments have been taken into consideration in the intelligent submission form, to enable quick and easy explanation by the project team for the authorities.

FIRST PROTOTYPES IN VIENNA

This integrated solution is currently being implemented in a co-creation process with 50 demo modules in the district of Favoriten. Interested parties were invited to make submissions in early 2019, in order to receive a BeRTA green facade module free of charge. "BeRTA" stands for the elements of the module in German: "Begrünung – Rankhilfe – Trog – All-in-One", or "Greening – Climbing support – Trough – All-in-one" in English.

The module consists of a 300-litre planting container, a climbing support (where required or technically feasible), substrate and two climbing plants, to provide around 8 m^2 of greening. The data entered online help the experts to select the individual module configuration for the building in question: plants are selected to suit the location and nature of the facade. Delivery, assembly and training for maintaining the greened facade are included.

SCIENTIFIC EVALUATION

The first 50 green facade modules are being scientifically supervised. This monitoring covers both the technical (and horticultural) aspects and the social impact of facade greening in the target district of Innerfavoriten, and supplies data for decision-makers, planners, builders and developers. On the basis of these findings, this innovative model should also be transferable to other cities. ●

https://50gh.at/

*** PROJECT PARTNERS:**
tatwort Nachhaltige Projekt GmbH (management), GrünStattGrau Forschungs- und Innovations GmbH (grünstattgrau.at), Die Wiener Volkshochschulen GmbH – DIE UMWELTBERATUNG, Vienna Environmental Protection Department (MA22) of the City of Vienna, University of Natural Resources and Life Sciences (BOKU), Department of Civil Engineering and Natural Hazards, Institute of Engineering Biology and Landscaping (IBLB)

LiLa4Green

Living Lab for "green" and "blue" infrastructure measures in Smart City Vienna

Project "Favoriten's Favourite Stripes", actual situation and visualisation of greening measures, authors: Verena Matlschweiger, Teresa Pink, Lisa Steiner, TU Wien (Vienna University of Technology)

In the project LiLa4Green, a research team led by the AIT Austrian Institute of Technology*, working together with city residents, is developing concepts and solutions for counteracting urban overheating in city districts. A green network of parks, green spaces and areas of water, facade greening and tree planting is intended to create "urban oases" and thus increase the quality of life on hot summer days.

Using the example of two existing urban areas in the 10th and 14th districts of Vienna, the aim is to investigate how so-called "Nature Based Solutions" (NBS) can be implemented in practice. The involvement and cooperation of residents plays a key role in this. The goal is to achieve a positive social effect and acceptance for the measures. User participation is facilitated with the help of innovative social-scientific methods in combination with the latest digital technologies. New forms of assessment (e.g. crowdsourcing) and visualisation (Augmented Reality) are also being tested.

SOLUTIONS FROM THE LIVING LAB

In the Living Lab, various solutions, with and without a networked system of urban oases, are compared and discussed with residents and stakeholders. Apart from calculating the ecological and microclimatic impact of "Nature Based Solutions", the costs and maintenance effort for the various measures are also being assessed. Measurements, simulations and surveys are to be carried out within the framework of a monitoring programme. The researchers also want to evaluate the social effects of these greening measures. The results of the investigations should subsequently be transferable to other Viennese districts and Central European cities. ●

https://lila4green.at/

*** PROJECT PARTNERS:**
AIT Austrian Institute of Technology GmbH, TU Wien (Vienna University of Technology) Institute for Urban Design, Urban and Regional Planning, Weatherpark GmbH Meteorological Research and Services, PlanSinn Planung und Kommunikation GmbH, GREX IT Services GmbH, GrünStattGrau Forschungs- und Innovations GmbH (grünstattgrau.at)

INTERACTION OF BUILDINGS AND OPEN SPACES

A functioning and coherent network of green and open spaces is important to keep the city properly ventilated. The density, in particular the relationship between the height of the buildings and the distance between them, determines how much sunlight penetrates an urban space and whether this space is able to cool down again at night.

