ÖSTERREICHISCHE GESELLSCHAFT
FÜR NACHHALTIGE IMMOBILIENWIRTSCHAFT
AUSTRIAN SUSTAINABLE BUILDING COUNCIL

THE FACADE OF THE FUTURE

A position paper of the ÖGNI working group “Facades”

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PARTICIPANTS IN THE WORKING GROUP

- Artner Lucas – iC group
- Engert Peter – ÖGNI
- Deinhammer Anna-Vera – Stadt Wien, Magistratsdirektion Bauten und Technik
- Formanek Susanne – GRÜNSTATTGRAU
- Friedrich Alexander – 3F Solar
- Knoglinger Martin – Archizoom-Architektur
- Labugger Reinhard – RM-Engineering
- Lichtblau Andreas – DieStadtbegrüner
- Müller Ewald – AluKönigStahl (Head of WK)
- Oszwald Oliver – HNP architects
- Polleres Sylvia – Holzforschung Österreich
- Rode Florian – HNP architects
- Saxa Katharina – ÖGNI (Head of WK)
- Stangl Rosemarie – Universität für Bodenkultur Wien
- Veits Alexander – Flughafen Wien
- Wirth Peter – Bluesave Consulting*

*alphabetically ordered

Publisher: ÖGNI – Austrian Sustainable Building Council
Author: Katharina Saxa – ÖGNI

Gender Disclaimer:
Exclusively for the purpose of better readability, gender-specific spelling is not used. All personal designations in this brochure are to be understood as gender neutral.

KEYWORDS

Architectural requirements, material requirements, user requirements, provision of added value, site-appropriate construction, facade greening, district consideration, resource conservation, climate protection, climate change adaptation, green infrastructures

INTRODUCTION

Our cities are currently undergoing significant change. An increasing sustainable use of resources is visible and leads to a rising ecological awareness. This is also reflected in the construction methods of buildings and in urban planning and development. The possibilities of facade design are manifold, and it is important to select the best possible materials and design for this. In the course of this, buzzwords such as vertical greening and energy generation are becoming omnipresent. A facade not only contributes to the quality of life in large cities, but also reduces the consequences of building density and climate change. But how do facades actually have to be designed today so that they will meet the requirements in 40 years' time?

A working group of the ÖGNI in cooperation with cross-sector experts dealt with the answer to this question in five sessions. The focus of the results was that a facade of the future will serve more than purely fulfilling functions, such as protection against the weather and environmental influences. From the point of view of architecture, the building envelope makes a significant contribution towards resource conservation, climate change adaptation and climate protection. On this basis, five theses were formulated, based on the goals of future building and facade solutions, the material requirements, user requirements, the added value of a facade as well as the location and district considerations, on which positions are taken.

For the facade of the future, a long-term, sustainable view is required and an adaptation to the achievement of the climate goals by 2030.

BACKROUND AND OBJECTIVES

About ÖGNI

The ÖGNI –Austrian Sustainable Building Council– is an NGO (non-governmental organization) for the establishment of sustainability in the construction and real estate industry. The ÖGNI's work focuses on the certification of sustainable buildings –Blue Buildings.

About the DGNB Certificate

The DGNB system of the ÖGNI serves to objectively describe and evaluate the sustainability of buildings and districts. The quality is evaluated, considering all aspects of sustainability, over the entire building life cycle. The DGNB certification system is internationally applicable. Due to its flexibility, it can be adapted precisely to different building uses and country-specific requirements. The DGNB system considers all essential aspects of sustainable buildings. These include the six subject areas of ecology, economy, socio-cultural and functional aspects, technology, processes, and location. The first four topics are equally weighted in the assessment. This makes the DGNB system the only system that gives equal weight to ecology and the other factors that make a decisive contribution to the creation of a sustainably successful building.

Purpose of the working group

The aim of the working group was to discuss the facade of the future, considering current and predicted changes and challenges, and to develop thought-provoking ideas and possible solutions on how to meet these. Since the topic of facades can only be dealt with in an intersectoral manner, the ÖGNI paid special attention to the interdisciplinary nature of the working group. To this end, experts from the fields of architecture, urban planning, real estate development, building physics, manufacturing, innovation management, landscape planning and facade greening, were invited to this working group. This made it possible to consider the most diverse aspects of a facade to obtain the broadest possible overall picture for the thesis formulation.

With this position paper, we want to show decision-makers in the real estate and construction industries, as well as urban and municipal developers, different aspects of the facade of the future, with which the future challenges can be met.

EXECUTIVE SUMMARY

Within the framework of the working group, five positions were defined on the basis of theses, which are oriented towards the requirements of future facade design and are intended to provide a guideline for the design of the facade of the future.
The basis of the thesis formulation is architecture, which is seen as an essential component of a resource-conserving and climate-protecting lifestyle. This circumstance becomes legible and visible in the architecture, which also changes the architectural language. Architecture is influenced, among other things, by three essential factors, climate protection, climate change adaptation and resource conservation. These three factors can also be described as the triumvirate of our living space (cf. Deinhammer et al., 2020). There is no doubt that decarbonization - i.e., the reduction of greenhouse gas emissions to zero - must be the overarching goal if we want to preserve our habitat. In parallel, we must adapt to the changes that are still to come. This means making our habitat as resilient as possible so that we are prepared for future climate events, such as heavy rainfall, longer periods of heat, urban heat islands, etc. This is the field of climate change adaptation, the topic that has become evident in the sense of intergenerational justice, which was first laid down in the Brundtland Report. Resource conservation, the field of the Circular City, arose from a different realization. Namely, that the industrialized countries have achieved their prosperity, among other things, due to the worldwide exploitation of natural resources. Fortunately, the standard of living is improving globally, but this is leading to an ever-increasing consumption of resources, which the earth can no longer cover from primary resources alone. Therefore, industrialized countries in particular have to radically reduce the material footprint and at the same time keep the resources already used regionally in circulation instead of always consuming new primary resources (cf. Deinhammer et al., 2020).

Basically, the building form must be considered from different perspectives. The working group focused on those topics that are particularly relevant for the requirements of a facade of the future. In summary, this results in five central topics:

- The building form and the building envelope from the point of view of architecture
- Material requirements and service life
- User requirements
- Provision of added value
- Districts and location considerations

This led to the formulation of theses, which are presented below and on which a position is taken. The interplay between architecture, the triumvirate of our living space (climate protection, climate change adaptation[1] and resource conservation) and the positions of this paper is illustrated in Figure 1.

