

Chapter 9

Pilot Action City of Vienna – UHI-STRAT Vienna

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Abstract The article presents the results of the pilot action “Urban Heat Islands–Strategy Plan Vienna” (UHI-STRAT Vienna). It sets out by determining what potential consistent consideration of urban climate aspects at different levels of action and decision-making has and how to implement such consideration. In a second step it looks at today’s and future development of UHI and the urban climate. The report goes on to explain the three fields of action identified, i.e. awareness building, information and public relations for UHI, as well as urban infrastructure and large-scale and more detailed technical and structural measures to support strong consideration of the issue. It shows up the levels of action in planning from the master plan to the actual project and the options available in the course. Two feasibility studies reveal how UHI-relevant measures can be implemented in designated areas of the city. They make a clear distinction between measures in the development of new city quarters and measures in adapting existing ones, and they also identify two different levels of planning, the strategic master plan on the one hand and the planning of legal provisions, i.e. the land-use and building development plans on the other hand. The “Master Plan for Nordbahnstraße – Innstraße” in Vienna’s 20th municipal district is used as an example to show how measures can be introduced at different stages of the master plan process. Proposed measures can be embedded in land-use and building development plans, as demonstrated in the case of the quarter surrounding the Vienna University of Technology (Karlsplatz) in the 4th municipal district. The studies were assessed as to the feasibility of the measures proposed, which involved participation of different agencies of the Vienna

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City Administration. The summary points out the project's added value for the city, indicating that the journey Vienna has taken to protect the climate while at the same time adapting to the consequences of climate change is bound for success.

9.1 Introduction

The pilot action “Urban Heat Islands – Strategy Plan Vienna” (UHI-STRAT Vienna) is meant to trigger discussion processes, to make the problems entailed in UHI visible for political decision-makers and the city administration, as well as to offer assistance and clearly defined solutions. The results of the pilot action UHI-STRAT Vienna are helping to put the issue of Urban Heat Islands in the focus of future urban development. Increasing heat stress and a rising temperatures during the summer months as predicted for the City of Vienna can be mitigated by putting into place the strategic and technical measures proposed. Protecting and expanding the city's green infrastructure, for example, can effectively reduce the consequences of UHI while at the same time improving people's quality of life and boosting urban biodiversity. The pilot action UHI-STRAT Vienna helps the participating administrative agencies identify the measures relevant for their work, the measures they can implement in their own areas of competence, the steering tools and levels at their disposal, and the potential of the different measures. The pilot action UHI-STRAT Vienna was developed in close coordination with representatives from the Vienna City Administration and outside experts on the basis of autonomous yet interlinked discourses (Hubo and Krott [2012](#)).

9.2 A Consistent Strategy for UHI in Urban Planning

The objective of the UHI-STRAT Vienna is to integrate consistent consideration of urban climate aspects at different levels of planning. There is a wide range of tools where the (urban) climate already features strongly, along with a number of strategies and rules on how to tackle the phenomenon of Urban Heat Islands. The subject matter includes contracts under international law, such as the UN Climate Change Convention, Austrian wide approaches, such as the Austrian Strategy on Adaptation to Climate Change, regional approaches, such as the Climate Protection Programme of the City of Vienna, as well as federal and provincial laws, guidelines, planning tools and planning assistance. Mitigating the effects of UHI combined with forward-looking urban planning for the prevention of Urban Heat Islands has become a very integrative task. Different fields of action, steering levels and planning processes are either influenced by the implementation of measures or influence the latter in turn. It is important in the context to bear in mind the hierarchy of the planning tools and the chronological order the different tools are used in the course of planning.

This is why many aspects of adaptation to climate change have found their way into programmes and activities pursued by the City of Vienna, mostly in conjunction with objectives of environmental protection:

The Municipal Department for Environmental Protection has been promoting roof and façade greening for many years, measures to this end ranging from presentations, international congresses, publications and consultation with individual projects. It even has its own test area with several types of roof greening on the Department's office building. Numerous studies, expert meetings and public relations activities are dedicated to forward-looking use of rainwater (rainwater management), particularly with a view to raising the rate of evaporation. There is positive interaction with "ÖkoKauf" (EcoBuy Vienna), a programme for sustainable procurement, and "Öko Businessplan" (EcoBusinessPlan Vienna), a cooperation initiative with the economic chamber to consult businesses on ecological measures.

The ecological criteria set out in UHI-STRAT are in line with the Environmental Department's wildlife conservation programme "Netzwerk Natur" (network nature), a topic which is also addressed in the project "Nachhaltiger Urbaner Platz" (sustainable urban space), a checklist for sustainable design of urban spaces.

"Microclimate" constitutes a separate assessment category along with other environmental goods incorporated into the "strategic preliminary assessment of environmental impacts caused by housing projects". This tool is to make different locations and projects for the creation of housing more easily comparable and comprehensible with regard to their environmental impact at the urban development level already. It is to ensure that all environmental aspects are duly considered when choosing from different planning options.

All of the above programmes and projects are brought together in the city's Smart City Strategy and the Climate Protection and Adaptation Programme (KliP II).

Implementation of UHI-STRAT Vienna must be addressed both in the different fields of action and at the various levels of planning. The UHI effect needs to be considered with measures relevant to the city as a whole, as well as with those that have a bearing on individual lots or buildings. It means acting strategically and setting specific measures within one's own competence. Aside from large-scale urban planning approaches it is also important to build public awareness and make members of different Municipal Departments and agencies with the Vienna City Administration sensitive to today's and tomorrow's challenges in tackling the UHI phenomenon.

The city administration, builders and developers, private ones too, have the right to set measures of their own accord for the purpose of reducing the UHI effect.

Circumstances and concepts for reducing or preventing the UHI effect may vary depending on the location and occasion. Each development task (e.g. planning a new city quarter, adapting and enhancing existing buildings or project-related processes) has its own set of actions and measures. Political and legal settings, as well as planning instruments provide the basis for realising urban planning and development that is sensitive to UHI. Adjustment measures to reduce Urban Heat Islands are positioned at various political and legal levels and provide the frame for UHI-STRAT Vienna.