At the training event "Grün'o'polis – Grüne Wege in der Stadt", at TU Wien (Vienna University of Technology), ideas and concepts for green and blue urban infrastructure in the LiLa4Green areas were developed and presented.

Image: Layout plan from the project "Favoriten's Favourite Stripes", authors: Verena Matlschweiger, Teresa Pink, Lisa Steiner, Vienna University of Technology

"High temperatures and persistent heat are a source of stress, particularly for residents of urban areas. The city is warming up – green oases and urban areas of water can counteract this as a natural air conditioning system. Of course, awareness must first be raised amongst the public and decision-makers about these (simple) measures. In the project LiLa4Green, we pursue a holistic approach that combines scientific and social aspects with the latest digital technologies. This means we are bringing the topic of Greenness to the streets and to the public, by developing and implementing solutions together with the resident population in a 'living laboratory'."

TANJA TÖTZER, PROJECT DIRECTOR OF LILA4GREEN
AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

Photo: AIT Austrian Institute of Technology GmbH/Zinner

For specific places in the urban area, visualisations of greening measures in public spaces can be accessed via a link. In the future, residents should be able to evaluate different variants from their mobile phones.
Photo: PlanSinn - Schopper

The potential for implementing green infrastructure measures was investigated for the area of Quellenstrasse Ost in Innerfavoriten, 1100 Vienna. The main focus of attention is on the dense stock of largely mid-19th century buildings, since the need for action is particularly urgent here.
Image: TU Wien (Vienna University of Technology)

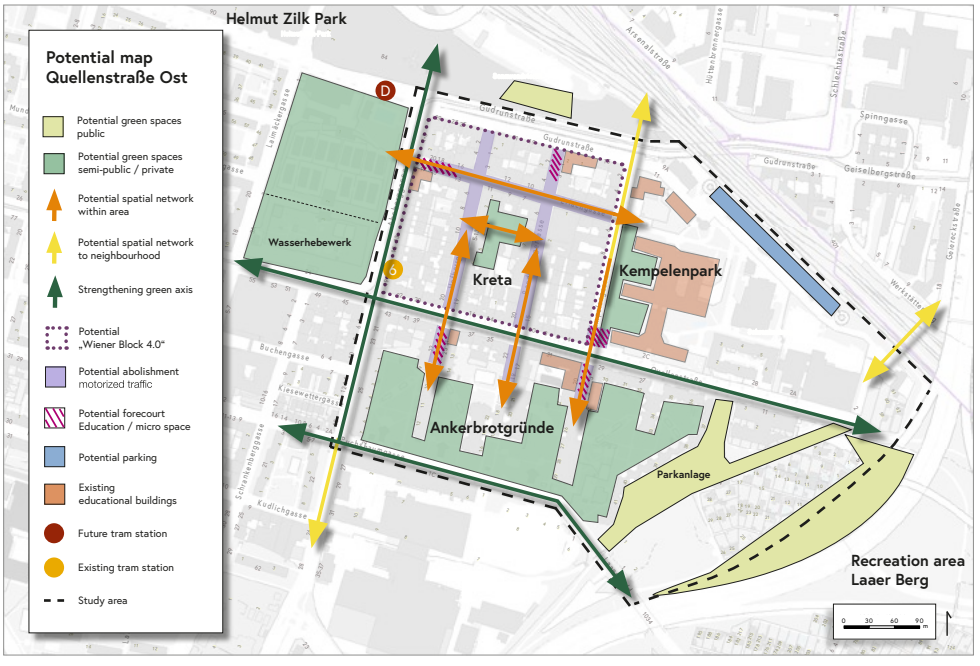


Photo: Municipality of Leibnitz

COOL LEIBNITZ

Smart and resilient urban development

Leibnitz in Styria, a district capital with 12,374 inhabitants (as at 1 January 2019), is one of the few growing small towns in Austria. Without corresponding countermeasures, the influx of people and redensification are leading to an increase in traffic, rising energy consumption and a loss of green spaces. This is likely to impair the quality of life in the town in the medium term.

Leibnitz is one of the warmest towns in Austria. Summertime overheating with temperatures close to 40 degrees Celsius has been a frequent occurrence for a number of years now and is degrading the quality of life, particularly in the town centre.