[1] Climate change adaptation means anticipating the adverse effects of climate change and taking appropriate measures to prevent or minimize the damage they may cause, or to take advantage of opportunities as they arise. Well-planned, early adaptation measures save money and lives (GRÜNSTATTGRAU, 2020).

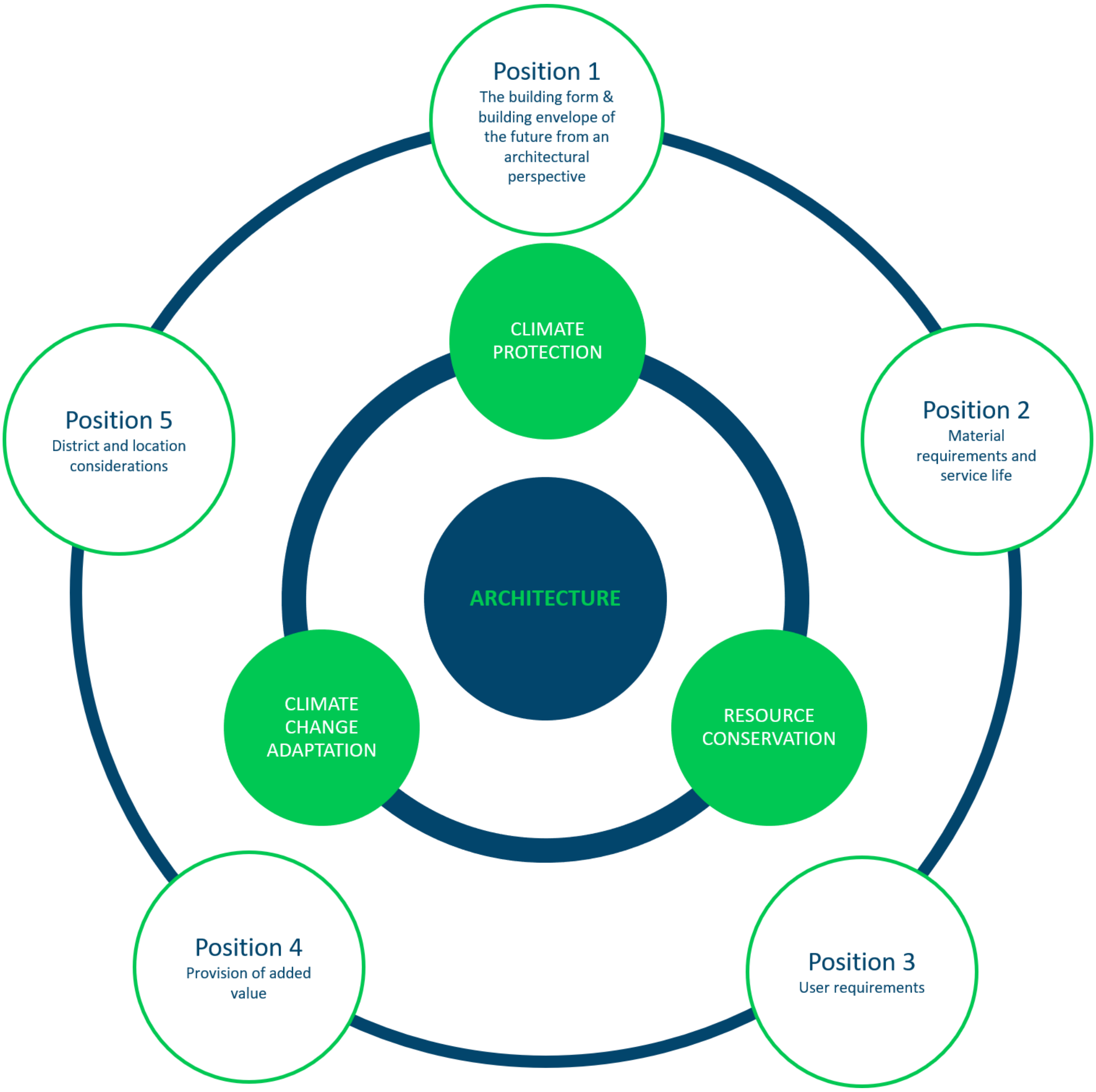

Figure 1: Requirements for the facade of the future, ÖGNI

POSITION 1: The building form and building envelope of the future from an architectural perspective

THESIS 1: Future building and facade solutions must fulfil multifunctional tasks:

Formal sustainability

- Architecture is the reflection of our society!

More leeway under building law

- More flexible zoning regulations for new developments
- Building forms improve the microclimate
- Fixed sun protection systems (cf. §84 BO)
- Facade greening

Elementary building

- Spatial elements for e.g., affordable housing
- Element facades with energy storage and/or energy harvesting modules

Integration of building services in the envelope

- Energy supply through e.g., PV systems and/or solar systems
- Decentralized ventilation systems
- Irrigation/drainage of green facades
- Smart buildings

Improvement of the microclimate (climate resilience)

- Shading systems
- Choice of colors
- Green facades
- Open space design

ARGUMENTATION

Architecture has to be seen as an essential component of a resource-conserving and climate-protecting way of life. This circumstance becomes legible and visible in architecture. This also changes the architectural language (HNP architects, 2020).

The innovative facade from the perspective of Austrian residential law requirements

In the future, the facade will continue to protect the building from environmental influences and shape the visual character of the house. However, the new functions of energy generation through the facade itself or new thermal and user-friendly functionalities require comprehensive renewal/adaptation and may require a legal "decoupling" of the facade from the building, which is currently not provided under Austrian residential law.

In the case of "changes to general parts of the house" - in the sense of residential law - which includes the facade, the 100% consent of all co-owners must be obtained. This also applies to "improvements". A stopgap measure under residential law is currently the "dynamic preservation concept" where measures in the sense of the "state of the art" can be implemented in individual cases.
Austrian residential laws legally "conserve" the state of the building and its appearance in the sense of preservation, but this contradicts the necessity of using modern technologies. Thus, the facade shares the fate of the installation of solar cells, e-mobility, etc., among other things.
In addition to the installation, the legally permissible billing for the manager or the billing company must be clearly regulated by law, because currently, for example, the Austrian property law requires unanimous resolutions for the use of deviating voting units or billing units, which can arise in practice.
Sensible energy measures and the use of different facade designs, according to the specific orientation of the building, are not considered in residential law.