9.2.1 Consolidation at the European and the National Level

The “EU Strategy on Adaptation to Climate Change” (2013) is based on the premise that climate protection measures must be paired with adaptation measures if Europe is to master the challenges of climate change. From the point of view of the EU Commission “it is cheaper to take, early, planned adaptation action than to pay the price for not adapting” (COM 2013, 2). The objective must be to raise climate resilience in Europe. The adaptation options are threefold: “gray” and “green” infrastructure approaches, as well as “flexible” structural approaches (COM 2009). Promoting functions and services within ecosystems is considered imperative as these are considered more cost-effective and sometimes more viable than simply trusting grey infrastructure (COM 2009, 6). The “Austrian Strategy on Adaptation to Climate Change” (2012) adopted by the Council of Ministers also makes it clear that along with measures to limit the global rise in temperature it also takes suitably and timely adaptation measures. This second pillar of climate policy constitutes a major complement to climate protection seeing as it reduces greenhouse gases. More specifically, the Austrian strategy emphasises the negative effects of heat waves on people’s health and the importance of measures to reduce these (Federal Ministry of Agriculture, Forestry, Environment and Water Management 2012a, b, 5). The rise in hot days and the heat stress they create are considered tomorrow’s challenges which adaptation measures are required for. Land-use planning is addressed as one of 14 main fields of activity (Federal Ministry of Agriculture, Forestry, Environment and Water Management 2012a, b, 16). “Prevention of overheating and heat islands and compensation of bioclimatic stress for people’s health” is to be made possible by providing, in development plans, “green” and “blue” infrastructure for built-up areas, as well as “measures with an impact on bioclimate” (Federal Ministry of Agriculture, Forestry, Environment and Water Management 2012a, b, 117f). The strategy also calls for a ‘Climate Proofing’ of spatial planning and tools “to systematically consider the impact of climate change” (Federal Ministry of Agriculture, Forestry, Environment and Water Management 2012a, b, 118f).

9.2.2 Strategic Approach to UHI-Relevant Aspects in Vienna

The City of Vienna has taken a strategic approach to climate-sensitive action and measures to adapt to climate change.

The objectives and results of the individual aspects were combined to form the “**Smart City Vienna Framework Strategy**” adopted by the Vienna City Council in 2014. It is an umbrella strategy for the period up to 2050 to be implemented step by step, individual objectives being subject to continuous monitoring. The overriding goal is to reduce CO₂ emissions from currently 3.1 tons per head to approximately one ton (minus 80 % from 1990 to 2050). Unlike comparable strategies in other cities it encompasses environmental protection goals beyond that, such as reducing the share of motorised private transport from currently 28 to 15 % by 2030, or maintaining the high share of green areas of 50 %.

The current *Climate Protection Programme of the City of Vienna (KliP II)* encourages strong consideration of the UHI effect in tools of spatial planning, nature conservation plans, as well as informal tools. The “Climate Protection Programme of the City of Vienna (KliP II) – update 2010–2020” adopted by the Vienna City Council has coined as its key goal the reduction of greenhouse gases and proposes measures to adapt to and mitigate the impact of climate change. It contains a separate field of action dedicated to “mobility and urban structure”. Again the focus is primarily on reducing energy consumption. The set of measures, however, clearly addresses urban planning measures that are to help reduce the UHI effect. Objectives for the field of action “urban structure and quality of life” include “pursuing integrated sets of measures to raise the quality of life in built-up urban areas (greening street space, courtyards and roofs, reducing soil sealing, upgrading green and open space,...)” (Vienna City Administration 2009, 93). Specific measures are “green paths, multiple use, activating green and open spaces already dedicated, roof greening, neighbourhood gardens and succession gardens” (Vienna City Administration 2009, 100). Regional cooperation must ensure “green and open space for the long term, linking green space (regionally) and strengthening awareness for agricultural products from the city region (Vienna City Administration 2009, 105et seq.). KliP II also for the first time stimulates Vienna’s measures to adapt to global climate change.

The *Urban Development Plan 2025* (STEP 2025) in particular broaches the issues of urban climate and climate protection. Its aim is to make “climate protection and adaptation to climate change integral elements of planning, implementation and further development of city quarters and open spaces”(STEP 2025, 85). This involves, amongst others, creating open and green spaces that can contribute towards reducing the UHI effect. Specific measures include the greening of roofs and facades, as well as planting trees and avenues (STEP 2025). The chapter on open spaces in STEP 2025 has a separate focus on “adaptation to climate change”. Green and open spaces in this context are granted a major role in adapting to climate change while special emphasis is placed on their positive influence on the urban climate. A network of open space is to improve the microclimate in individual city quarters. The initiative “urban green instead of air conditioning” wants to identify the areas concerned and reduce UHI.

The *Vienna Nature Conservation Act* wants to protect and “take care of nature in all its forms across the city and to ensure urban ecology functions” (Nature Conservation Act §1). Protection of green and natural areas includes urban climate aspects considering that climate is part of the landscape balance (section 3, para. 2). “All measures must be planned and implemented in such a way as not to endanger or seriously impair 1. the balance of the landscape, 2. its structure or 3. its recreational effect on human beings” Vienna Nature Conservation Act §4 para 2). Site protection as provided for in the Nature Conservation Act essentially ensures that green spaces and their role for the climate in Vienna are maintained for the long term.

The *Building Regulations for Vienna* (Vienna Urban Development, Urban Planning and Building Code) set out the principles of urban planning, land use and construction engineering. The first part lists the objectives for determining or

amending land-use and building development plans. These refer to climate-relevant aspects only indirectly, e.g. the objective “to (4.) preserve or create environmental conditions that will ensure a healthy environment, in particular with a view to housing, work and leisure time ” (Building Code for Vienna, §1, para 2 Z4).

Protection of the urban climate has been embedded in the strategic and legal tools to enable targeted measures for reducing the UHI effect.

9.3 UHI and the Urban Climate in Vienna – Status Quo and Future Developments

Building up natural permeable surfaces is considered the main culprit in the development of Urban Heat Islands (Kuttler 2011). The UHI effect is further enhanced by both a steady decrease and fragmentation of urban green spaces and the waste heat produced by industrial processes, air conditioning and motor vehicles. Construction developments also increase the surface roughness, slowing down wind speed in the course. They prevent cold air flows generated in undeveloped “cold air production sites” from entering the densely built-up city. Building developments in many cases act as an additional blockade for cold air flows from undeveloped environs to agglomeration areas. Generally speaking temperatures are expected to rise from the periphery to the city centre (see Fig. 9.1).

The isothermal map highlights the Urban Heat Islands, the outlines of the built-up area, as well as the “hot spots”, such as sealed car parks or industrial areas, and “cold spots”, such as parks, agricultural areas and bodies of water in Vienna.