AN INTEGRATED OVERALL CONCEPT

With Cool Leibnitz (**C**limate **O**ptimised **O**ffensive for **L**eibnitz)*, the municipality has launched a comprehensive, participative process for smart and resilient urban development. To this end, numerous topic-specific concepts have been merged into an integrated overall plan. This plan includes the transport and traffic concept, the town's spatial planning model, a completely revised energy concept, concepts for public green spaces for the town's infrastructure department, the mobilisation of building land, flood protection concepts, the purchase of land by the public sector as well as a concept prepared by the business association WISTA SÜD. The framework conditions for realising this comprehensive concept were created through collaboration between investors and developers, policymakers, administrators and citizens.

ADAPTING TO CLIMATE CHANGE

Cool Leibnitz established a link for the first time between "Sustainable development", "Quality of life" and "Resilience to climate change". An important focus is the development of strategies for managing extreme weather events. Overheating in summer needs to be tackled with the targeted expansion of "green" and "blue" infrastructure in the town centre. The first step involved identifying the existing green spaces within the housing structures of the municipality of Leibnitz and analysing their influence on the town's climate and quality of life.

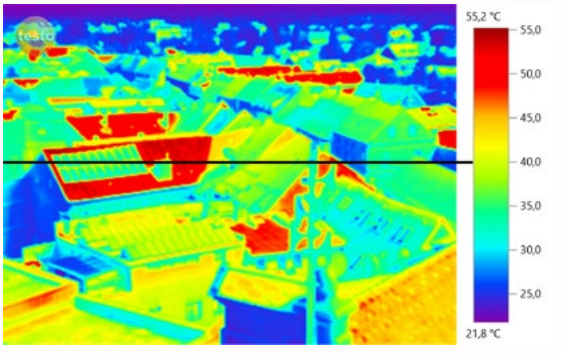
In summary, the analysis reveals a significant lack of public green spaces in a densely populated district. Blue infrastructure is entirely absent in the urban area. A map of the "heat islands" clearly shows that the proportion of critical areas rises with increasing proximity to the town centre and intensity of use. The available facts and figures lay the foundation for future urban planning decisions.

In the follow-on project "Cool Leibnitz DEMO", the example of City Centre South will demonstrate how qualitative redensification as well as cooperative and integrative planning processes support the transformation to a mixed-use, climate-resilient and liveable area of experience, social interaction and economic activity. ●

https://smartcities.at/stadt-projekte/smart-cities/#cool-leibnitz
https://smartcities.at/stadt-projekte/smart-cities/#kooperativer-transformationsprozess-stadtkern-sued-in-leibnitz

*** PROJECT PARTNERS:**
Municipality of Leibnitz, HC-Heigl Consulting ZT GmbH, Horn Consulting, StadtLABOR – Innovationen für urbane Lebensqualität GmbH

Images from a thermal imaging camera in Leibnitz, measurements by StadtLABOR Graz, Hans Schnitzer



TRÖPFERLBAD 2.0

"Coolspots" as cool urban oases

For several decades from the end of the 19th century, a type of public baths known in Vienna as 'Tröpferlbad' were the only way for the city's residents to keep themselves clean. Today, there is less focus on hygiene: "coolspots" are intended to improve the quality of life in the city on hot days.

Airship.01 in the MuseumsQuartier Vienna, photo: Waldhör KG

How is it possible to plan, develop and implement "cool retreats" in the heart of the city? This is currently being investigated and tested by Green4Cities GmbH in cooperation with the Breathe Earth Collective, and in collaboration with the City of Vienna and numerous partners*, in the project Tröpferlbad 2.0.

"Coolspots" are cooling-optimised outdoor spaces which have a noticeably lower temperature on hot days. These mobile spaces, constructed from lightweight elements, should have a modular and flexible design and are intended for use throughout the urban area, adapted to the location in question. The open spaces, where the city's residents can recover from high temperatures, will be equipped with "green" and "blue" infrastructure. Shading elements, fans and spray mist systems support the plants with evapotranspiration and help to cool the air in a natural way.