When constructing a **new building**, it is necessary to anchor housing law rules among the owners and in the tenancy agreements, which is easy to solve legally.

In the case of **renovation** of existing buildings, the implementation of the necessary legal agreements is difficult to solve, which slows down the implementation of innovative measures.

Legislators are therefore called upon to intervene in the ABGB, WEG, MRG, WGG, building regulations, subsidy law and in the depreciation period under tax law (Wirth, P., Bluesave Consulting GmbH, 2020).

Considering:
Wohnungseigentumsgesetz (WEG), in its present form
Mietrechtsgesetz (MRG), in its present form
Wohnungsgemeinnützigkeitsgesetz (WGG), in its present form
Allgemeines bürgerliches Gesetzbuch (ABGB), in its present form

POSITION 2: Material requirements and service life

THESIS 2: Materials for facades will fulfil extended requirements in the future:

- Long service life in the sense of "eternally" durable
- durable "forever" taking maintenance into account
- reusable in the long term
- recyclable

ARGUMENTATION

Individual components and their service life have a fundamental influence on the service life of buildings. The total service life of buildings is usually assumed to be 40 to 100 years, depending on their value and use. With regular maintenance and care, this value can be exceeded by far, but it can also be fallen short of if there is no or poor maintenance and intensive use. The quality of the individual building materials is also decisive for the quality of the building. Accordingly, good maintenance and care are also decisive for the service life of the building components. It should also be emphasized that the service life of the individual materials depends on the entire component construction and that the service life is determined by the components with the shortest service life. In this context, one can speak of a so-called community of fate of components (cf. Bund Technischer Experten e.V., 2018, p. 2 f.). For this reason, the working group sees the necessity of using "everlasting" durable materials as well as the further evaluation sequence as stated above.

In any case, the highest average span of life is achieved with good planning, execution, and maintenance. This service life is determined by the intrinsic qualities of the building materials depending on natural influences such as environmental influences, indoor climate, and use (cf. IBO Österreichisches Institut für Baubiologie und -ökologie GmbH, 2009, p. 18). In terms of sustainability and consideration of the entire life cycle of a building component, the factors of useful life, maintenance effort and ease of maintenance and recyclability come to the fore (Chval, M. et al., 2019, p. 103).

The durability and ecological quality of all materials based on service life as well as the environmental indicators of global warming potential, acidification potential and the demand for non-renewable primary energy represent a combination that allows for a new evaluability. Thus, in the long term, a quantitative statement can be made for the potential for global warming, environmental acidification, and the consumption of non-renewable energy resources (GRÜNSTATTGRAU, 2020).

In order to keep the CO_2 emissions of a building as low as possible, attention must be paid to a resource-conserving use of materials and an efficient use of resources. Here, it is important not to use primary resources for the construction and maintenance of buildings (cf. DGNB, 2018). The use of renewable energy (e.g., from hydropower) in combination with an increase in the use of recycled materials would have a positive impact on the holistic balance (Chval, M. et al., 2019, p. 15).

As a strategy for increasing current material effectiveness, it is important to ensure that materials are recycled with as little loss as possible, in combination with a significant reduction in the materials used. The creation of a "circular economy" should enable actors and users to reduce the extraction of natural resources to a minimum, or at best to do without them altogether. The long-term objective of this DGNB criterion on "deconstruction and recycling-friendliness" in building certification, which requires profound knowledge of the materials used in buildings, allows buildings to be understood as "raw material storages" and to be planned as lucrative investments for their own future (cf. DGNB, 2018).

The company bauXund forschung und beratung gmbh and the baubook (www.baubook.info) from the IBO - Austrian Institute for Building and Ecology, among others, serve platforms for checking the ecological quality of building materials.

POSITION 3: User requirements

THESIS 3: A facade of the future meets the following minimum criteria in terms of user requirements:

- Individuality
- Integration of building technology
- Sustainable assurance of serviceability
- Integration into urban planning specifications
- Microclimate regulation
- Indoor climate enhancement
- Processes in construction, building procedures (e.g., type of connections and joints)
- Flexibility (adaptation to external and internal influences)
- Noise reduction / sound insulation
- Fine dust binding
- CO_2 binding
- Economic efficiency
- Energy generation
- Energy saving
- Reduction of climate-damaging gases in production
- Recyclability
- Ease of maintenance
- Easy to clean

ARGUMENTATION

The participants of the working group are convinced that diversity must be the goal, because every location, every task requires a different architectural response. This diversity can only be achieved by a holistic view of the minimum criteria in superimposition with building site and district related requirements. Furthermore, the weightings of the individual criteria are always to be considered different. For example, the improvement of the microclimate is of greater importance in urban areas than in rural areas; the integration of building technology is strongly dependent on the needs and financial possibilities of the users (affordable housing versus corporate headquarters), etc. Great potential is seen here in new zoning or building code requirements (HNP architects, 2020).

POSITION 4: Provision of added value

THESIS 4: A facade of the future adds / fulfills value to society.

The facade of the future will not serve purely technical functional fulfillment alone. Rather, a facade of the future should actively add value to society.
Social added value can be determined based on sociocultural sustainability. The use of site-specific and typical materials or facade solutions are identity-forming characteristics of a region, a district. They contribute to the preservation of the different building cultures and prevent - in a positive sense - standardized design solutions "off the shelf".
Therefore, the formal design of a building must not only follow technical and legal requirements, energy-optimizing measures, and economic constraints without comment. It is the task of architects to face this tightrope walk. A technically and economically perfectly optimized building, whose facade, however, has to be reconstructed within a short time due to lack of acceptance by the users, can therefore not be the ecological and economic goal. At this point, we can also speak of formal sustainability, which may - and must - initially cost something, but in the longer term has a positive effect on all areas of sustainability (HNP architects, 2020).

Facades must therefore meet the following criteria in order to fulfill a social added value:

- Customary design solutions
- Customary functional design solutions
- Improvement of comfort, well-being, and health
    - Microclimate regulation
    - Quality of stay of the open areas
    - Noise and emission reduction
    - Sound absorption
    - fine dust binding
    - Avoidance of light pollution - especially through advertising
- Procurement of materials from the region, if possible
- Barrier-free use

POSITION 5: District and location considerations

THESIS 5: The Location at the district level determines the functionality and thus the added value of a facade.