Forecasts for climate development are subject to a certain amount of uncertainty. From today’s point of view temperatures in Vienna are reckoned to increase. “The 2040ies in the eastern parts of Austria will likely see an increase in temperatures of 1.3–1.8 °C in winter, 1.8–2.5 °C in spring, 2.0–2.5 °C in summer and 2.5–.0 °C in autumn, compared to the 1980s. Heat waves will be on the rise. Between 1961 and 1990 there were an average of 5.1 heat wave days per year (also known as “Kysely days”), between 1976 and 2005 there were as many as 9.1 already, and the current forecast for the period between 2010 and 2039 in the centre of Vienna is an average 17.7 Kysely days per year, the inner districts, because of the UHI effect, being more affected by the heat stress than the periphery” (Vienna City Administration 2009, 196) (Fig. 9.3).

The Central Institute for Meteorology and Geodynamics in Vienna (ZAMG), during the project “Focus I” (Zuvela-Aloise et al. 2013), calculated high-resolution, climate simulations of future heat stress in Vienna and examined the effectiveness of adaptation strategies in urban planning aimed at reducing heat stress in densely populated areas. The simulation showed how to improve buildings and open spaces by raising the amount of green and water surfaces, as well as the level of desealing, and by exploiting the Albedo (reflection coefficient) effect on surfaces and roofs.

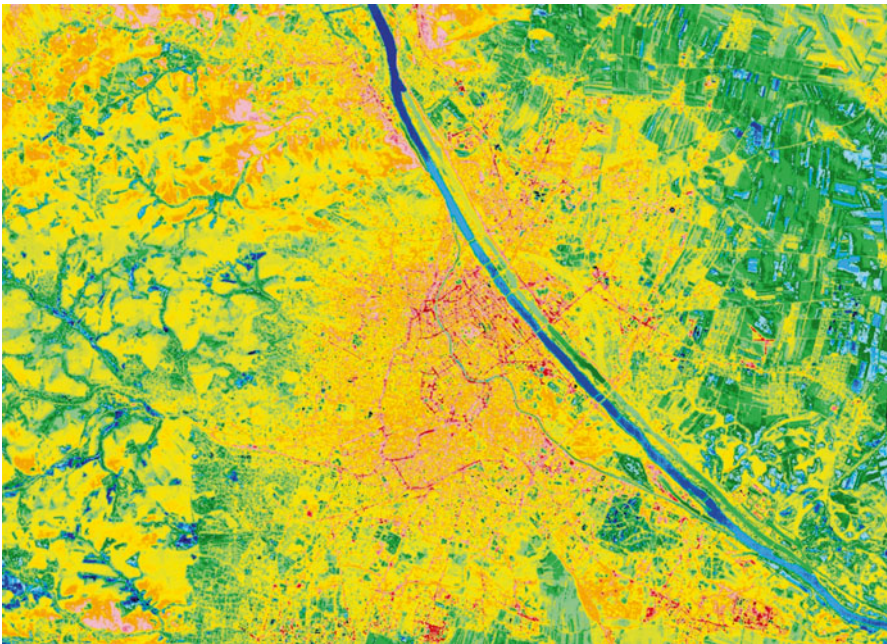


Fig. 9.1 Thermal image of Vienna and surroundings by night. There is a noticeable difference between the urban agglomeration and the cooler rural areas (Source: City of Vienna, MA 22)

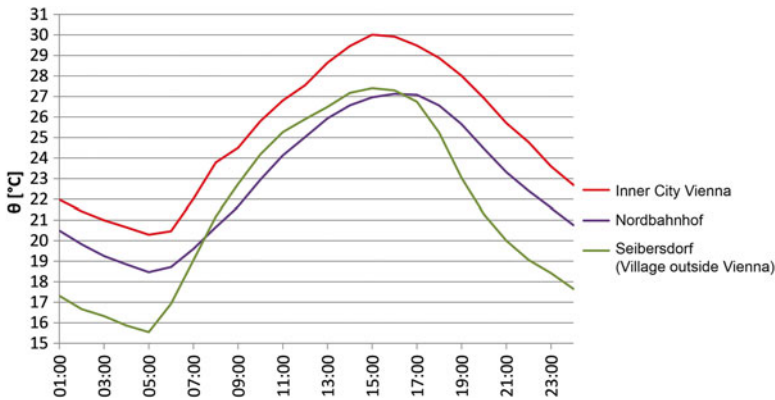


Fig. 9.2 The Fig. shows the average hourly temperature distribution on a given day in the summer of 2012 – pictured here are two selected areas in Vienna (see Sect. 9.6.2) compared to a rural area in Seibersdorf. Results clearly reveal significant differences in the microclimate of the areas studied, with conspicuously high temperatures in the city centre (Source: Vienna University of Technology, Mahdavi et al. 2014)

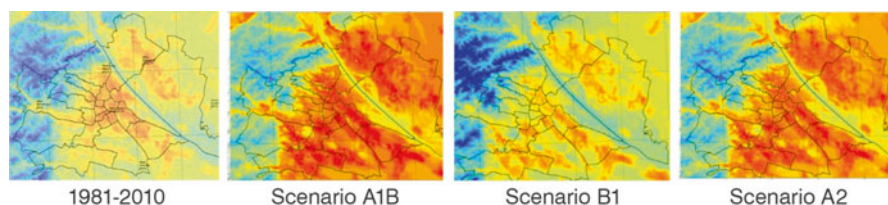


Fig. 9.3 Average annual number of summer days 1981–2010 (*far left*) and possible climate scenarios 2071–2100 (Source: Zuvela-Aloise et al. 2013)

The aim was to create a scientific foundation for urban planning to build on. The MUKLIMO_3 experiments, for the purposes of urban development strategies, arrived at the conclusion that there is a great need for adaptation measures if heat stress in the city is to be reduced significantly. Targeted small-scale measures, when combined with each other, such as increasing the share of green space (+20 %), reducing building density (–10 %) and desealing (–20 %), also have a decidedly positive effect (Zuvela-Aloise et al. 2013). All of the above can compensate the impact of climate change at least to some extent. Model results also revealed that because of the topography, the prevailing atmospheric circulation (NW and SE winds) and the different urban structures adaptation measures will not be felt the same throughout the city. Raising the share of green space (+30 %), for example, has a higher cooling effect in the city centre than it does in districts on the outskirts.

9.4 Fields of Action for UHI-STRAT Vienna – City-Wide Actions and Actions for Individual Lots and Buildings

UHI-STRAT Vienna identifies three fields of action to enhance consideration of the UHI effect, i.e. (1) awareness building, information and public relations for UHI, (2) urban infrastructure and large-scale strategic measures (3) and more detailed technical and structural measures.

9.4.1 Awareness Building, Information and Public Relations

This field of action covers measures aimed at making heat a major issue for future urban planning and development and at building awareness among people and planning experts in general.

It is primarily about providing information, whereby a distinction has to be made between information for residents and visitors to the city on the one hand and information relevant for planning purposes on the other hand. Information on (impend-

ing) heat stress for the city has been available since 2010. The Vienna Health Board in cooperation with the Central Institute for Meteorology and Geodynamics provides preventive information on expected heat waves on its website and via the local media (<http://www.wien.gv.at/gesundheit/sandirektion/hitzebericht.html>). This site, as well as that of the Public Health Services of the City of Vienna (MA 15) (www.gesundheitsdienst.wien.at), also explains about what to do in the event of a heat wave.

Implementing the UHI-STRAT also means building awareness and competences for the UHI issue and its impacts among the departments responsible for planning and projects at the City Administration. Spatial research and research projects on climate change are already generating information relevant for planning to some extent.

9.4.2 Urban Structure, Large-Scale Strategic Measures

When implementing measures a distinction is made between long-term strategic measures and the more specific technical and structural ones, the difference being the scale – from the city as a whole down to individual buildings and open spaces – and the time horizon. Building an interconnected network of open spaces to generate and distribute cold air and expanding the tree population in the city are strategic measures with a long-term effect.

9.4.3 Specific Technical and Structural Measures

This field of action describes different approaches for implementing the strategic goals of UHI-STRAT Vienna, as well as large-scale strategic measures for the planning and project stages. The 24 specific technical and structural measures are divided into five different areas, (1) green and open spaces (incl. streets), (2) water bodies in the city, (3) shading, (4) mobility and (5) buildings. The measures prepared take into account suitable courses of action with both existing and planned new structures.

9.5 Level of Action – From Master Plan to Project

Bearing in mind the overarching significance of Urban Heat Islands, the environmental and climate policy approaches for the protection of the (urban) climate and the rules and regulations associated with them the following main levels of action were identified for UHI-STRAT Vienna: (1) master plans and urban development guidelines; (2) strategic environmental assessment (SUP) and environmental impact

assessment (UVP); (3) land use and building development plan; (4) planning and development of public green and open space; (5) developer competitions, housing initiatives and public housing construction; (6) planning and development of public utility buildings and (7) subsidising measures.

When implementing measures it is important to take into account the hierarchy of planning levels and the chronological order different tools are employed in during the planning process. Interfaces with the various tools call for integrated planning and harmonisation across departments and agencies if the measures employed against the UHI phenomenon are to be successful.

9.5.1 Master Plans and Urban Planning Mission Statements

Urban development mission statements and master plans have a major bearing on subsequent steps of planning and development in city quarters (MA 21B, 2010). They harmonise public and private interests and create the foundation for further planning. Urban development structures, building density and distribution of open spaces are determined right here. While this planning level is not legally binding it is usually confirmed by a City Council decision to be used as a guiding principle for further development.

Urban development master plans, as a rule, are developed through a number of processes, e.g. citizen participation and competitions, and take into account the challenges planning entails, such as planning of new buildings, the development of former railway locations or branches of industry. Major subject matter and strategies are incorporated into this planning level to weigh up (partly) contradictory urban development objectives, such as densification vs. expansion of open space.

9.5.2 Strategic Environmental Assessment and Environmental Impact Assessment

Major projects require various testing methods, more specifically the environmental impact assessment (UVP) and strategic environmental assessment (SUP). UVP is used for the approval of specific projects that have a major impact on the environment while SUP is implemented as early as the planning stage to set the course for decisions relevant to the environment. Both assessment methods investigate the impact of projects on the following protected goods: human beings, animals, plants and their habitat, soil, water, air and climate, landscape, material goods and cultural assets, as well as the interactions between them. Climate already ranges high with the assessment methods and projects are currently run to find out whether, how and to what extent climate change is considered in these methods.

9.5.3 Land Use and Building Development Planning

Land use and building development planning sets out legally binding conditions for all subsequent planning and development processes. Here is where building types, building heights and their orographic alignment are decided. Special Conditions also determine a number of UHI measures at this stage. Aside from building alignments and size, rules may be defined to determine the amount of green space on a given parcel of land, as well as the size and location of windows. Details on roof and façade greening may also be provided at this point.

9.5.4 Planning and Development of Public Green and Open Space

Planning and development of public streets, squares, green and open spaces is vital for the implementation of UHI-reducing measures, because here is where qualities are determined for the long term. Major emphasis is placed on incorporating UHI-sensitive criteria into design competitions. Internal guidelines and checklists, some of which contain climate-sensitive aspects, facilitate implementation of measures at this level.

9.5.5 Developer Competitions, Housing Initiatives and Public Housing Construction

Approximately 60% of households in Vienna live in subsidised apartments (Kolbitsch and Stalf-Lenhardt 2008). This level of action is therefore relevant for many parts of the city. Developer competitions have proven successful in Vienna since 1995. The competitions help to promote quality in subsidised apartments. Four main criteria are used to assess the quality of drafts: architecture, economy, ecology and social sustainability. In addition there are “theme” competitions for low-energy and passive houses or car-free housing developments. Competitions to date have considered microclimate for the design of open spaces and have also included the vision of “climate neutral cities” (e.g. Aspern Urban Lakeside).

The housing initiative launched in 2011 has contributed to ensuring quality based on a two-tier cooperative planning process. Both programmes have always emphasised climate protection but have not paid much attention to adaptations to climate change. Evaluation of these instruments (Liske 2008) shows that new and quite specific topics can be integrated into urban development at this level and turned into pilot projects for other projects to copy.

9.5.6 Planning and Development of Public Utility Buildings

Being a “model” in its own sphere of competence allows the City of Vienna to influence commercial developers and participants in competitions. This applies to all Viennese kindergartens, schools and campuses (Vienna Model where different school levels, from kindergarten to secondary schools, share the same building), as well as administrative buildings and other city-owned buildings. The “Space Book” (Municipal Department 34 – Building and Facility Management) and the “Criteria for Energy-conscious Building for Service Buildings in Vienna” (Municipal Department 20 – Energy Planning) define quality standards for the purpose. These guidelines contain a number of UHI-relevant aspects and measures, such as effective sun protection, reducing the externally induced cooling energy provided for in the building code or avoiding large glass constructions to prevent overheating.

9.5.7 Subsidising Measures

Subsidies are a way of influencing private persons and institutions. Municipal Department 42 (Parks and Gardens) has been subsidising roof greening, courtyard and vertical greening successfully since 2003. Subsidies for roof greening are calculated on the basis of the thickness of the rooting substrate. The example shows how subsidies can promote quality-assuring aspects and measures for the reduction of UHI.