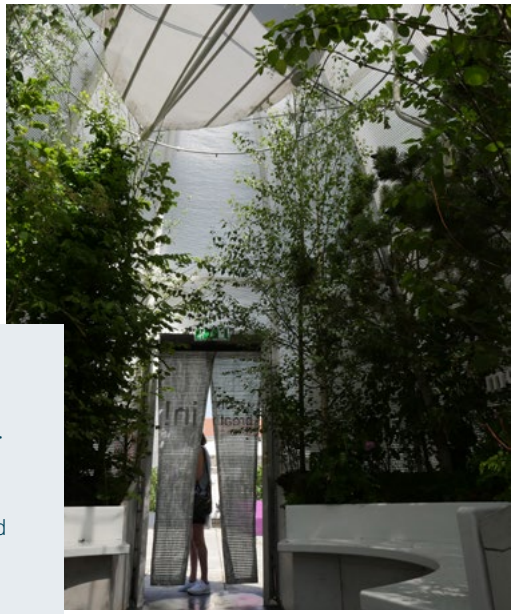
Technical, ecological and social aspects of the concept are being explored within the framework of this application-oriented research project. To ensure climate effectiveness, microclimatic simulations are carried out using GREENPASS®. Findings on the microclimate, the materials used, the provision of energy and user behaviour are collected and analysed. Participation measures for ensuring public involvement are also being developed and tested.

Initial prototypes will be implemented on the basis of these findings. In the medium term, the City of Vienna wants to create a network of cool urban oases distributed across the entire city. ●

*** PROJECT PARTNERS:**
Green4Cities GmbH, Breathe Earth Collective, City of Vienna (MA 18, MA 20, MA 22, MA 25 and KBI), Austrian Society for Environment and Technology, Urban Innovation Vienna GmbH, Rockets Holding GmbH, Wien Energie GmbH, Büro für nachhaltige Kompetenz B-NK GmbH, Die Treiber e.U.

Airship.01

This mobile art installation is a prototype for a cooling-optimised urban open space. The forest oasis cleans the air, cools the urban space and produces fresh oxygen for visitors. The installation was developed in 2016 by the Breathe Earth Collective on behalf of Österreich Werbung as a further development of the award-winning Expo pavilion "Breathe Austria" in Milan.



Airship.01 , MuseumsQuartier Vienna (until 15 September 2019), Home to 12 trees and 200 shrubs, the pavilion is open to the sky and equipped with a reflective outer membrane, fans and a spray mist system, photo: Waldhör KG

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www.energy-innovation-austria.at

INFORMATION

Green and resilient city
Control and planning instruments for climate-sensitive urban development
University of Natural Resources and Life Sciences, Vienna (BOKU)
Institute of Landscape Planning
Contacts: Assoc. Prof. Doris Damyanovic
doris.damyanovic@boku.ac.at
Florian Reinwald
florian.reinwald@boku.ac.at
www.rali.boku.ac.at/ilap.html

KELVIN
Reducing urban heat islands by improving the radiating properties of buildings and districts
JOANNEUM RESEARCH Forschungsgesellschaft mbH
Contact: Hannes Schwaiger
hannes.schwaiger@joanneum.at
www.joanneum.at

Greening 50 Houses
Green facade system undergoing testing
tatwort Nachhaltige Projekt GmbH
Contact: Victoria Hala
victoria.hala@tatwort.at
https://50gh.at

LiLa4Green
Living Lab for "green" and "blue" infrastructure measures in Smart City Vienna
AIT Austrian Institute of Technology GmbH
Contact: Tanja Tötzer
tanja.toetzer@ait.ac.at
https://lila4green.at

Cool Leibnitz
Smart and resilient urban development
Municipality of Leibnitz
Contact: Astrid Holler
astrid.holler@leibnitz.at
www.leibnitz.at/projekte/smart-cities

Tröpferlbad 2.0
Coolspots as cool urban oases
Green4Cities GmbH
Contact: Doris Schnepf
office@green4cities.com
www.green4cities.com

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