ARGUMENTATION

The technically best facade is of no use if it does not improve the quality of the location, because not every criterion can be solved via technically sophisticated facade solutions. It is therefore necessary to sound out and define the relevant features for the respective district in advance of a dedication procedure. This is the only way to ensure the quality of a district in the course of further planning. Providing sufficient leeway for architecture and facade technology here is the responsibility of the approving authorities and requires proactive and close cooperation between the authorities and the developers and planners. Ongoing evaluation processes in the course of a district development and a respectively upgrading of existing districts are indispensable for this. Transparent and widely communicated decision-making processes are essential for this (HNP architects, 2020).

The goal is to protect buildings and their users from the effects of negative environmental influences and extreme events. In doing so, the resilience of buildings to potential impacts at the microsite should be promoted. For the assessment of environmental risks at the microsite, 14 indicators are to be considered, including earthquake, storm, hail, and air quality. In the future, these will also become increasingly important in facade design. Especially the air quality at the site can be influenced by the facade. This indicator is evaluated in relation to the main pollutant source, traffic. For this purpose, it is determined whether the legal limit values for particulate matter (PM10) and nitrogen dioxide (NO2) are complied with at the location. At the same time, the planned building must not worsen the immission situation in the surrounding area to such an extent that the limit values are expected to be exceeded. The improvement of air quality through active measures on the facade or in the direct outdoor space of the building has a positive effect on the rating of a building according to DGNB. Greening or photocatalysis on the facade can be used for this purpose, among others (DGNB, 2018).
Facades can also have a strong impact on the environment from a noise perspective. Smooth facades lead to unfavorable reflections and can worsen the immission situation in the district (Artner, L., iC group, 2020).

Setting high technical standards can enhance a building, but the location and the embedding in the district can remunerate the real estate, especially in the coming mutual provision of objects, rooms, and spaces. Greening buildings favors shared activities and the "sharing economy" (GRÜNSTATTGRAU, 2020).

If we grasp the concept of economy in its holistic meaning, we must address the allocation of all resources, that is, the sustainable allocation of space, materials, and human or brainpower. The enumerated requirements for the building envelope should therefore not be defined individually for each property in silo fashion. Rather, the goal is to make the district sustainable and resilient. If one building makes a major contribution to the microclimate with its building greening, the neighboring building could generate energy as a priority and thus also supply the other. The same applies to listed buildings, which make a massive contribution to the creation of identity, but whose energy efficiency can only be increased at very high cost, both monetarily and materially. As international examples show, an energetic load balancing between old and new can produce good effects (Deinhammer, A.-V., City of Vienna).

Accordingly, location- and use-oriented planning and building requires a comprehensive analysis of the district. This is a process with the goal of creating added value (cf. Position 4) for the entire building association and all those affected. The consideration of functional, social, and socio-economic requirements leads to an increase in the quality of the living space, but also of the building culture. The building envelope of each object, which is coordinated within the association, thus determines the value and quality of a district with its appearance and the functions to be fulfilled (Deinhammer, A.-V., City of Vienna).

EXAMPLES FROM THE FIELD

Architecture

1. Example residential building Solaris, ertex solar

On the shore of Lake Zurich, between the busy Seestraße and the railroad embankment, stands the newly built Solaris residential building, which offers space for ten apartments. Besides the sounding name, however, it is not apparent from the outside that the house is in fact a solar house. At a second glance, the shimmering rust-brown all-over shell of ribbed cast glass does not suggest that thousands of solar cells are installed in the glass. A total of 1,300 PV modules from ertex solar were installed on the entire facade. During the planning phase, the architects at huggenbergerfries were convinced that the building need not look like a solar house at first glance. In the end, they truly succeeded in this with Solaris. The outer shell consists of a structured, aubergine-colored cast glass, the color of which was developed together with the Lucerne University of Applied Sciences and Arts after months of development. Different lighting situations and viewing angles make the building appear dark red to violet to silvery in a wide spectrum of colorfulness.
Behind the modules are 350 power optimizers that group the modules together in units of no more than 80. The building is covered on all sides by the modules, allowing the sun to be used from any direction. This results in a relatively constant power output distributed throughout the day, and also avoids power peaks. Each side of the house has an inverter, these are located in the basement of the building and convert the direct current into alternating current. Another system component is the battery storage, this can store 10 kWh, the rest goes to the public grid.

Integrated facade elements:
Module manufacturer: ertex solartechnik GmbH
Number of units: 805 VSG 10/5 in size 1960x360mm 630 ESG 4/5 in size 1960x485mm
Structure: glass-glass module
Cells: monocrystalline silicon cells

Figure 2: huggenbergerfries residential house Solaris, ertex solar, Dieter Moor

Author: ertex solar

2. Example Pottendorfer Straße, Wiener Neustadt, ertex solar

In Wiener Neustadt, located directly on Pottendorfer Straße, the Green Point project was realized - an exemplary renovation of an old building that now houses apartments and business premises. The entire structure was planned in accordance with an environmentally friendly sustainability concept, and the result extends from the basement through the individual apartments to the roof. The first floor, for example, offers space for offices and stores ranging from 40 to 900m², which are powered by solar energy.
Solar modules from ertex solar were integrated into the loggia parapets of the apartments. A total of 144 PV modules are installed in black, with a total output of 52 kWp. In addition to generating sustainable electricity, residents benefit from e-charging stations in the basement, sophisticated lighting and heating control, and the use of Gidrolock.at - a sensor-based alarm system that reports a water leak to the water supply ball valve and to the apartment owner via SMS.

Integrated facade elements:
Module manufacturer: ertex solartechnik GmbH
Number of pieces: 144 VSG ESG 5/5, 2.490x1070mm
Structure: glass-glass module Cells: monocrystalline silicon cells

Figure 3: Attractive rental flats in Wiener Neustadt, www.green-point.at

Figure 3: Attractive rental flats in Wiener Neustadt, www.green-point.at

Author: ertex solar

3. Example AK Plösslgasse, Archizoom-Architektur

Another example of a sustainable facade is a competition entry by Archizoom together with neustädter+mramor Architekten for the AK Plösslgasse in which individuality, integration of building technology, serviceability, integration into urban planning specifications, microclimate and flexibility are taken into account.