Fig. 9.4 Planning levels in the city relevant for the reduction of the UHI effect (source: from top to bottom: Stadtentwicklung Wien, Magistratsabteilung 18 – Stadtentwicklung und Stadtplanung, 2014, STUDIOVLAY; Stadtentwicklung Wien; Büro tilia; Jürgen Preiss, MA 22)

9.6 Feasibility Studies

The feasibility studies described below want to demonstrate how UHI-relevant measures can be put into practice using two selected areas in the city as examples (Fig. 9.5). They make a clear distinction between measures in the development of new city districts and measures in adapting existing ones, and also identify two different levels of planning, the strategic master plan on the one hand and the planning of legal provisions, i.e. the land-use and building development plans on the other hand. The “Masterplan Nordbahnstraße – Innstraße” in Vienna’s 20th municipal district is used as an example to show how measures can be introduced at different stages of the master plan process. Proposed measures can be embedded in land-use and building development plans, as demonstrated in the case of the quarter surrounding Vienna University of Technology (Karlsplatz) in the 4th municipal district. Workshops were held with different agencies at the Vienna City Administration to assess how the UHI catalogue of measures can feasibly be implemented at these planning levels. The Institute for Building Physics and Building Ecology at Vienna University of Technology simulated measures for both selected areas (e.g. tree planting, roof greening) to find out what impact these measures have on air temperature (Figs. 9.10 and 9.12).

The results of a survey carried out for the case study UHI STRAT Vienna are presented here to set the scene for the description of the feasibility studies. The

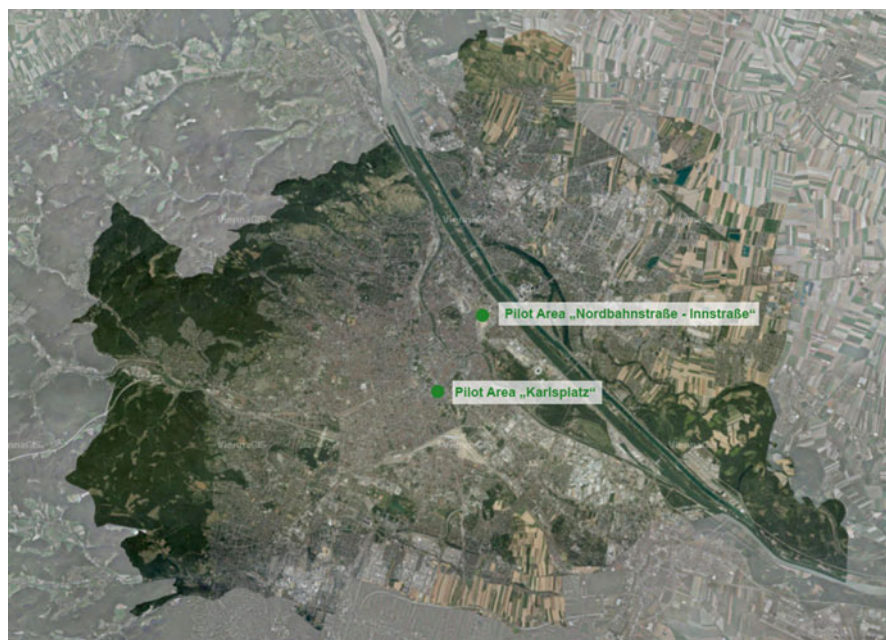


Fig. 9.5 Location of the two pilot areas in the city (Source: Vienna GIS)

survey reflects people’s attitude towards heat in the city, their behaviour during heat waves, as well as their assessment of the measures employed to reduce the UHI effect.

9.6.1 People’s Attitude Towards Heat in the City

385 answers were collected during this postal survey among people in Vienna to assess their perception and attitudes towards heat in the city.

The survey was done in August 2013. Questionnaires were sent to 3792 households in Vienna, which approximately 10 % of the addressees replied to. 27 blocks of flats were picked out randomly from different areas in Vienna, some more densely built-up than others, and the responses were weighted to arrive at as representative as possible a sample. Almost everyone in Vienna has witnessed at least one heat wave already. Three quarters consider this a negative experience. Heat is felt particularly strongly in the streets and in people’s homes (Fig. 9.6).

People in their homes try to adjust to the heat and find ways to reduce its effect. Most frequently cited measures to fight heat are: open windows during the night (88 %), make sure to take in more liquids (86 %), keep blinds and curtains closed (80 %). A negligible number of people considered leaving the city or working fewer hours an option during the last heat wave. Only 6 % of the respondents used air-conditioning in their homes. Approximately half of the respondents used fans.

Most frequently perceived public measures against the heat are air-conditioning in public transport (64 %), drinking fountains in the city (59 %) and trees in the streets (51 %). Respondents have hardly noticed measures, such as brightening of street surfaces, shading of pavements or greening of rail or tram tracks.

A vast majority (86 %) believes that trees are a suitable measure for reducing heat stress in the city. An even greater number agrees that trees have a positive effect on

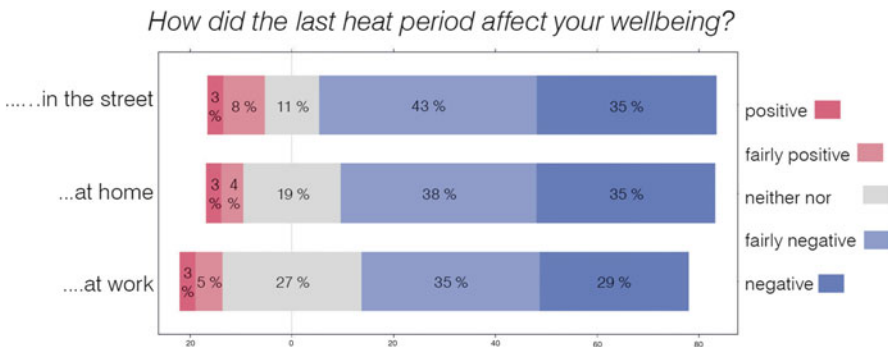


Fig. 9.6 Responses to: how did the last heat period affect your wellbeing? (Source: INWE)

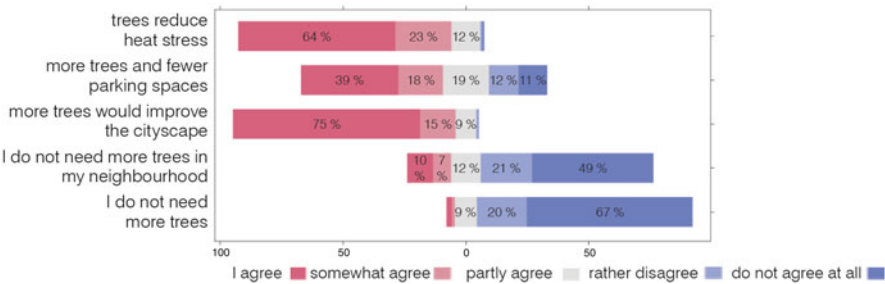


Fig. 9.7 Responses to: attitude towards measures against heat development, weighted values (Source: INWE)

the streetscape. Most respondents would like to see more trees in their neighbourhood (70 %) and across the city (87 %). A majority of 54 % endorses the claim for “more trees and fewer parking spaces in my district”. Only 24 % are not in favour of this measure (Fig. 9.7).

