

BUOLUS

BUILDING PHYSICS DESIGN OF URBAN SURFACES
FOR SUSTAINABLE ENVIRONMENT AND QUALITY
OF LIFE IN CITIES

OVERVIEW

Overview

Structural-spatial design and urban land use belong to the essential transformative fields of action of cities. The quality of life and the environment, identity and uniqueness of cities are significantly influenced by urban surfaces, as well as participation of municipal communities. So far, most of these surfaces have been designed for the continued fulfilment of specific purposes; in addition, however, they hold much greater potential in terms of functionality and adaptability, quality and efficiency.

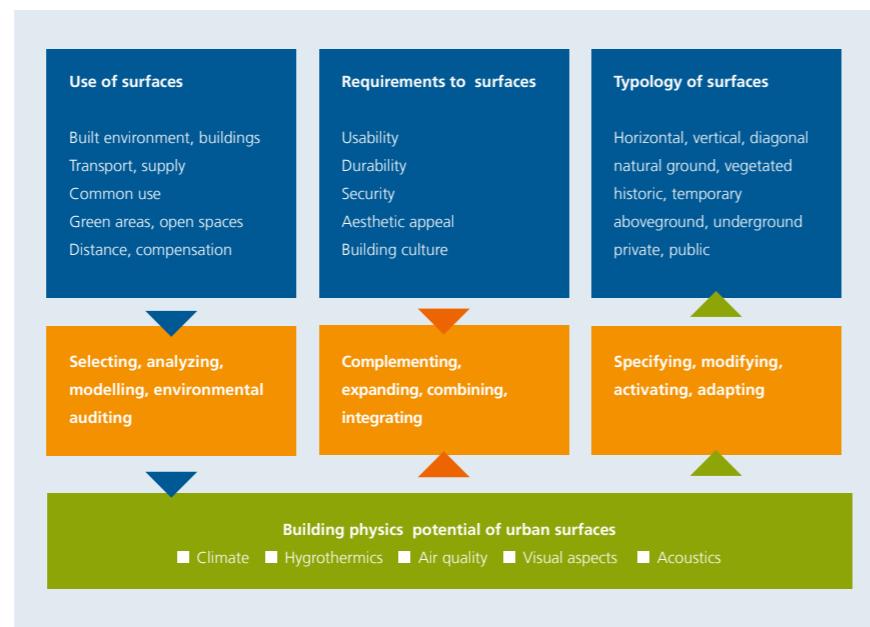
Regarding this situation, an integrated approach is considered appropriate to develop, evaluate, technologically enhance and practically test the building physics potential of urban surfaces. In view of the growing impacts on urban structures resulting from climatic influences such as flooding, extreme weather conditions or heat islands, new possibilities, processes, systems or materials are needed to improve climate resilience. In the BUOLUS project (Building physics design of urban surfaces for sustainable environment and quality of life in cities), exemplary developments are being pursued which

can be combined to complement each other. Hydroactive surfaces, for example, can buffer rainwater and release it with a time delay in order to reduce both heat and flooding. Green building shells will improve the urban climate and air quality, and sound absorbing façades will reduce inner-city noise. Optimized cleaning of circulation areas and open spaces will reduce maintenance efforts. Further, optimization potentials of municipal material flows can be identified by conducting Life Cycle

Assessment analyses (for short: LCA) to analyze management processes.

Background

The majority of surfaces for settlement areas, circulation areas and buildings, in particular, have been designed for the long-term fulfilment of specific purposes. Yet, these surfaces offer much greater scope for design within the boundaries



BACKGROUND AND OBJECTIVES

of the "urban district" and "city systems", i.e. they include options for taking action to improve functionality and adaptability, quality and efficiency.

Tapping these options will require bringing together all relevant aspects and actors involved in a structured and moderated interdisciplinary process. After all, owners and users of urban surfaces come from all parts of urban society and have different interests. The concrete planning and design solutions must focus on the building physics characteristics of urban surfaces. At the same time, these measures must also be conducive to achieving functional management of urban materials, surfaces and components.