Figure 5: Integration into urban planning guidelines

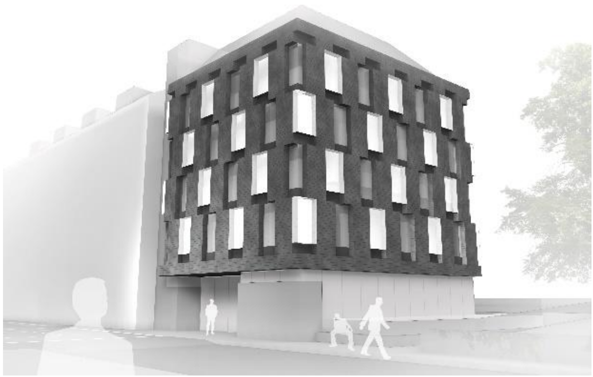

Figure 6: Individuality - high recognition value

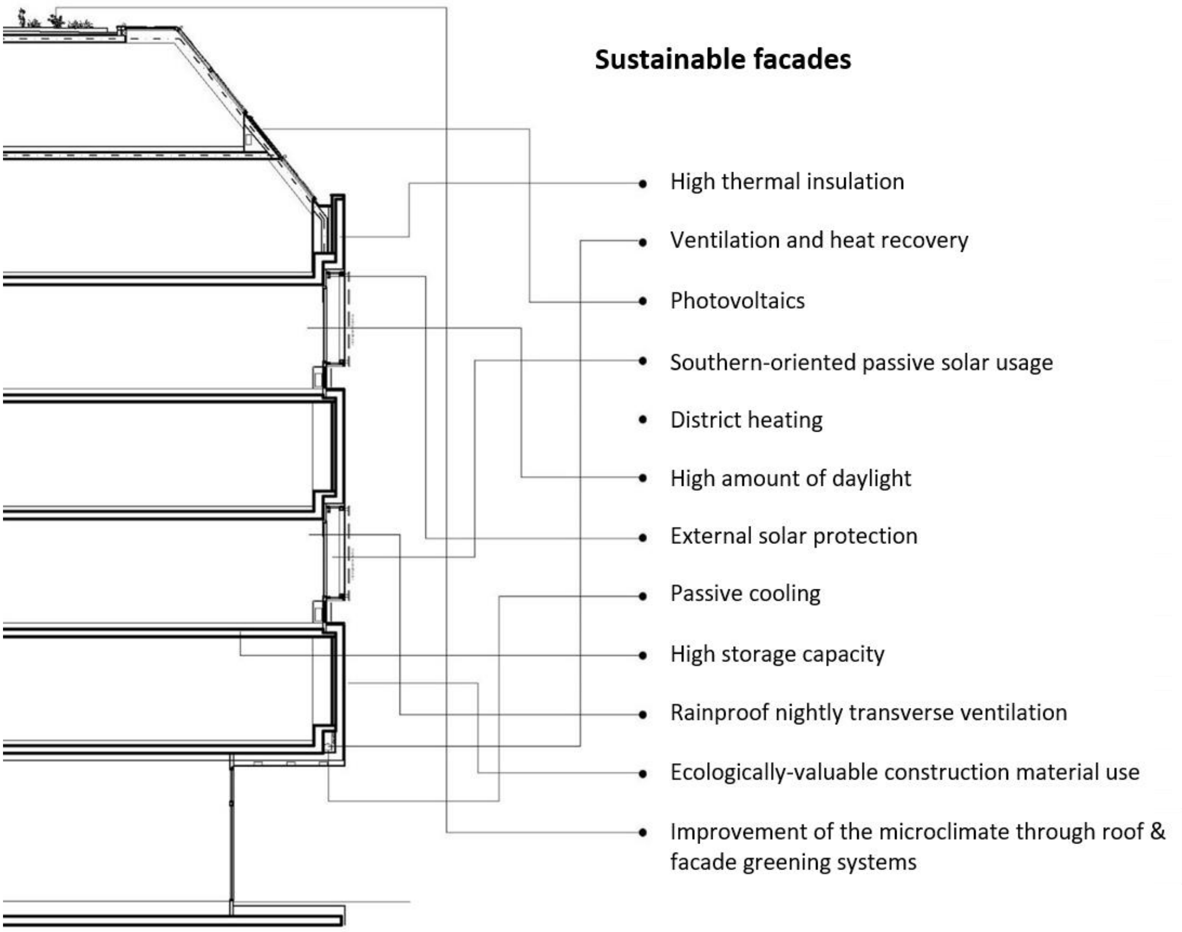

Figure 7: Integration of building technology with horizontal and vertical distribution within the facade

Author: Martin Knoglinger, Archizoom-Architektur ZT GmbH

Architecture & Site

1. Example Office Park 4, Vienna International Airport


Figure 1: Office Park 4, Vienna International Airport, FWAG

Office Park 4 is located on the entrance road to Vienna Airport. The ultra-modern office building, together with the pedestrian bridge built in parallel, has created a new, unmistakable entrance to Vienna Airport, which, with its banded facade, reflects the landmark of the location, the tower, plays with its appearance and complements it. Levels zero and one feature a mullion and transom facade with optimized thermal insulation and highly wind-resistant shading. Levels two through eight feature a ribbon facade. The facade is made of memory-effective parapets, and is covered with Alucobond panels, which gives the distinctive look. According to the client's requirement, the facade panels were made dirt-repellent.

The windows, equipped with highly energy efficient Schüco profiles, were designed as composite windows with an integrated impact pane. The shading runs in the resulting gap between the window construction, protected from wind and weather. Depending on daylight and temperature, the light is directed via the automatic adjustment of the slats. Cleaning is carried out from the inside through openable windows. A maximum glass proportion of 60% prevents overheating in summer, while allowing a desired energy input in winter. The building geometry and its floor plan layout also succeed in optimally supplying all workplaces with light (Daylight factor DF > 3.00 % according to EN 15193).

The facade insulation was designed based on computer simulation results in such a way that energy measures (heating/cooling) were optimized in their energy consumption. In this specific case, it was found that excessively high insulation thicknesses would have had a negative impact on the annual energy balance. The insulation was therefore reduced accordingly, but without sacrificing comfort and overall energy consumption. In addition to the economic requirements, an essential factor in the planning of the building was the improvement of the location.

The floor plan in a modified delta-wing form was chosen to improve the microclimate and wind protection in the surrounding area and thus achieve a high quality of stay at the site. Office Park 4 was awarded the ÖGNI Kristall Award and certified according to ÖGNI Platinum.