9.6.2 Feasibility Study for the Urban Development Master Plan

Planning and realisation of large-scale urban expansion and urban development projects can take years and even decades which is why it so important to find ways of reducing heat in city quarters at this strategic level. Urban development master plans and guidelines require intensive planning processes, usually in combination with participation processes. To implement UHI sensitive planning and development means to involve experts early on in the process, ideally when preparing the strategic objectives for the master plan.

9.6.2.1 UHI-Relevant Links in the Master Plan Process

The following description of ways to incorporate UHI-relevant issues into the different stages of developing an urban development master plan or guideline is based on the study “planning as a process” commissioned by Municipal Department 21B – District Planning and Land Use – to collect experience with master plan processes in Vienna and internationally. Master plan development is characterised by the four stages of “opening, setting the programme, consolidating and implementing” (MA 21B 2010), during which UHI-relevant issues may be introduced and put into practice.

During the opening stage political and planning requirements, as well as the various expectations with regard to future development are identified. Process structures and participants are determined at this point so it is imperative to include

persons knowledgeable in climate-sensitive urban planning. This stage also determines what basic information, plans, expert reports and studies will be required for the process. The master plan process has to specify what basic information on climate conditions in a city quarter must be obtained (e.g. main wind directions, significance of the area as a cold air production site, link with major cold air corridors etc.).

Setting the programme for actual planning usually means drawing a rough urban development guideline to give the project direction. The interests of politics, investors, landowners and representatives from the administration are translated into functional and structural specifications for the development of an area.

Structural and urban development criteria to prevent heating in future city quarters may be introduced at this stage. The objectives, challenges and general framework defined here provide the setting for further development. Analysing the planning area also reveals links that UHI-relevant aspects can be attached to. This means, amongst others, assessing the availability of green and open space in neighbouring quarters, wind corridors, air flows and water permeability of the soil.

The most important step towards incorporating UHI-relevant issues and measures (see below) at this stage is to define the requirements for preparing qualification processes and urban development competitions. The actual urban development qualification process rounds off this phase.

The “consolidation” phase in the planning and development process is about turning the competition results into specific guidelines, preparing feasible concepts and developing detailed implementation projects. By transferring the requirements to the land-use plan and preparing the environmental assessments and environmental impact assessments as needed UHI-relevant strategic objectives and clearly defined measures are introduced to the process. Issues, such as the effect of planned construction on the microclimate, must be dealt with in detail at this stage.

The phase is completed by an interface with the legally binding land-use and building development planning “Not every urban development aspect in the master plan requires binding regulations. By the same token it would be negligent to waive binding and reliable regulations in favour of informal agreements” (MA 21B 2010, 51). Ways of embedding UHI-relevant measures in the land-use and building development plan are described extensively in the second example.

The implementation stage is about developing individual projects for the social and technical infrastructure provided by the public authorities, about implementing public space and building development. Technical and planning measures to reduce the UHI effect are put into practice at this stage (Fig. 9.8).

9.6.2.2 UHI Measures in the Master Plan for “Nordbahnstraße – Innstraße”

“Nordbahnstraße – Innstraße” is located on the premises of the former Nordbahnhof (a railway station in the 20th municipal district) developed gradually over the course of the past few years. Employees of the Vienna City Administration acted out a



Fig. 9.8 Stages of the master plan process and links to implementation of the measures (Source: MA 21B 2010)



Fig. 9.9 Feasibility Study “Nordbahnstraße – Innstraße” – section from an aerial view (*left*) and measures discussed (*right*) for the winner in the urban development competition (Source: City of Vienna)

scenario to transfer competition results into an urban development mission statement that encompasses UHI-relevant measures (Fig. 9.9).

To spark the discussion objectives were defined for the “competition inviting urban development ideas for Nordbahnstraße – Innstraße”. Additional competition documentation defined quality objectives along with “hard” project requirements, such as gross floor area, the mix of residential areas/offices/retail/commerce in percent, as well as social infrastructure. Following spatial analyses and information campaigns for the public the “general conditions and objectives for the competition inviting urban development ideas” (MA 21A 2011) were drawn up. It was during this early planning stage that the first UHI-relevant goals and criteria were drafted. A number of solutions mentioned in the collection of measures were strategically positioned at this point already. The objectives for the urban development competition reveal modalities of how these measures may have a bearing on subsequent implementation stages. One of the requirements, for instance, was to create a system of green and open spaces with a high quality of use for everybody, another was to link the new city quarter with the surrounding main green and open spaces. Other requirements included minimising the degree of soil sealing, as well as considering and integrating urban climate aspects (sun/shade/wind/humidity) in competition submissions across the board (MA 21A 2011).

There was general agreement among staff from the relevant departments that most UHI-reducing measures at this planning level can be introduced during the phases of opening and setting the programme for the master plan process. It is important if not imperative to coin UHI-relevant propositions in the urban development guidelines already. Participatory development during the feasibility study and cross-agency discussions about chances and restrictions have proven successful. These negotiating processes can set the frame for addressing conflicting objectives and challenges and thus support the process of weighing up individual objectives. Attention also needs to be paid to bringing on board the “implementers”, e.g. Vienna Public Transport for matters relating to designing and placing bus or tram stops, or coordinating green and open spaces across construction sites to minimise overheating in a quarter. Listed below are the points and issues that can and ought to be addressed and finalised during this early stage of urban planning and development: (1) What impact will the planned project have on climate? (2) Which measures for reducing the UHI effect can be implemented in the urban development scenario proposed? (3) Who is responsible for implementation? (4) Which tools will be employed and which planning processes applied to implement the measures? Which challenges does or may implementation pose?

9.6.2.3 Modelling Measures and Their Impact with the Example of “Nordbahnstraße – Innstraße”

The Department of Building Physics and Building Ecology at Vienna University of Technology (Mahdavi et al. 2014) was commissioned to simulate the impact of the master plan on microclimate based on the results of the winner in the competition inviting ideas for development of the former brownfield Nordbahnstraße – Innstraße.

As soon as the buildings were simulated the mean night air temperature in the area under investigation was seen to rise. This may be explained by a reduced sky view factor, an increase in thermal mass in the area and an increase in the long-wave radiation emitted as a result. In the daytime, however, a significant reduction in mean air temperature was noted (see Madhavi et al. 2014) (Fig. 9.10).

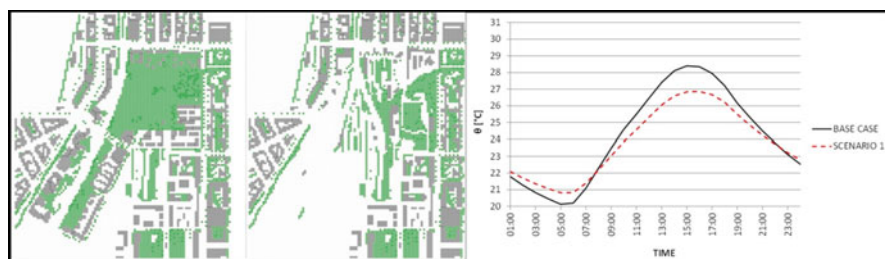


Fig. 9.10 ENVI-met model before and after building development plus a comparison of average hourly temperatures in the course of a reference day before and after building development (Source: TU Vienna, Mahdavi et al. 2014)

9.6.3 *Feasibility Study at the Level of Land-Use and Building Development Planning*

Permissible utilisation and development on individual sites are made legally binding for owners and developers during land-use and building development planning. As a rule sites are zoned for building purposes, as green areas or as traffic areas. Aside from this classification the land-use and building development plan also defines the building categories, building methods and building regulations, height and cross-section of traffic areas (§5 Vienna Building Code), as well as additional definitions and “Special Conditions”.

9.6.3.1 UHI-Relevant Links in the Land-Use and Building Development Plan

In principle a distinction has to be made between new developments and structural improvements to existing buildings. Of course, there is more scope for implementing UHI-relevant measures with new developments. However, there is a wide range of regulations that can be implemented for future projects in existing buildings as well. Where major changes are made to existing buildings these must be adapted to the land-use and building development planning valid at the time. Again, this proves the long-term strategic significance of this planning level.

Essentially there are two areas where UHI-relevant topics and measures can be incorporated: in the drawn and in the written part. The drawn part sets out rules for escape routes, conditions for use or building classes, i.e. rules to do with the urban structure and the shape of buildings, as well as measures aimed specifically at reducing the UHI effect, such as various greening measures, or at mitigating the impact, such as requirements for shaded pathways and arcades. “Special Conditions” (BB) in the written part of the building development plan contain specifications for the defined area, offering additional suggestions for integrating measures to reduce the UHI effect. This includes, in particular, targets for garden design, roof greening, façade greening, desealing, greening of courtyards and tree planting.

Measures in the drawn part may range from directions of the streets to the geometry of a building. Streets heat up more in the course of a day than their environment. It is recommended that street layout and adjacent buildings with a shading effect on the streets are considered at this level. The width of streets is connected to the height of buildings with relevant regulations set out in the Vienna Building Code (§75 para. 4). These regulations are generally applicable with the exception of protected zones or areas designated “urban development hotspots”. There is little point in narrowing the cross sections of streets as this would necessitate a reduction in building heights to avoid difficulties with lighting and exposure to light. Wider cross sections combined with green infrastructure can help to reduce the UHI effect. Depending on the direction of a street (E-W, N-S) measures, such as planting rows of trees or utilisation of surfaces may have more or less of an impact. Alignment of

streets must take into account the main wind direction so as not to hinder the exchange of air. The height of buildings, their position in relation to each other and the shade they subsequently produce must be coordinated separately for each location. There is no rule of thumb here as the local wind situation, topography and supply of green space vary widely. For complex urban development situations or where climate challenges, such as strong winds, prevail microclimate simulation with different building scenarios is recommended. The drawn part can set the scene for “public pathways” and “arcades” for sun protection along major pedestrian axes. Measures may also be specified in the written part, i.e. the special conditions, as demonstrated in the second, inner-city example below.

9.6.3.2 UHI for the Land-Use and Development Plan for Karlsplatz and Surroundings

The second example is located in the area surrounding Vienna University of Technology in the 4th municipal district of Vienna. An analysis was made as to how to incorporate requirements when revising the land-use plan to make sure that new constructions with and renovations of existing buildings take into account the phenomenon of UHI. Most of the area was developed during the Gründerzeit (in the late nineteenth century) with an utilisation mix of apartments, offices and commerce and is comparable to many quarters in the city centre of Vienna.

Special Conditions are particularly suitable for determining how UHI-relevant measures can be implemented in areas already developed. The Fig. 9.11 shows the potentials staff from the Vienna City Administration gathered during an experimental game based on the requirements set out in the Special Conditions for land-use and building development planning. The Special Conditions proposed are concerned primarily with tree planting, roof and façade greening, landscape design of surfaces, as well as with requirements that have a bearing on the level of soil sealing, both in public and in private areas. Qualities, such as substrate thickness with roof



Fig. 9.11 Feasibility Study “Karlsplatz” – section from an aerial view (*left*) and the measures discussed (*right*) (Source: City of Vienna)

greenings, or accessibility of roof gardens may also be defined in the Special Conditions. Other issues addressed may include taking the necessary steps to enable tree planting along streets and in public squares, determining the permissible percentage of sealing on a plot of land to reduce the level of soil sealing in park areas or specifying whether arcades are to be built in the area (Fig. 9.11).

9.6.3.3 Modelling Measures and Their Impact with the Example of Karlsplatz and Surroundings

Three adaptation measures were modelled for assessment of the city centre. The scenarios include: a base case without measures, (1) tree planting, (2) roof greening and (3) a combination of tree planting and roof greening. The figures below show the difference in climate conditions between the current building stock and the simulated implementation of individual measures on a reference day. The models were built by the Department of Building Physics and Building Ecology, Vienna University of Technology using ENVI-met 4.0 (Mahdavi et al. 2014). Clearly visible are the differences in air temperature between the current situation and after the simulated impact of the measures selected.

Results reveal that adaptation measures have the potential to reduce air temperature in the research areas on hot summer days. As expected different adaptation measures also have different levels of impact. Roof greening in the city centre has no noticeable effect on air temperature in the open spaces of streets (scenario 2), while trees do (scenario 1). The combination of the two selected measures proved particularly effective (scenario 3). Looking at the time patterns showed that differences in air temperature are more distinct in the evening and during the night (see Fig. 9.12).

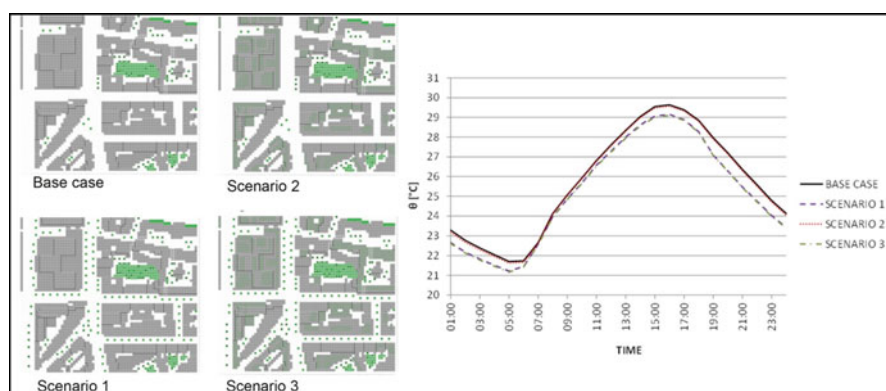


Fig. 9.12 The research area in the ENVI-met model and after implementation of selected adaptation measures, as well as average hourly temperature on a reference day, shown for the current building stock and for the three adaptation scenarios (Source: Vienna University of Technology, Mahdavi et al. 2014)

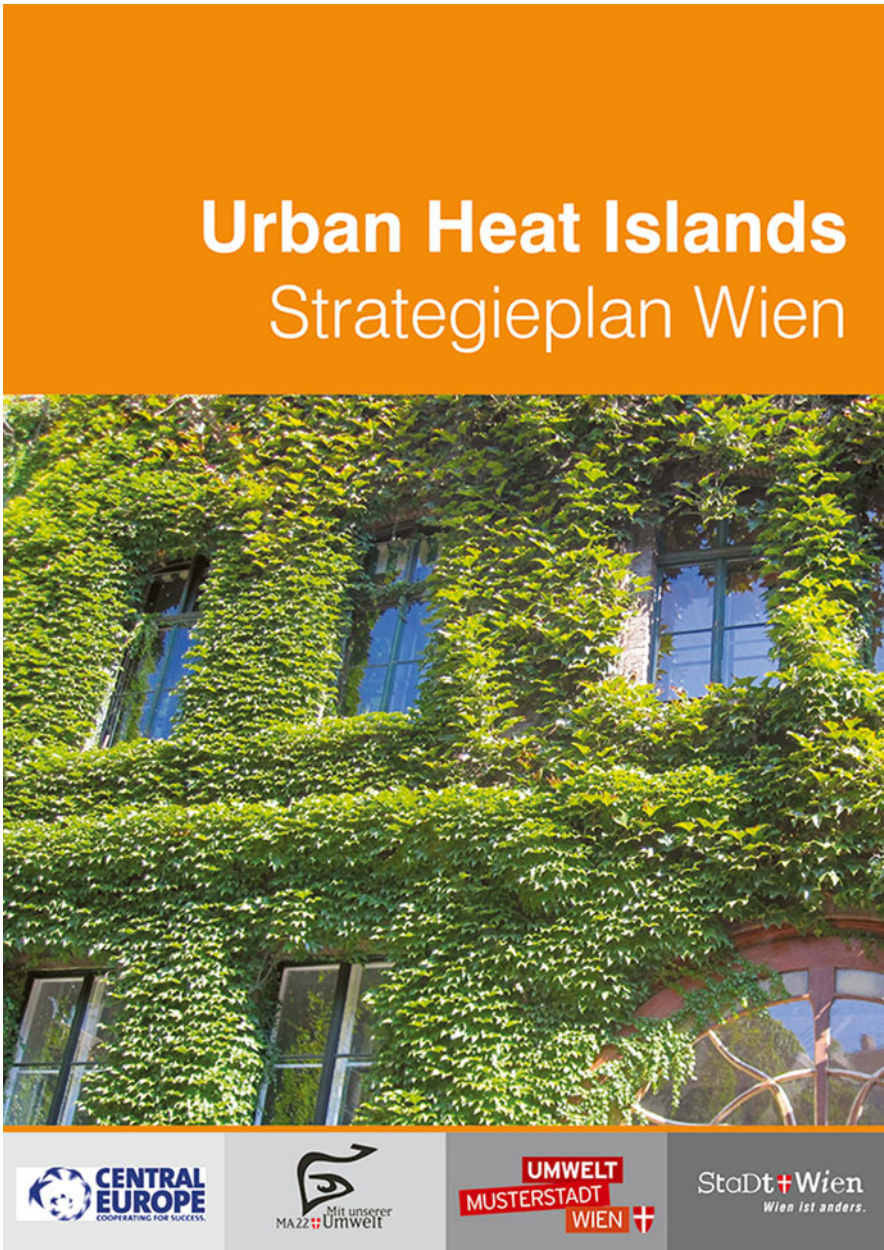


Fig. 9.13 Cover of the UHI-STRAT Vienna; Download (in German): <https://www.wien.gv.at/umweltschutz/raum/pdf/uhi-strategieplan.pdf>

9.7 Conclusion

The pilot action UHI-STRAT Vienna shows how measures for reducing the UHI effect can be implemented in urban planning and urban development in Vienna. There is in fact a wide range of tools to trigger action at various levels of planning and to make urban planning climate-sensitive, from strategy planning to development and completion. Close cooperation with the administrative agencies relevant for planning confirmed that existing tools of urban planning, formal and informal, are quite capable of reducing the UHI effect. Many examples revealed during the project process are proof that urban climate is an issue already for many administrative agencies in their day-to-day business. The examples can help to make sure that Vienna will continue its successful venture of protecting the climate while at the same time adapting to the impact of climate change. This must be considered at an early stage at the strategic level and then broken down to the various levels of planning and finally development.

“Green” measures proved especially effective for Vienna. A growing city where densification of built-up areas is necessary to keep distances short can employ these measures to create green and recreational areas for residents, while at the same time reducing the UHI effect. There are strong synergies between measures to reduce the UHI effect and other strategies pursued by the City of Vienna, e.g. reducing (leisure time) traffic, promoting biodiversity, improving water retention and establishing a network of open space. UHI-STRAT Vienna provides the setting for the implementation of these measures Fig. 9.13.

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