Objectives

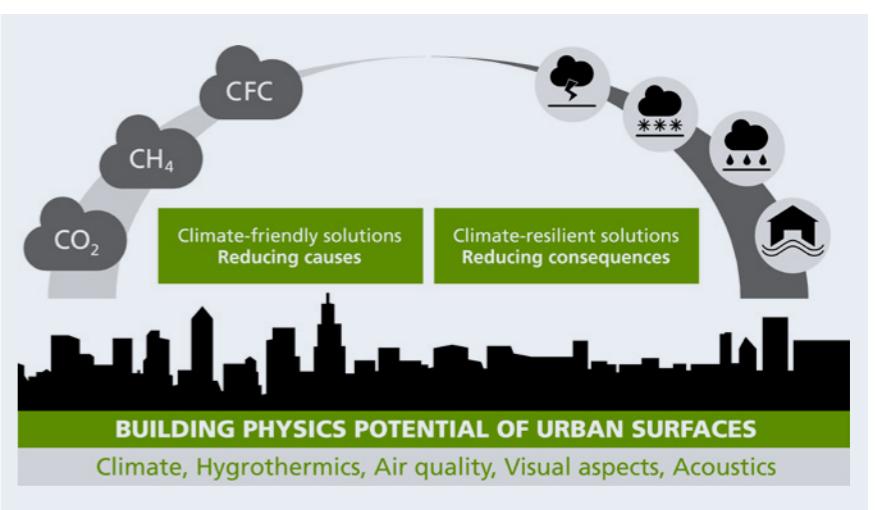
The overarching goal of the BUOLUS project, which is coordinated by the Fraunhofer Institute for Building Physics IBP, is to evaluate and develop, in an integrated approach, the building physics impact potential of settlement areas, circulation areas, green areas and building surfaces.

This process will include technological

enhancement and practical testing. The focus is on examining the effectiveness of urban surfaces in relation to climate, hygro-thermal properties, air quality, lighting and noise control.

This integrated approach is deemed essential to ensure space efficiency and social acceptance. In view of growing climate-related influences on urban structures (e.g. lack of water or flooding, unusually hot and cold weather conditions, heat islands and haze domes), with direct and indirect consequences ensuing, the project explores new possibilities,

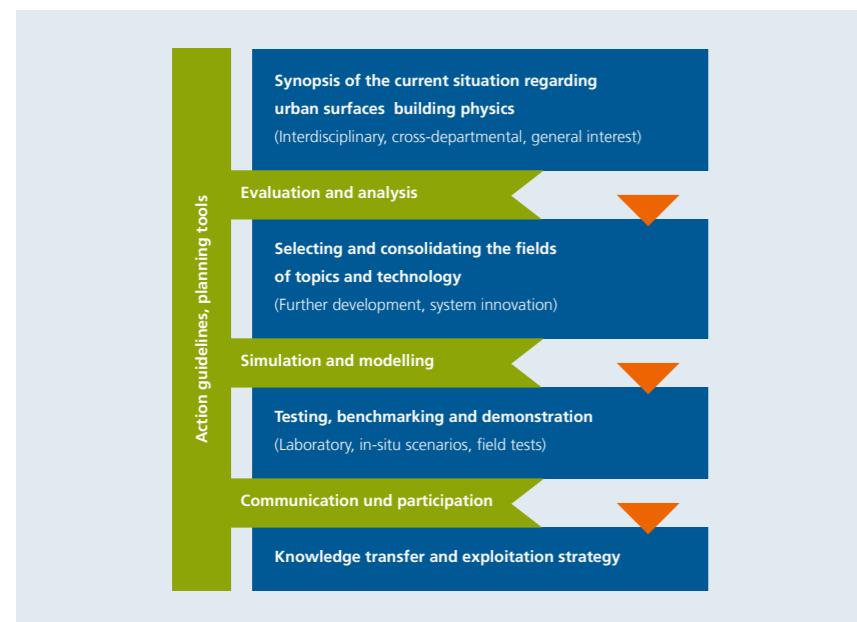
processes, systems and materials for improving climate resilience. These new options should also sustainably improve the quality of life and the environment in cities, promote municipal identity and diversity, and ensure participation of the inhabitants. The project is oriented towards the actual needs of the municipalities, their concerns and the urgent problems they are facing such as limited resources and strained budgets.



METHODOLOGY

Methodology

BUOLUS is a joint project that unites municipalities and science, urban planners and developers, as well as construction companies and manufacturers of building materials. Consequently, the individual effects and the interactions of urban surfaces and functions are addressed under aspects of building physics. The beneficiaries of this extended design scope are those involved in and affected by municipal control, planning and design.



- Long-term models and concepts of urban development can be updated and supplemented by options for action and solutions with regard to the physical functionality of urban surfaces. This concerns both the mitigation of focal points and the reduction of permanent exposure. The participating municipal partners' projects are used as validated practical examples, ensuring reproducibility.
- The increased efficiency of urban surfaces that is achieved using new building physics technologies will improve the quality of environments and life in cities, along with a sustainable increase in resource efficiency and climate resilience. Both effects can be planned, quantified and calculated using the aids and tools developed in the project and will be clearly communicated to the citizens in participation processes.
- Finally, the technological impetus of the project proposes starting points for local and regional companies in regards to developing and manufacturing new products with extended building physics functionalities. Here, too, the regionally connected municipal and commercial project partners promote concrete possibilities for demonstration.

EXAMPLES OF NEW DEVELOPMENTS

Hydroactive surfaces

Unrestrained land use and subsequent compaction by buildings and roads increases the proportion of sealed surfaces in the total area. This leads to problematic precipitation runoff during heavy rainfall, and to a reduction in the amount of water used for evaporation cooling and groundwater recharge during hot, dry weather periods.

The so-called "sponge city" principle, in which urban surfaces are increasingly used for the intermediate storage of precipitation, offers an approach to both prevent heat and flooding. This can be achieved, for example, by greening of roof and façade surfaces, which allows precipitation buffering and evaporation cooling. In this way, water-permeable circulation areas can be used to combine increased drainage with a summer heat sink.

Façade greening

In terms of building physics, the greening of buildings or façades helps achieve further benefits besides the retention of precipitation. For example, vegetation can contribute

to noise reduction in the neighbourhood, it can reduce summer heat stress in urban areas working as a "natural air-conditioning system" and provide additional thermal insulation in winter. Moreover, extensive green façades improve urban air quality by filtering and reducing pollutants such as carbon dioxide, nitrogen dioxide and particulate matter.

The promotion of domestic flora and the resulting expansion of niche habitats supplied for numerous animal species can also reduce the existing natural deficit in urban areas. Another reason for favoring site-specific plants (e.g. mosses) is that they are (predominantly) self-sufficient and, therefore, help to minimize the conservation effort.

Sound absorbing façades and open spaces

The noise impact that urban systems are exposed to is increasing due to the high attractiveness of cities, the unrestrained need for mobility and the current trends towards post-compaction and mixed use. Noise has thus become a central factor affecting the quality of life and the environment. To date,

façades have contributed to noise exposure through ventilation openings, movable shading systems or wind noise acting on aero acoustically sensitive surfaces. They also amplify and spread urban noise through sound reflection and scattering.

A substantial reduction in the sound energy that is generated is only possible by absorbing or dissipating sound waves through appropriate surfaces (e.g. materials, layers and structures). The acoustic modification of rear-vented curtain façades provides specific options for improving low-noise urban design: this façade type is characterized by high design variety and it is unproblematic with regard to building physics functions (protection against moisture, heat and fire).

Cleaning of circulation areas and open spaces

When it comes to planning and maintenance of circulation areas and open spaces (e.g. sidewalks, pedestrian zones) the effort and efficiency required for cleaning and maintenance are taken into account far too rarely. Apart from this, some environmentally harmful cleaning methods may no

EXAMPLES OF NEW DEVELOPMENTS

longer be used. With a new examination and evaluation procedure, it is now possible to record and compare the tendency to pollute and the cleanability of urban floor coverings. In the case of concrete paving stones, for example, an optimized formulation was found to be advantageous, as typical soiling penetrates less deeply into the structure and adheres less to the surface.

Special surface protection systems also facilitate mechanical cleaning and promote accelerated natural cleaning by rain, wind and UV radiation. In addition, solid jointing (e.g. using cement or epoxy resin) is a very effective remedy against weeds and leads to a significant reduction in cleaning effort, especially in hard-to-treat areas such as bus stops.

Management and Life Cycle Assessment

LCA analyses provide the appropriate instruments for quantifying, in detail, the sustainability of the mentioned processes, such as cleaning and maintenance of urban surfaces. On the one hand, a balance of the entire material and energy

input is calculated according to type and quantity; on the other hand, the resulting environmental impacts are recorded and evaluated.

In this way, possible optimization approaches can be investigated and, in particular, the recycling of material flows can be improved. In an urban context, there are underground material and energy flows (e.g. water, heat, electricity) and aboveground material flows, which arise on or through urban surfaces and need to be managed (e.g. maintenance, cleaning, winter services).

Since various operating materials (such as cleaning agents or road salt in winter) are used for this purpose, which are sometimes procured, stored and transported in considerable quantities, detailed balance calculations and optimization of resource efficiency and ecological aspects is required.

Nowadays, the spatial and temporal analysis of urban material flows benefits from the direct link to Geographical Information Systems (GIS), which also enable visualization and plausibility checks of complex spatial data and options for the management of urban areas.

CONSORTIUM AND SPONSORS

Consortium and sponsors

BUOLUS is a joint project of municipal and scientific institutions, urban planners and developers, building contractors and manufacturers of building materials. The abbreviation stands for the German project name "Bauphysikalische Gestaltung urbaner Oberflächen für nachhaltige Lebens- und Umweltqualität in Städten" (Building physics design of urban surfaces for sustainable environment and quality of life in cities).

The 16 project partners from science, industry and local authorities are engaged in a network of 16 sub-projects which are relevant to the municipalities. The overarching project, which covers a wide range of topics, was launched in April 2018 and is scheduled to run for three years.

BUOLUS is funded by the German Federal Ministry of Education and Research (BMBF) via the project management organisation DLR within the framework of the "National Platform City of the Future."

Project partners

In alphabetical order

Scientific partners

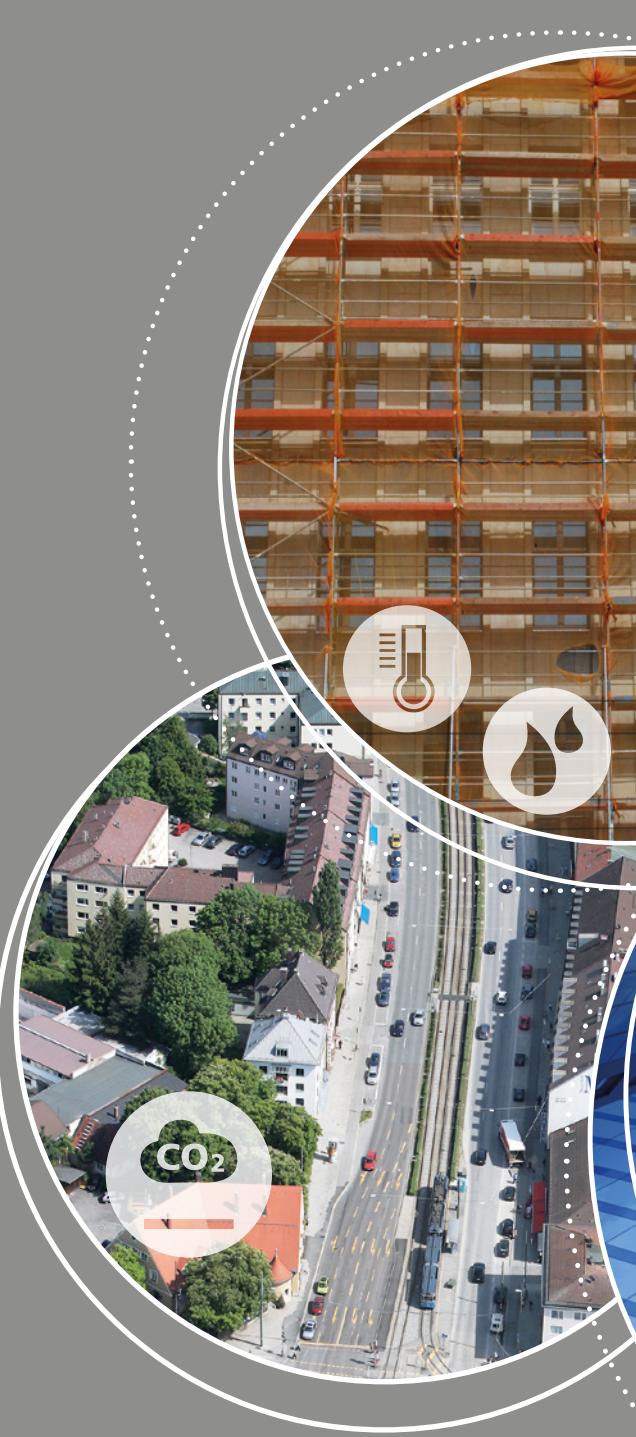
Fraunhofer Institute for Building Physics IBP
Technical University of Munich (TUM)
University of Stuttgart IABP

Industry partners

Adolf Würth GmbH & Co. KG
CalCon Holding GmbH
Drees & Sommer Advanced Building Technology GmbH
Optigrün International AG
Saint-Gobain Central Europe
Sattler Ceno TOP-TEX GmbH
virtualcitySYSTEMS GmbH

Municipal partners

City of Rosenheim
District of Miesbach
Market town Holzkirchen
Municipality of Irschenberg
Municipality of Rottach-Egern
Municipality of Valley



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