- → Site improvement through microclimate regulation, wind protection and high quality of stay
- → Storage effective mass in parapets
- → High supply of daylight to all workplaces
- → Automatically controlled and individually adjustable, wind-protected sunshade
- → Very high flexibility in the course of tenant fit-out due to small-scale fit-out grid

Authors: Alexander Veits, Vienna Airport, Architecture, and general planning: HNP architects

Greening

The Innovation Lab GRÜNSTATTGRAU is the competence center for structural greening and has built up various infrastructures in recent years to facilitate access to expertise on structural greening for business, science, the general public and the public sector. The Innovation Lab consists of an interdisciplinary team from business and science with the aim of promoting structural greening throughout Austria. Meanwhile, the network is already over 340 partners strong and active throughout Austria. In addition to sustainable market development, GRÜNSTATTGRAU ensures the affordability of technologies and their broad applicability.
Modern, technical building greening, as it is known and executed today, has been realized in Austria since the mid-1980s. From these beginnings, specialized companies have developed, which joined together in 1991 to form the Association for Structural Greening in Austria with the goal of quality assurance.
In addition, with its headquarters in Vienna and the goal of enabling building greening throughout Europe, the European Federation of Building Greening Associations (EFB), founded in 2005, now brings together associations and value chains from a total of 16 EU countries. The open, best-practice-sharing organization facilitates technological exchange and innovation in the field of green roofs and facades in various climatic zones in Europe.
A comprehensive performance showcase of available green building technologies is provided by the Green Market Report, which documents market developments to date based on the facts and figures collected. With the growth and future projections derived from this and a detailed presentation of the companies active in the greening value chain, a meaningful business card of the greening industry has been created (cf. GRÜNSTATTGRAU, 2021).

Facade greening - technology overview

Over the course of time, a wide range of solutions have been researched, developed, and brought to market maturity for specific and increased demands on greening for building optimization. In the meantime, quality-assured greening solutions are available for all areas of application. The definition of the greening objectives determines the subsequent technology application.
Likewise, the facade greening market has numerous technologies for the design of the building envelope, which are used in accordance with the wishes and greening goals of the client and the conditions of the facade. The types of facade greening can be roughly divided into ground-based greening using climbing plants with or without climbing aids, trough greening and facade-based greening in curtain-type, rear-ventilated construction. Furthermore, according to ÖNORM L1136 (2021), they are divided into the following categories:

Ground-based vertical greening with self-climbers aims at an area-shaped direct growth on the facade with climbing plants that grow up the wall surface with adhesive discs or climbing roots. Plants such as ivy (Hedera helix) or wild vine (Parthenocissus sp.) are suitable here. This variant requires a ground connection in the area of the facade and presupposes an intact, undamaged facade. Technical devices such as overgrowth strips can be installed to guide and specifically stop the growth of the plant (e.g., at windows, wall projections, outbuildings) as well as to enable easier maintenance.

In addition to this, different growth characteristics are used for **ground-based vertical greening with climbing aids and climbing plants** (climbers, winders, splayed climbers, shoot climbers, leaf stem climbers, etc.). Here, adapted to the growth characteristics, climbing aids in the form of rods, ropes, lattices, and nets are used, which are usually mounted on the building wall or presented to the facade with individual constructive solutions. In this type of greening, mostly greening goals such as shading of window surfaces to avoid heating of the building's upper surface play a role.

Point or linear trough systems on the facade and ground are suitable if no direct ground connection can be made and can be installed specifically as required in the facade or, for example, subsequently on the street side. They are particularly suitable for greening with various climbing plants with or without climbing aids; in some cases, other woody plants are also used as climbing plants.

In the case of **wall-bound facade greening** (Living Walls), partial-area or full-area vegetation supports are attached to the facade using curtain-type, rear-ventilated construction techniques without ground contact. Partial-surface modular systems in the form of linear planting troughs equipped with water-storing substrate and drainage elements are planted with perennials, grasses, and herbs for immediate greening. Full-surface systems are equipped with pre-cultivated, planted fleeces or geotextiles to create a holistic appearance of the supporting structure. Automatic irrigation and nutrient supply are essential (Stadt Wien, 2019).

Figure 9: Facade greening - technology overview, GRÜNSTATTGRAU

1. Example 50 Green Houses, Vienna

Vienna and other cities offer numerous opportunities for building greening. Nevertheless, there are usually major challenges and hurdles until the implementation. For this reason, there is a need for an overall solution that facilitates the technical implementation of green buildings along streets quickly and cost-effectively, as well that reduces the complexity of the implementation and permission processes.
The project "50 Green Houses" addresses these challenges and, with BeRTA, a green facade module and a specially developed online submission tool, will make it prospectively even easier to implement green building projects in the city.
For the first time, an interdisciplinary team - together with the City of Vienna - has developed an integrated combined solution for greening the facades of existing buildings, which is being tested in the district Innerfavoriten. Using a low-tech plant trough solution with climbing aids, greenery is being implemented on 50 existing buildings in the Innerfavoriten target area. These make a significant contribution to protecting against overheating in summer and improve comfort and quality of life in the densely built-up city.
The project simplifies all the coordination processes required for the greening: these include the owners' declarations of consent, permits for the green facade from the City of Vienna, and the coordination of trades. The online tool (www.50gh.at) guides interested parties through the process and asks for all information necessary for planning and approval in just a few steps. The research project also explores social aspects (e.g., involvement of users in the care of the plants) to ensure the lasting functionality of the greening (see. GRÜNSTATTGRAU, 2018).

Figure 2: 50 Green Houses, A. Ackerl, IBA_Wien

Figure 3: 50 Green Houses, A. Ackerl, IBA_Wien

Author: GRÜNSTATTGRAU

2. Example MA 48, Vienna

The construction of the vertical facade greening by the Municipal Department 48 (MA 48) already took place in 2010, with the aim of making the brick building from the 1960s more efficient and, moreover, more innovative through a full-scale renovation.

In a total of 2,850 lm aluminum planters grow 17,000 plants, resulting in a total greening area of impressive 850 m^2.

The project was carried out in scientific cooperation with the University of Natural Resources and Applied Life Sciences Vienna (BOKU). Parameters such as air temperature and air humidity behind, inside and in front of the facade greening were investigated, as well as soil moisture, radiated heat, water balance, effects on building physics and the build-up of biomass.

Investigations by BOKU have shown that since the renovation of the building, a reduction of heat loss in winter by up to 50% (measured in W/m^2) could be achieved.

In summer, the facade-bound vertical greening serves to protect the building from overheating. Consequently, on sunny days, a 10 °C cooler surface temperature can be measured in the light-colored rendered area of the building, or 15 °C cooler surface temperature at the dark gray base of the building.

An evaporation capacity of up to 1,800 l of water is achieved per day, which corresponds to a cooling line of about 45 cooling units with 3,000 W cooling capacity and 8 hours operating time. This evaporation capacity corresponds to that of 4 fully grown beech trees!

Figure 12: Facade-bound vertical greening, MA 48 Vienna, DieStadtbegrüner

Author: DieStadtbegrüner

3. Example Hannovergasse, Vienna

The goal of the greening project in Hannovergasse in Vienna's 20th district was to unite the diversity of different greening methods of a facade at one location and thus bring diversity into the city.

DieStadtbegrüner focus primarily on modern, facade-bound vertical greening, which is installed directly on the wall without any connection to the ground. Immediately after implementation, the desired facade is fully greened and thus completed. In addition, with this method, all floors as well as partial areas can be greened, there is hardly a limit. Various plant species are used, from flowering to evergreen plants, whereby a high diversity is achieved, with a seasonal change. But also classical facade greening is combined from the experienced pool of knowledge in a symbiosis.

Viewed from bottom to top, the planted area begins on the first floor with pre-cultivated plant hedges and troughs with climbing plants, which extend to the second floor. The second floor continues with the typical Viennese 'BlumenkisterIn' (flower cisterns), equipped with hanging plants. On the third floor, one finds a curtain-type and back-ventilated facade greening system in layered construction, which was planted with perennials and herbs. On the last floor, two rotating trees, so-called 'GraviPlants', protrude horizontally from the facade. The final part of the greening project is a green roof with a classical method for self-planting, mainly with troughs in system design.

Figure 13: Combination of different facade greening systems, Hannovergasse Vienna

Author: DieStadtbegrüner

RELEVANT CRITERIA FOR THE DGNB CERTIFICATE

Some criteria of the DGNB system already deal with the above-mentioned positions, also with regard to the design and construction of building envelopes. The table below provides an overview of these relevant criteria to be met for the certification of buildings and districts.

	ECOLOGICAL QUALITY
ENV 1.1 Building	**Life cycle assessment of the building** Buildings cause emissions and require resources in all phases of their life cycle, from production (e.g., through the use of building materials and building products) to use (e.g., through building operation, maintenance) to end of life (e.g., through deconstruction). The aim is to consistently plan buildings on a life-cycle basis to minimize emission-related environmental impacts and the consumption of finite resources throughout all phases of a building's life.
ENV 1.3 Building	**Responsible resource extraction** Promoting the use of products in the building and its outdoor facilities that are transparent in terms of ecological and social impacts across the value chain and whose raw material extraction and processing meet approved ecological and social standards.
ENV 2.3 Building	**Land consumption** The aim is to reduce the additional use of land for building purposes and to limit soil sealing of undeveloped areas. Compensatory measures can be claimed in the assessment that are realized on the property or in the immediate vicinity. These include all measures commonly accepted under building regulations. These include special stormwater management and infiltration measures, green roofs or facades, and plantings.
ENV 2.4 Building	**Biodiversity on site** People tend to feel better when they spend time in natural environments. Well-being has a major impact on people's health and performance. Furthermore, plants on and in the building, as well as the careful treatment of wildlife, serve to enhance the positive image of the building. This is reflected in a higher value of the property. In addition, choosing plants that suit the location can reduce follow-up costs, as they are often more robust, less susceptible and require less maintenance.

	ECONOMIC QUALITY
ECO 1.1 Building	**Building-related life cycle costs** The economic viability of buildings depends not only on income from production and utilization costs, but also on their cost-efficient operation. Life cycle costing provides a medium- to long-term view of the costs of a building. Life cycle costs usually include all costs incurred over the lifetime of a building: Production or (initial) investment costs, follow-up costs or selected utilization costs (property management, operating and maintenance costs), utilization costs (costs for demolition, dismantling, recycling, and disposal).
	SOCIOCULTURAL & FUNCTIONAL QUALITY
SOC 1.1 District	**Microclimate - Thermal comfort in open space** The aim is to increase the attractiveness of public spaces by taking microclimatic effects into account during planning. This is intended to promote a pleasant, varied climate in the district throughout the year that meets the different individual thermal needs of users.
SOC1.4 Building	**Visual comfort** The aim is to ensure a sufficient and trouble-free supply of daylight and artificial light in all permanently used indoor spaces. Visual comfort forms the basis for general well-being and efficient and performance-enhancing work. Natural light has a positive effect on people's mental and physical health. In addition, proper use of daylight results in a high energy savings potential for artificial lighting and cooling.
SOC 1.5 Building	**User influence** Satisfaction with a building depends not only on the actual conditions provided, but also to a large extent on the possibilities for self-determined adjustment of ventilation, sun and glare protection, temperature and lighting conditions to individual preferences, even beyond the standard settings. Sun protection should prevent a building from overheating through absorption (e.g., by cantilevered elements) or reflection (e.g., by external hangings). At the same time, window surfaces should be as completely shaded as possible. Examples of solar shading that allow the user to exert an influence include awnings, blinds, movable louvers, movable perforated sheets, folding shutters, and other elements that the user can change in arrangement. Solar control glazing and rigid elements cannot be influenced by the user and are therefore not accepted. The solar protection must be placed either between the panes or on the outside of the facade.

	TECHNICAL QUALITY
TEC 1.3 Building	**Quality of the building envelope** A well-planned building envelope is the basis for high user comfort and low energy costs. Indicators: transmission and diffusion via envelope components, transmission via thermal bridges, air tightness of the building envelope, summer thermal insulation
TEC 1.4 Building	**Use and integration of building technology** The goal is a building design with the best possible use of passive systems and the integration of renewable energies for the required technical systems. In addition, the aim is to ensure that a building can be adapted to changing conditions of use or to technical innovations with as little effort as possible and that the technical systems used are integrated in the district.
TEC 1.5 Building	**Cleanability of the building structure** How a building structure can be cleaned has a major impact on the cost and environmental impact of a building during its use. Surfaces that are easy to clean require fewer cleaning agents and incur lower cleaning costs. The goal must therefore be to keep the operating expenses for cleaning as low as possible, while at the same time allowing the materials used to have a long service life.
TEC 1.6 Building	**Deconstruction and recyclability** Economical use of natural resources and their efficient utilization. No use of primary resources for the construction and maintenance of buildings; strategy for increasing current material effectiveness: for a virtually loss-free recycling of materials - in conjunction with a substantial reduction in the materials used; creation of a "circular economy" that enables players and users to reduce the depletion of natural resources to a minimum, or at best to do without them altogether. For building owners who implement a reduced use of materials in their buildings, lower costs can already be realized during construction. For users, in turn, positive effects can be expected in the operating phase - with in some cases significantly lower expenditures / costs for modernization work as well as for maintenance, repair and, in particular, conversion measures. The long-term objective of this criteria - which requires profound knowledge of the materials used in buildings - allows buildings to be understood as "raw material stores" and to be planned as lucrative investments for their own future.
TEC 1.2 District	**Energy infrastructure** The goal is to create the technical conditions for the optimization (efficiency, effectiveness, generation) of energy demand, renewable energy, and costs in the provision of energy in the district.

	SITE QUALITY
SITE 1.1 Building	**Microsite** The goal is to protect buildings and their occupants from the effects of adverse environmental conditions and extreme events and to promote building resilience to potential microsite impacts. Natural hazards arise from the geographic conditions of the building site. Their intensity and frequency are usually beyond control and difficult to predict. It is therefore more important to classify them correctly and to compensate for or avoid the adverse effects for people in and around the building. Taking into account the respective probability of occurrence or the possible severity of the effect as part of the planning process reduces the costs for any retrofitting that may be necessary. Resilient buildings that are adapted to their surroundings are sustainable buildings in many respects.

CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT GOALS

With the Sustainable Development Goals (SDGs) as a central element of the Agenda 2030, the United Nations defined specific goals in 2016 to make the further development of our world meaningful and thus enable long-term rethinking and living in a sustainable world. ÖGNI supports these goals and wants to make a tangible, positive contribution to this achievement by means of certification. Together with other European Green Building Councils, the CPEA (Climate Positive Europe Alliance) initiative was founded in order to promote solutions based on the SDGs to make the European building sector as climate neutral as possible.

The working group also takes the SDGs into account, as the building sector must make an important contribution to a sustainable future. If we want to achieve a climate-neutral EU, we must start acting. The DGNB certificate promotes sustainable and future innovations making sure that the focus is on people. If we consider the core issues described in this paper, and – whether as individuals or enterprises – implement suitable measures in practice and daily life, we can contribute to the SDGs mentioned below. We can also become part of an economic turnaround because climate protection and the well-being of all will also bring economic benefits in the long run.

3 Good health and well-being
11 Sustainable cities and communities
12 Sustainable consumption and production
13 Climate action

Please find further information at:
https://www.cpea.eu/

CONCLUSION

The results of the working group show that there is no such thing as the one facade of the future. Rather, the construction of a building envelope will take into account current and forecast changes and challenges. The task of the working group was to develop thought-provoking ideas and possible solutions to meet the requirements of a facade within the next 40 years.

It is undisputed that the building envelope must provide protection against the weather and environmental influences, but from an architectural point of view, the facade also makes a significant contribution to resource conservation, climate change adaptation and climate protection. Based on this, the first thesis and position arise, which emphasizes the multifunctionality of the building envelope. This ranges from formal sustainability, more freedom under building law, element-based construction, and the integration of building technology in the envelope to the improvement of the microclimate.

In order to actively counteract climate change, it is also necessary to consider the materials used. High quality is crucial to significantly extend the service life of materials and thus of buildings, while good maintenance and care are also crucial. In addition, it is important not to use primary resources for the construction and maintenance of buildings and to increase the use of recycled materials. The goal is to create a "circular economy" that enables stakeholders and users to reduce the extraction of natural resources to a minimum, and at best to do without them altogether.

Furthermore, the user requirements for a facade of the future have to be taken into account and are characterized by the term "diversity", because depending on the building or neighborhood location as well as the needs and financial possibilities of the users, these are weighted differently.

This results in a further step in position 4, because a future building envelope will not only serve the pure fulfillment of function but will also provide an active social added value. This can be found above all in the socio-cultural sustainability criteria. Indispensable for an economic and ecological planning and construction of a facade is the acceptance of the users, which provides the basis for the provision of added value.

In addition, the functionality as well as the added value of a facade will be even more influenced by the location and district considerations in the future. Here, it is important to promote the resilience of buildings to influence at the micro-location as well as to consider individual buildings and consequently also their envelope in interaction with other buildings and thus at the district level. If one building makes a high contribution to the microclimate with its building greening, the neighboring building could prioritize energy generation and thus co-supply the other. Listed buildings, in turn, can contribute to identity creation.

As shown in the table on pages 27 to 30, the aspects of the formulated positions are already reflected in some criteria of the DGNB certification system. A building and district certification according to DGNB therefore already enables a targeted review and expert confirmation in this direction. Nevertheless, it will be necessary to continue to work on this to achieve a stronger focus with regard to the aforementioned items within the scope of certification as well.

Already realized projects show that the created positions are by no means future fantasies, rather individual concepts are already successfully implemented today and address the mentioned requirements and challenges of the future.

The question of the requirements of the facade of the future is not definitively answered by this position paper, since there is no single facade solution that can meet the challenges of the future. This position paper also does not specifically focus on any particular materials or particular systems for future facades. Rather, it will be a combination of the above-mentioned positions that will serve as a prerequisite for the facades of the future and will subsequently be implemented with the appropriate materials and systems.

Accordingly, decision-makers in the real estate and construction industries, as well as urban and municipal developers, will be given an overview of which aspects will gain enormous relevance for facade solutions in the future and should by no means be ignored.

LIST OF FIGURES

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ÖGNI – Austrian Sustainable Building Council

The ÖGNI – Austrian Sustainable Building Council – is an NGO (non-governmental organization) for the establishment of sustainability in the construction and real estate industry. The aim of the ÖGNI is to demonstrate the added value of building certification in order to create environmentally friendly and resource-saving buildings with high economic and social efficiency, which can be used flexibly over generations and have a positive effect on the health, well-being and performance of the users.

The ÖGNI was founded in 2009 and is a cooperation partner of the DGNB (German Sustainable Building Council), whose certification system was adopted, adapted to Austria and has been continuously developed since then.

The ÖGNI is the only Austrian council that is an "established member" of the World GBC (World Green Building Councils) and strives to strengthen the European quality certificate at the international level.

Österreichische Gesellschaft für Nachhaltige Immobilienwirtschaft
Austrian Sustainable Building Council
Vorgartenstraße 206C, 1.OG
1020 Vienna
Austria

+ 43 66415 63 507 I office@ogni.at I www.ogni.at

Partner of: