BuGG-Market Report on Building Greening 2021

Green Roofs, Green Facades and Interior Greening in Germany

Excerpted translation of the original German version

BuGG®
Bundesverband GebäudeGrün e. V.
Dach-, Fassaden- und Innenraumbegrünung

Imprint

BuGG – Market Report on Building Greening 2021
Green roofs, green facades, and interior greening
Germany

Publisher

BuGG®
Bundesverband GebäudeGrün e. V.
Dach-, Fassaden- und Innenraumbegrünung

Bundesverband GebäudeGrün e.V. (BuGG)
Albrechtstraße 13
10117 Berlin
Telefon: +49 30 40054102
Telefax: +49 681 9880572
info@bugg.de
www.gebaeudegruen.info

Authors

Dr. Gunter Mann, Rebecca Gohlke und Fiona Wolff.
Supported by Rebekka Renneberg, Michelle Bruchmüller, Susanne Herfort, Simone Luck, Felix Mollenhauer, Paul Struß, Sylvia van Meegen, Laura Vötig and Tina Weigel.
All Bundesverband GebäudeGrün e.V. (BuGG)

Editorial

Dr. Gunter Mann, Bundesverband GebäudeGrün e.V. (BuGG)

Design/Editing

Andrea Lorenz, Bundesverband GebäudeGrün e.V. (BuGG)

Photos and Illustrations

All Bundesverband GebäudeGrün e.V. (BuGG)
(unless otherwise declared)

Table of Content

1 Preface

The Bundesverband GebäudeGrün e.V. (BuGG) published last year its first market report about 2020 which comprised an overview of the most important figures on green roofs, facades, and interiors in Germany. In doing so, a reference work has been created that, was used thousands of times by policymakers, industry, construction, the media, universities, and students.

With the present market report of 2021, the figures of the building greening market are updated, focusing on the increase of green roofs and facades, and the BuGG City Survey 2021 on municipal subsidy instruments.

In accordance with its statutes, the Bundesverband GebäudeGrün e.V. has the task of promoting the many positive effects of green roofs, facades, and interiors to the general public. This is done by supporting research projects, documenting and dissemination of scientific and technical findings, drafting of publications, educational and informative events, and cooperation with national and international institutions.

Dr. Gunter Mann
President
Bundesverband GebäudeGrün e.V. (BuGG)

The BuGG can only take on this special role, because it is supported by the broad base of more than 400 members from a wide range of sectors.

Special thanks go above all to the BuGG-Team, which has collected a great amount of data. Moreover, I want to thank the many German cities that participated in the city survey, and all the BuGG members who offered us advice and support.

We hope you enjoy reading this report, and that you will help developing many more green buildings and structures!

2 The Market for Building Greening in Germany

2.1 Green roofs

2.1.1 Areas newly greened in 2020

Method for determining newly greened roof areas:

A survey of the total market of annually newly greened roofs has been carried out since 2008 by the Fachvereinigung Bauwerksbegrünung e.V. (FBB), one of the two predecessor associations of the Bundesverband GebäudeGrün (BuGG).
The BuGG has been continuing this analysis since 2018. For this purpose, the largest possible sample of substrate manufacturers and suppliers were asked about the quantities of the following substrate types supplied in Germany:

- Extensive substrate, single layer
- Extensive substrate, multi-layer
- Intensive substrate, single layer
- Intensive substrate, multi-layer

With the help of the determined delivery quantities and fixed assumptions on the installation heights of extensive and intensive green roofs in single and multi-layer construction, the overall new green roof area could be calculated approximately and differentiated into extensive, intensive, single- and multi-layer.

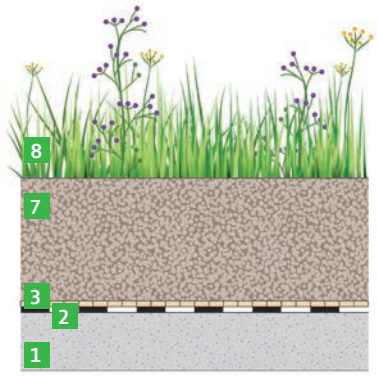

Fig. 1 Schematic representation of a single-layer green roof. Source: BuGG

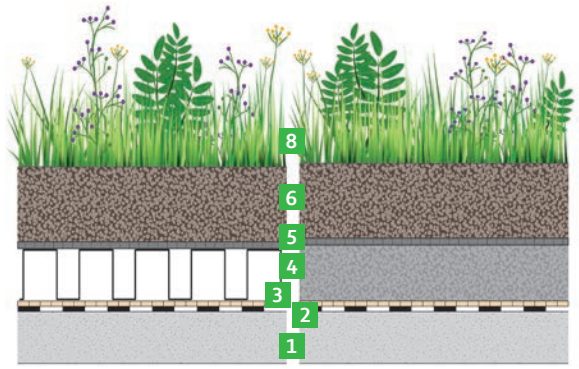

Fig. 2: Schematic representation of a multi-layer green roof. Source: BuGG

1 Suitable roof substructure
Sufficient load-bearing capacity, suitable thermal insulation if necessary.

2 Roof waterproofing or root protection membrane
Root resistant according to FLL or DIN EN 13948 Protection against water and roots.

3 Protective layer
Protective layer of fleeces, rubber granulate mats, etc., to protect the roof waterproofing from mechanical damage.

4 Drainage
Storage of rainwater and drainage of excess water to drainage facilities. The drainage can consist of plastics ("solid drainage") or bulk materials such as lava ("bulk drainage").

5 Filter fleece
Synthetic fleeces that separate the drainage from the vegetation base layer and prevent fine particles from being washed into the drainage.

6 Multi-layer substrate
Vegetation support layer; Special, technically produced substrate according to the characteristic parameters of the FLL Green Roof Guideline for multi-layer construction.

7 Single-layer substrate
Vegetation support layer and drainage layer; special, technically produced substrate according to the characteristic values of the FLL Green Roof Guideline for single-layer construction.

8 Vegetation
Plant species adapted to the special habitat and proven over many years.

Results of the BuGG - Green Roof Substrate Survey

The most important results of the BuGG Green Roof Substrate Survey are summarised and presented below.

- In Germany, a total of 7,839,977 m² of green roofs were added in 2020.
- The newly added total green roof area divided into extensive and intensive green roofs results in:
- Extensive green roofs: 6,437,762m². This corres ponds to a market share of 82.1 %.
- Intensive green roofs: 1,402,215 m². This corres ponds to a market share of 17,9 %.

Green Roof Area 2020		
Extensive, total	m²	6,437,762
	% of total	82.1
single-layer	m²	1,720,876
	% of ext.	26.7
multi-layer	m²	4,716,886
	% of ext.	73.3
Intensive, total	m²	1,402,215
	% of total	17.9
single-layer	m²	99,823
	% of int.	7.1
multi-layer	m²	1,302,392
	% of int.	92.9
Total	m²	7,839,977

Tab. 1: Results of the BuGG Green Roof Substrate Survey 2020. Source: BuGG.

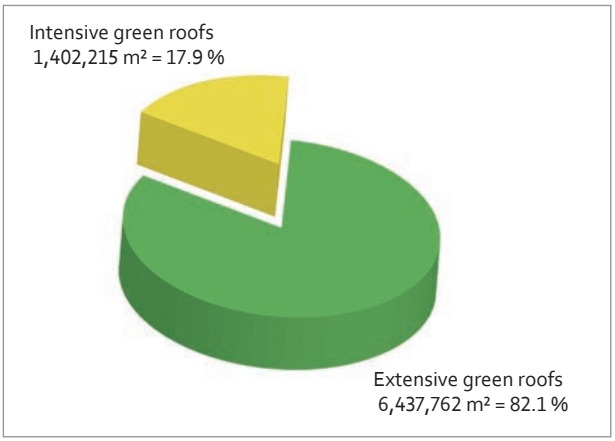

Fig. 3: Green roofs added in 2020. Proportions of extensive and intensive green roofs. Source: BuGG

Fig. 4: In 2020, 82.1 % extensive (in the picture on the left and right) and 17.9 % intensive greening (in the picture center bottom and at top) was carried out. Source: BuGG

Going into more detail, a further distinction is made between single and multi-layer construction for extensive and intensive greening and results in the following:

- **Extensive green roofs** in single-layer construction: 1,720,876m². This corresponds to 26.7 % of the extensive greening.
- Extensive green roofs in multi-layer construction: 4,716,886 m². This corresponds to 73.3 % of the extensive greening.

- **Intensive green roofs** in single-layer construction: 99,823 m². This corresponds to 7.1 % of the intensive green areas.
- Intensive green roofs in multi-layer construction: 1,302,392 m². This corresponds to 92.9 % of the intensive greening.

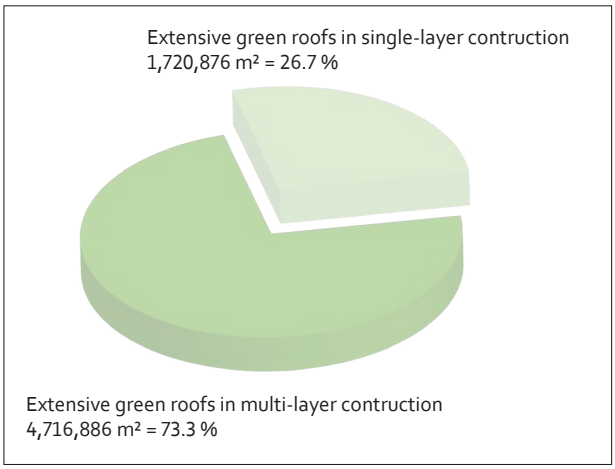

Fig. 5: Extensive green roofs 2020. Ratio of single- to multi-layer construction. Source: BuGG

The determined total green roof area includes all types of green roofs; the method currently does not allow a differentiation between flat and pitched roofs or underground garages or even building types.

It can be assumed that in addition to the companies participating in the annual surveys, there are other, mostly regionally active substrate manufacturers whose delivery quantities are not considered, nor are "conventionally" (gravel and earth filled) designed underground parking green spaces.
Although this was compensated by a correction factor, it can be assumed that the total area of annually greened roofs is likely to be even higher than the numbers determined by the BuGG surveys.

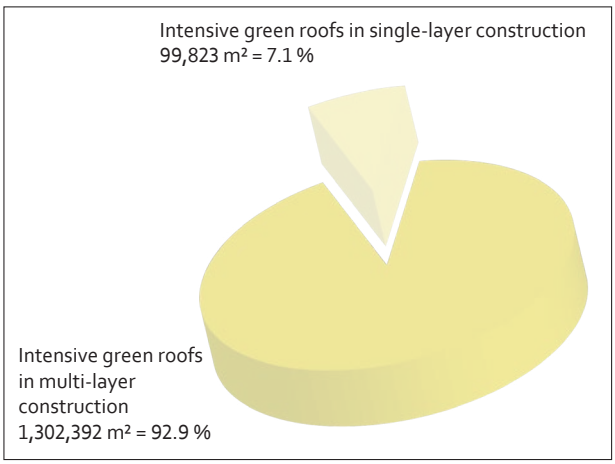

Fig. 6: Intensive green roofs 2020. Ratio of single- to multi-layer construction. Source: BuGG

The new green roof area of around 7.800.000 m² added in 2020 sounds a lot at first, but this is only around 8 % in relation to the assumed 100.000.000 m² of new flat roof area*.

This means that in 2020, about 92 % of flat roof areas remained ungreened - an enourmous potential for further growth.

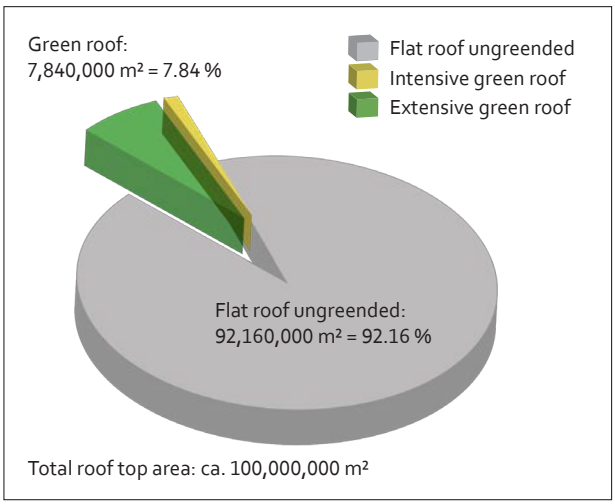

Fig. 7: Green roofs added in 2020 in relation to newly created flat roof area. Source: BuGG

*Note:
According to industry information from the Central Association of the German Roofing Trade (Zentralverband des Deutschen Dachdeckerhandwerks). Newly created flat roof area: new construction and renovation.

2.1.2 Developments of the green roof market 2008 to 2020

Since the method of the BuGG Green Roof Substrate Survey and the companies involved have remained constant over the years (since 2008), the years can be easily compared with each other, developments can be shown, and trends can be derived.

The BuGG was able to determine the following market figures based on this:

- Development of the overall green roof areas
- Annual development/increase
- Development of the ratios of extensive and intensive greenery
- Development of the proportions of single- and multi-layer construction methods for extensive and intensive green roofs.

Table 2 on the following page shows all collected data from the BuGG green roof substrate surveys from 2008 to 2020.

In conclusion, the following can be stated:

- A total of 66,181,175 m² green roof area was created from 2008 to 2020.
- Of the total amount, 55,543,998 m² of roof area was extensively greened, which equals 83.93 %.
- Of the total amount, 10,637,177 m² of roof area was intensively greened, which equals 16.07 %.
- On average, the green roof market is growing by about 7 % each year.
- The green roof market has grown by 117% from 2008 to 2020.
- The trend moves towards intensive green roofs (roof gardens) and therefore (predominantly) accessible and usable green roofs. While the amount of intensive green roofs in 2008 was just 11.4 % (extensive: 88.6 %), it has taken on a much higher dimension in 2020 with 17.9 % (extensive: 83.5 %).
- The average annual growth of intensive green roofs was higher than that of extensive green roofs. Over the last 13 years, extensive greening has grown by an yearly average of 6.7 %, while intensive greening has grown by an average of 10.6 %.
- Even more obvious is the trend towards extensive greening in multi-layer construction: while the ratio of single to multi-layer was 47:53 in 2008, it was 27:73 in 2020.
- For intensive greening, the single-layer construction method plays a subordinate role.

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Summen
Extensive, total	m²	3,197,430	3,163,786	2,754,869	3,720,750	3,445,036	3,812,746	4,159,762	4,244,366	4,228,843	4,708,932	5,645,296	6,024,421	6,437,762	55,543,998
	% of total	88.59 %	85.33 %	83.15 %	86.65 %	86.00 %	85.96 %	84.59 %	84.72 %	83.15 %	80.91 %	81.53 %	83.47 %	82.11 %	Ø 83.93 %
Annual growth	%		-1.05 %	-12.92 %	35.06 %	-7.41 %	10.67 %	9.10 %	2.03 %	-0.37 %	11.35 %	19.88 %	6.72 %	6.86 %	Ø 6.65
single-layer	m²	1,506,180	1,501,786	1,177,574	1,560,330	1,384,546	1,374,570	1,681,842	1,595,872	1,447,030	1,777,189	1,628,206	1,656,796	1,720,876	20,012,795
	% of ext.	47.11 %	47.47 %	42.75 %	41.94 %	40.19 %	36.05 %	40.43 %	37.60 %	34.22 %	37.74 %	28.84 %	27.50 %	26.73 %	Ø 36.03
Annual growth	%		-0.29 %	-21.59 %	32.50 %	-11.27 %	-0.72 %	22.35 %	-5.11 %	-9.33 %	22.82 %	-8.38 %	1.76 %	3.87 %	Ø 9.71
multi-layer	m²	1,691,250	1,662,000	1,577,294	2,160,420	2,060,490	2,438,176	2,477,920	2,648,495	2,781,814	2,931,743	4,017,090	4,367,626	4,716,886	35,531,202
	% of ext.	52.89 %	52.53 %	57.25 %	58.06 %	59.81 %	63.95 %	59.57 %	62.40 %	65.78 %	62.26 %	71.16 %	72.50 %	73.27 %	Ø 63.97
Annual growth	%		-1.73 %	-5.10 %	36.97 %	-4.63 %	18.33 %	1.63 %	6.88 %	5.03 %	5.39 %	37.02 %	8.73 %	8.00 %	Ø 9.71
Intensive, total	m²	411,701	543,827	558,288	573,146	560,867	622,655	758,047	765,539	857,243	1,111,140	1,279,211	1,193,299	1,402,215	10,637,177
	% of total	11.41 %	14.67 %	16.85 %	13.35 %	14.00 %	14.04 %	15.41 %	15.28 %	16.85 %	19.09 %	18.47 %	16.53 %	17.89 %	Ø 16.07
Annual growth	%		32.09 %	2.66 %	2.66 %	-2.14 %	11.02 %	21.74 %	0.99 %	11.98 %	29.62 %	15.13 %	-6.72 %	7.51 %	Ø 10.55
single-layer	m²	3,817	4,630	0	0	0	54,724	40,356	0	0	581,574	606,002	100,355	99,823	1.491.281
	% of int.	0.93 %	0.85 %	0.00 %	0.00 %	0.00 %	8.79 %	5.32 %	0.00 %	0.00 %	52.34 %	47.37 %	8.41 %	7.12 %	Ø 14.02
Annual growth	%		21.28 %	-100.00 %	0.00 %	0.00 %	0.00 %	-26.25 %	-100.00 %	0.00 %	0.00 %	4.20 %	-83.44 %	-0.53 %	Ø 11.84
multi-layer	m²	407,884	539,197	558,288	573,146	560,867	567,931	717,691	765,539	857,243	529,566	673,208	1,092,944	1,402,215	9,245,720
	% of int.	99.07 %	99.15 %	100.00 %	100.00 %	100.00 %	91.21 %	94.68 %	100.00 %	100.00 %	47.66 %	52.63 %	91.59 %	92.88 %	Ø 86.92
Annual growth	%		32.19 %	3.54 %	2.66 %	-2.14 %	1.26 %	26.37 %	6.67 %	11.98 %	-38.22 %	27.12 %	62.35 %	8.30 %	Ø 11.84
Sum (ext+int.), total	m²	3,609,131	3,707,612	3,313,157	4,293,896	4,005,902	4,435,400	4,917,809	5,009,905	5,086,086	5,820,072	6,924,506	7,217,720	7,839,977	66,181,175
Annual growth	%		2.73 %	-10.64 %	29.60 %	-6.71 %	10.72 %	10.88 %	1.87 %	1.52 %	14.43 %	18.98 %	4.23 %	8.62 %	Ø 7.19

Tab. 2: Green roof areas annually added from 2008 to 2020. Source: BuGG

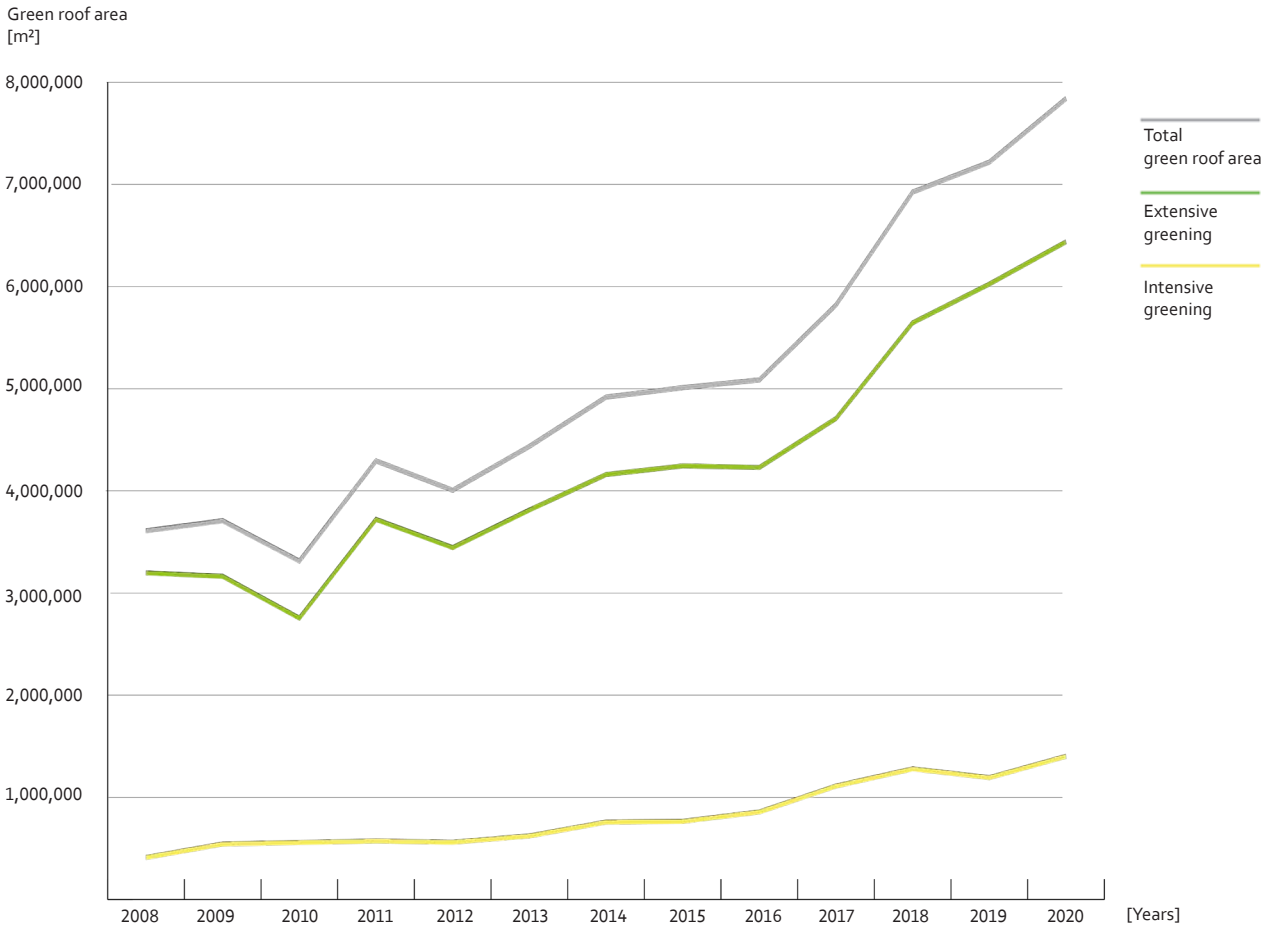

Fig. 8 Development of annual green roof areas from 2008 to 2020. Source: BuGG

Tab. 3: Green roof expansion rates from 2008 to 2020. Source: BuGG

Year	Total green roof market	Extensive greening	Intensive greening
2009	+2.7 %	-1.1 %	+32.1 %
2010	-10.6 %	-12.9 %	+2.7 %
2011	+29.6 %	+35.1 %	+2.7 %
2012	-6.7 %	-7.4 %	-2.1 %
2013	+10.7 %	+10.7 %	+11.0 %
2014	+10.9 %	+9.1 %	+21.7 %
2015	+1.9 %	+2.0 %	+1.0 %
2016	+1.5 %	-0.4 %	+12.0 %
2017	+14.4 %	+11.4 %	+29.6 %
2018	+19.0 %	+19.9 %	+15.1 %
2019	+4.2 %	+6.7 %	-6.7 %
2020	+8.6 %	+6.9 %	+7.5 %
Ø	**+7.2 %**	**+6.7 %**	**+10.6 %**

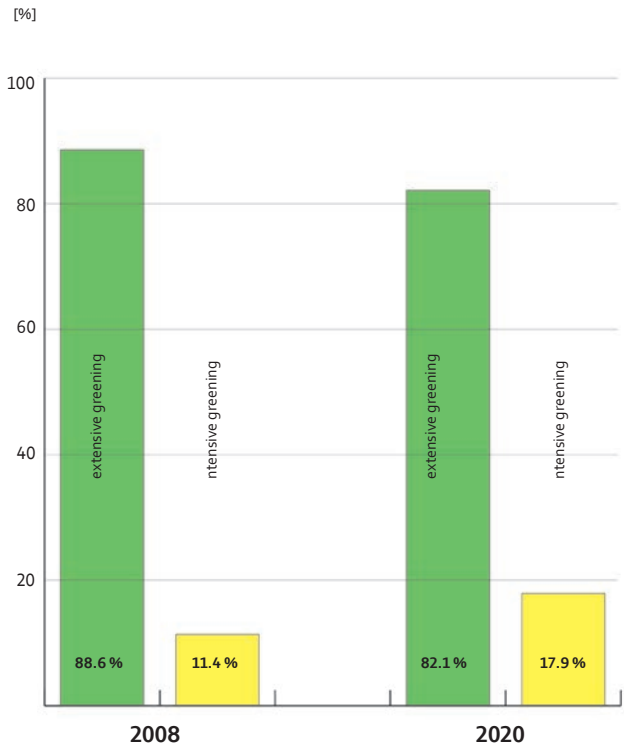

Fig 9: Development of the ratio of extensive to intensive greening 2008 to 2020. Source: BuGG

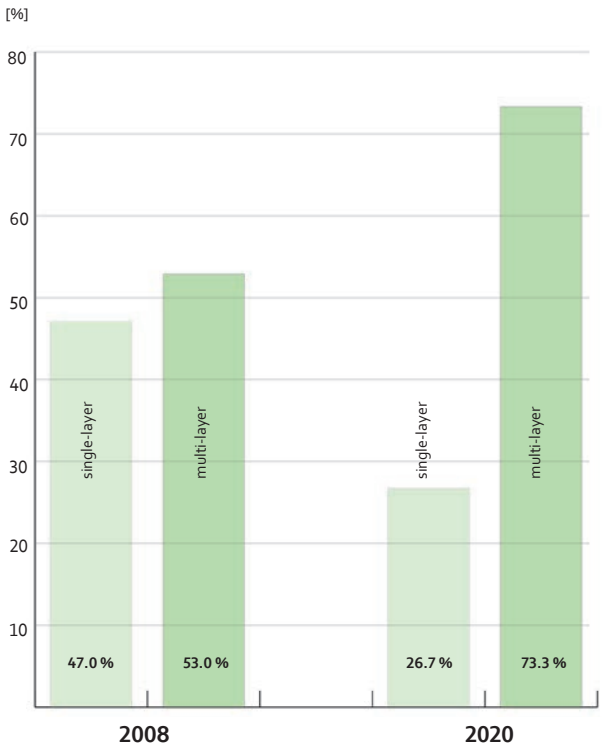

Fig. 10: Development of the construction method of single- and multi-layer extensive greening 2008 to 2020. Source: BuGG

Fig. 11: The trend in the past few years moves in the direction of intensive greening; i.e. roof gardens. Source: BuGG

2.1.3 Green Roof Inventory, Green Roof National League and Green Roof Index

So far, only a few German cities have taken and published inventories of their existing green roofs throughout the urban area. There are different approaches and methods to record existing green roofs.

One method was developed as part of a DBU funded project 2013 - 2016. Together with the German Aerospace Center (Deutschen Zentrum für Luft- und Raumfahrt (DLR)), the German Roof Gardeners Association (Deutsche Dachgärtner Verband e.V. (DDV) - now Bundesverband GebäudeGrün e.V. (BuGG) completed the research project "Inventory and Potential Analysis of Green Roofs" and developed a standardised method for determining the inventory and the potential. The outcome of the project was the development of a software application that allows a fast and efficient analysis of urban roof surfaces. In the process, aerial or satellite images, i.e. remote sensing data, are linked with high spatial resolution and building data. Cities usually keep this data in their geo-data systems. The combined evaluation of the data sets allows green roof analyses for the entire urban area down to the level of individual buildings. The advantage of the method is the fast, automated and cost-effective determination of the green roof inventory and the potential of roof areas that still could be greened. A brief description is available in the BuGG brochure "Inventarisierung und Potenzialanalyse von Dachbegrünungen".

The BuGG has determined the surveyed inventory data of green roofs of different cities and compared these data with different variants. For 15 cities, such information were available. These included:

- Berlin
- Braunschweig
- Dresden
- Düsseldorf
- Frankfurt a. M.
- Hamburg
- Hannover
- Karlsruhe
- Mannheim
- Munich
- Nuremberg
- Nürtingen
- Osnabrück
- Ottobrunn
- Straubing
- Stuttgart

Fig. 12: BuGG Green Roof National League. Good perspectives with green roofs.Source: BuGG

The BuGG has created three variants of the BuGG Green Roof National League:

- Version 1.1: Number of square metres of green roof area without underground car park greenery
- Version 1.2: Number of square metres of green roof area with underground car park green roofs
- Version 2: Green roof index (green roof square me tres per inhabitant)

Version 1.1: Number of square metres of green roof area without underground car park greenery

In version 1.1 (Tab. 4), cities are listed according to the total number of green roof areas they have, excluding underground car park green roofs. Munich leads the table with 3,148,043 m² of green roofs, just ahead of Berlin (2,969,396 m²). As expected, the large cities have advantages in this version compared to small cities, such as Nürtingen (59,450 m²).
The included 16 cities had a combined green roof inventory of 14,997,030 m² at the time of data collection.

Tab. 4: BuGG Green Roof National League Version 1.1: sorted by square metre of green roof area without underground car park greening. Source: BuGG

Ranking	City	Year of data collection	Green roof area without underground park green roofs [m²]	Data collection method	Source
1	Munich	2016	3,148,043	Evaluation of high-resolution aerial photographs and building cadastre data or digital building models	Ansel, W., Zeidler, J., & Esch, T. 2015
2	Berlin	2016	2,969,396	Evaluation of digital color infrared orthophotos and building cadastral data	Coenradie et al., 2016
3	Stuttgart	2017	2,593,670	Evaluation of high-resolution aerial photographs and building cadastre data or digital building models	Landeshauptstadt Stuttgart, Amt für Umweltschutz 2019
4	Frankfurt am Main	2015	1,436,371	Evaluation of high-resolution aerial photographs and building cadastre data or digital building models	Stadt Frankfurt am Main, Umweltamt 2019
5	Hamburg	2018	1,684,355	Based on the subarea data from the split wastewater fee project by the public-law company HAMBURG WASSER (HW), aerial photo resolution DOP 5	Behörde für Umwelt, Klima, Energie und Agrarwirtschaft, 2018
6	Düsseldorf	2018	972,800	Evaluation of aerial photographs with the help of of a geographic information system and wastewater data	Umweltamt Düsseldorf 2020
7	Hannover	2016	633,076	Evaluation of aerial photographs and with the help of a topographic map and digitization by GIS Software	Landeshauptstadt Hannover, Fachbereich Umwelt und Stadtgrün 2020
8	Dresden	2018	463,670	Evaluation of high-resolution aerial photographs and building cadastre data or digital building models	Landeshauptstadt Dresden, Umweltamt 2019
9	Nuremberg	2016	450,000	Evaluation of aerial photographs, building cadastre data and digital building models	Stadt Nürnberg, Umweltamt 2020
10	Braunschweig	2008/2010	186,536	Evaluation of georeferenced infrared aerial photographs (2008) and a building occupancy map (2010), measurement error: up to 15 %	Stadt Braunschweig, Fachbereich Umwelt 2020
11	Karlsruhe	2015	177,546	Evaluation of high-resolution aerial photographs and buildin cadastre data and digital building models	Ansel, W., Zeidler, J., & Esch, T. 2015
12	Osnabrück	2017	157,000	Evaluation with GIS and laser scanner data	Stadt Osnabrück, Fachbereich Umwelt und Klimaschutz 2020
13	Nürtingen	2015/2008	59,450	Evaluation of high-resolution aerial photographs (2015) and building cadastral data and digital building models (2008)	Ansel, W., Zeidler, J., & Esch, T. 2015
14	Straubing	2020	33,617	Evaluation of aerial photographs and precipitation water charges (green roofs on properties with rainwater infiltration were not taken into account)	Stadt Straubing, Stadtentwicklung und Stadtplanung 2020
15	Mannheim	2014	22,000	Evaluation of orthophotos	Umweltplanung Bullermann Schneble GmbH 2015
16	Ottobrunn	2016	9,500	Evaluation of high-resolution aerial photographs	Gemeinde Ottobrunn, Landkreis München, Umweltschutz 2020
		Sum:	**14,997,030**		

Remark:
Comparability is limited due to different recording methods and years

Version 1.2: Number of square metres of green roof area with underground car park green roofs

In variant 1.2 (Tab. 5), the cities are listed according to the total number of their green roof areas; these also include the greened underground car parks. Not all of the listed cities have published an inventory of underground car park green roofs as well, so this version of the BuGG Green Roof National League only includes six cities. Here, Munich leads the table again with 4,548,043 m² of green roofs and underground car parks, just ahead of Stuttgart (4,416,190 m²). At the time of data collection, the six cities had a total green roof area (including green underground car parks) of 17,829,067 m². The total of greened underground car parks alone adds up to 6,075,711 m².

Version 2: Green roof index (green roof square metres per inhabitant)

In version 2 (Tab. 6), the total amount of green roof areas in each city is set in relation to the corresponding number of inhabitants. This results in the green roof square metre ratio per inhabitant ("green roof index").

The average "green roof index" of the 16 cities is 1.3 m²/inhabitant. The current leader, Stuttgart, has a "green roof index" of 4.1 m²/inhabitant, which makes an average of 4.1 m² of green roof per inhabitant.

The attractive aspect of this approach is that also smaller cities can compete in the " championship", because relative numbers are used. This means, the ranking is independent of the size of the city. In this version, Nürtingen now ranks on place 6 with a green roof index of 1.5 m²/inhabitant.

It is important to mention that the values of the individual cities are only comparable to a limited extent, since both the methods and the dates of the inventory differ in some cases.

Updates and the inclusion of further cities are possible at any time. If additional cities have conducted an inventory of their green roof areas and can provide figures, they will be included in the "BuGG Green Roof National League".

With the "BuGG Green Roof National League", there are well-founded values on the green roof index in a city comparison, in order to provide a key figure for politics and urban planning. Cities can now also better classify themselves and their green roof activities in comparison to other cities. Ideally, cities should carry out an inventory of their green roof areas at regular intervals, in order to track and control the effects of direct and indirect support measures introduced for green roofs, for example.

Green roof inventory in Germany

Germany has a long green roof tradition. Roofs have been professionally greened since the mid-1970s. Initially on a smaller scale than in recent years, this has nevertheless resulted in a significant number of green roof areas from 1974 to 2007 (i.e., before the BuGG Green Roof Survey). Since 2008, the newly added area has been recorded by the BuGG Green Roof Survey.

Based on the available figures from the BuGG Green Roof National League, the BuGG surveys and the extrapolation derived from those, the BuGG assumes a total of 110,000,000 to 130,000,000 m² of green roof areas in Germany. This includes extensive, intensive, and underground car park green roofs.

Fig. 13: Decades ago, entire housing estates were completely "green roofed" as shown here in Hannover. Source: BuGG

Fig. 14: The green roof index in Germany currently averages about 1.3 m² green roof per inhabitant. Source: BuGG

Tab. 5: BuGG Green Roof National League version 1.2: sorted by the number of square metres of green roof area with underground parking. Source: BuGG

Ranking	City	Year of data collection	Green roofs with underground car park greening[m²]	Only underground car park greenings [m²]
1	Munich	2016	4,548,043	1,400,000
2	Stuttgart	2017	4,416,190	1,822,520
3	Berlin	2016	4,002,682	1,033,286
4	Düsseldorf	2020	2,063,700	1,090,900
5	Frankfurt am Main	2015	1,962,252	525,881
6	Hannover	2016	836,200	203,124
		Sum:	**17,829,067**	**6,075,711**

Note: Comparability is limited due to different recording methods and years.

Tab. 6: BuGG Green Roof National League version 2: sorted by green roof area per inhabitant ("Green Roof Index"). Source: BuGG

Ranking	City	Year of data collection	Inhabitants	Green roofs without underground car parks [m²]	„Green Roof Index" [m² green roof/inhabitant]
1	Stuttgart	2017	632,742	2,593,670	4.1
2	Munich	2016	1,464,301	3,148,043	2.1
3	Frankfurt am Main	2015	732,688	1,436,371	2.0
4	Düsseldorf	2020	620,523	972,800	1.6
5	Hamburg	2018	1,121,000	1,684,355	1.5
6	Nuremberg	2015/2008	40,395	59,450	1.5
7	Hannover	2016	532,864	633,076	1.2
8	Osnabrück	2017	164,374	157,000	1.0
9	Nürnberg	2016	511,628	450,000	0.9
10	Berlin	2016	3,574,830	2,969,396	0.8
11	Dresden	2018	560,641	463,670	0.8
12	Braunschweig	2008/2010	246,012	186,536	0.8
13	Straubing*	2019/2020	48,110	33,617	0.7
14	Karlsruhe	2015	300,051	177,546	0.6
15	Ottobrunn	2016	21,000	9,500	0.5
16	Mannheim	2014	296,690	22,000	0.1
				mean	**1.3**

Notes:
* Green roofs on properties with Stormwater Infiltration were not considered. Comparability is limited due to different recording methods and years. Green underground car parks are not included. Number of inhabitants at the time of the survey.

2.2 Facade greening

2.2.1 Newly greened areas in 2020

It is harder to determine the size of the greened facade areas in 2020 than it is for the greened roof areas. The method of monitoring substrate quantities and converting them into greening area, which is used for green roofs, is not possible for green facades due to the design of the system. While the data for "wall-bound" facade greening can be determined quite easily, since the system solutions are only sold and installed for the purpose of greening and in square metres, the situation is different for "ground-bound" facade greening. System suppliers of climbing aids (e.g., ropes and nets) are often unable to clearly identify whether the products sold are used for greening purposes and which spaces are actually greened. Depending on the spacing between linear climbing aids installed next to each other, the greening areas vary in size. One running metre of linear climbing aid is not necessarily equal to one square metre of facade greening.

An exact determination of newly planted areas of ground-based facade greening with self-climbing plants (direct greening without climbing aids) is not possible for various reasons. Among other things, the distribution channels of plants used in greening facades are diverse. Additionally, both professionals and laymen are mplementing ground-based facade greening. Lastly, it is difficult to determine the area that might be greened in the coming years.

The Bundesverband GebäudeGrün e.V. (BuGG) asked its members who offer product and system solutions for facade greening about greened areas in 2020. The total areas of both ground- and wall-bound facade greening were surveyed, although in the case of ground-bound facade greening, only the areas with climbing aids were surveyed.

- According to this, a total of approximately 55,000 m² wall-bound and ground-bound facade greening (with climbing aids) was installed in Germany in 2020.
- The wall-bound green facades cover an area of about 10,000 m².
- the total ground-bound facade greening area planted with climbing aids is about 45,000 m².

Fig. 15: In Germany, about 45,000 m² of ground-bound facade greening with climbing aids (left side of picture) and about 10,000 m² of wall-bound facade greening (right side of picture) were built in 2020. Source: BuGG

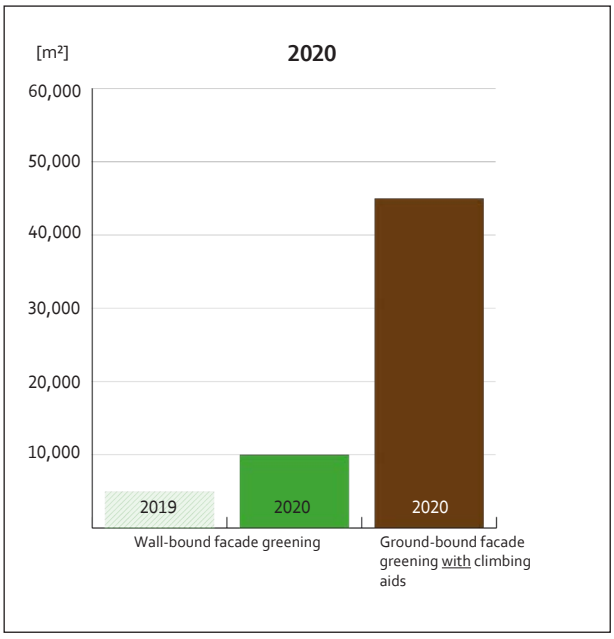

Fig. 16: Determined and estimated size of the newly greened facade areas in 2020. Source: BuGG

Fig. 17: It´s not always easy to tell, how many square metres of greened wall can be assigned to one running meter of climbing aid. Source: BuGG

Fig. 18: Ground-bound facade greening with nets or grids are easy to record... Source: BuGG

Fig. 19: ... as well as wall-bound facade greening. Here it's easy to record the area in square metres. Source: BuGG

Fig. 20: The amount of newly greened areas per year by self-climbers cannot be determined due to the numerous distribution channels and possibilities of origin. Source: BuGG

2.3 Interior greening

2.3.1 Look back interior greening and hydro culture 2020

The Fachverband Raumbegrünung und Hydrokultur (FVRH) is part of the Zentralverband Gartenbau e. V. (Central Horticulture Association). It represents the economical and professional interests of over eighty members. Its strength is based on its high degree of organization and international orientation. A large part of the European greening and hydroponics industry is represented in the association. These are both companies from interior greening and trade as well as production and industry. As with the companies themselves, the year 2020 was largely characterized by the development of information around Covid. Members were regularly informed by the office about all developments. There was assistance in the way of newly developed sample letters. Other elements of the work in 2020 were the combined press and social media work with the Green Media House (GMH), the cooperation with field research of indoor greening and hydroponics, and the cooperation with other associations.

Fig. 21: Execution and maintenance of indoor greening were often limited due to the Corona pandemic Source: BuGG

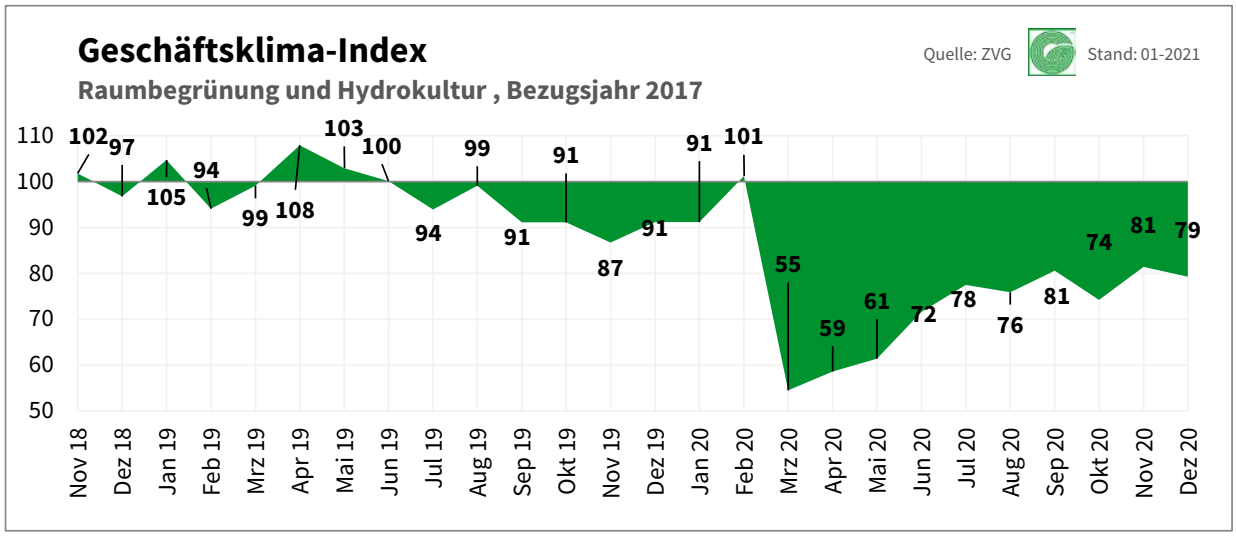

Fig. 22: Business climate index indoor greening and hydroponics. Source: ZVG

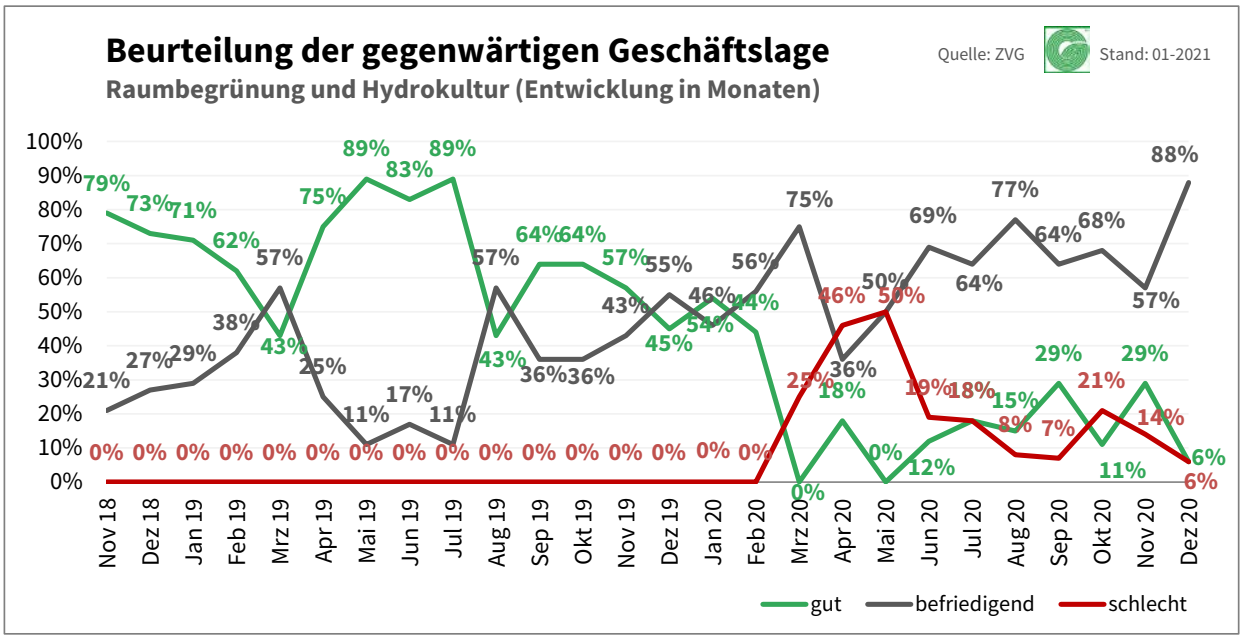

Fig. 23: Assessment of the current business situation indoor greening and hydroponics. Source: ZVG

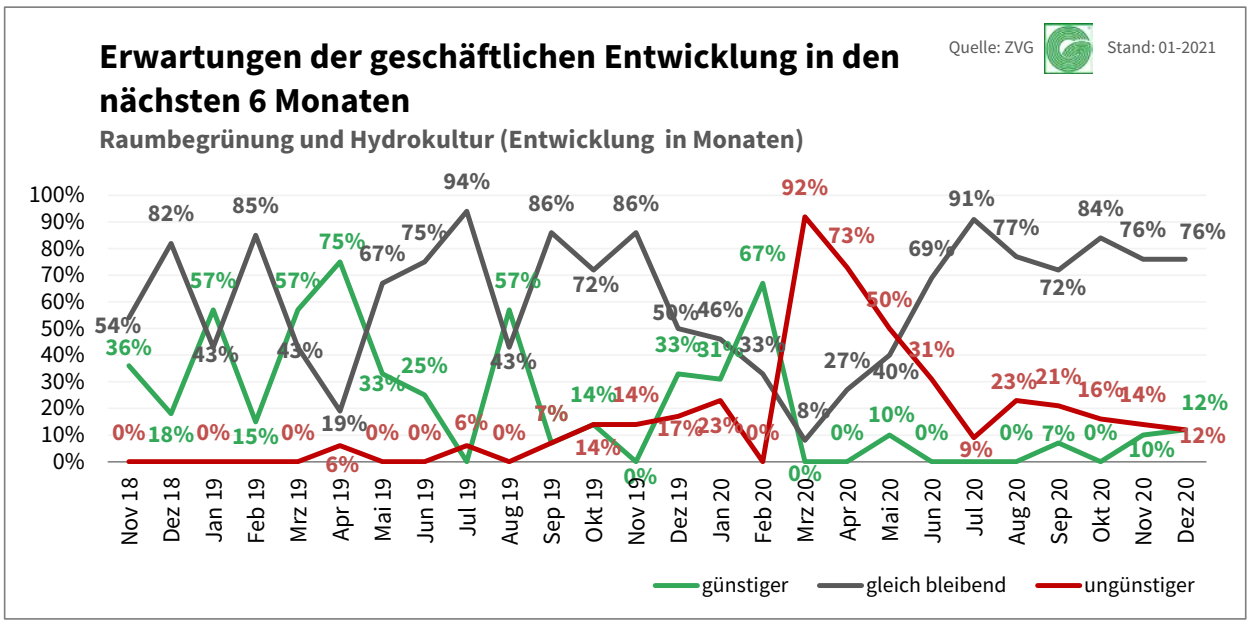

Fig. 24: Expectations of the business development of indoor greening and hydroponics in the next 6 months. Source: ZVG

The business climate index conducted by the Zentralverband Gartenbau e. V. for the sector of indoor greening and hydroponic specialists in 2020 is clearly characterized by the Covid pandemic. At the beginning of the year, the industry had started optimistically. With the begin of the crisis, the assessment of the companies has turned out to be very negative. Companies in the industry have had to deal with the lockdown rules and the associated restrictions over the past year. Sales to corporate customers have collapsed for many companies. Unfortunately, regular maintenance of greenery in offices was no longer possible. There is a need to respond to a changed working world after Corona, such as with concepts for home office workplaces or co-working spaces. Digitalization must find its way into the companies themselves even faster. External appearances on the Internet and social media must become more professional and imaginative. Companies should even include their own Internet stores in their strategic orientation.

2.4 Subsidies for green roofs and facades

2.4.1 Overview of municipal subsidy instruments

Green roofs and facades are gaining importance nationwide in the context of climate-adapted and water-sensitive urban development, because they provide multiple benefits for the city. At the municipal level, green roofs and facades can be promoted through various means which differ in their field of action, their liability, and their financial expense for the city. Directly and indirectly promoting instruments are presented in this chapter:

- Determinations in development plans
- Design statutes
- Subsidy programmes with financial subsidies
- Eco-points within the framework of the impact regulation
- Fee reduction for the split wastewater fee

The aim of this chapter is to present the various instruments, to show examples and to outline the current status of municipal support for green roofs and facades in Germany. The basis for this is the BuGG city survey of 2021, with which the survey series of the former Fachvereinigung Bauwerksbegrünung e.V. (Green Roof Association) (FBB) and the Naturschutzbund Deutschland (Nature and Biodiversity Conservation Union) (NABU) was continued. For the present Market Report Building Greening 2021, the survey data was expanded with our own research to provide a comprehensive picture of the promotion of building greening.

At the beginning, the results of the city surveys of recent years are presented and the most important developments are summarised. This is followed by a table on the current promotion of greening in all German cities with more than 50,000 inhabitants (E), before the individual subsidy instruments for green roofs and facades are discussed in more detail.

Tab. 7: Results of the city surveys on the subsidy of green roofs and facades from 2010 - 2021. Source: BuGG

	1				2		3	
	FBB-NABU Survey (cities >10.000 E)				BuGG Survey (cities >20.000 E)		BuGG + Research (cities >50.000 E)	
	2010	2012	2014	2016/17	2019	2021	2019/20	2021
Number of cities contacted	1.499	1.499	1.499	1.499	700	701	191	193
Response rate	579 (39%)	564 (38%)	510 (34%)	400 (27%)	199 (28%)	196 (28%)		
Roof greening								
Green roof bylaws	-	-	-	-	-	12 (6%)	-	24 (12%)
Subsidy programme (direct grants)	36 (6%)	32 (6%)	31 (6%)	32 (8%)	37 (19%)	58 (30%)	48 (25%)	82 (42%)
Determinations in development plans	198 (34%)	208 (37%)	202 (39%)	213 (53%)	133 (67%)	118 (60%)	138 (72%)	160 (83%)
Ecopoints	50 (9%)	59 (11%)	55 (11%)	50 (13%)	42 (21%)	40 (20%)	45 (24%)	48 (25%)
Fee reduction with split wastewater fee	221 (38%)	276 (49%)	270 (53%)	217 (54%)	98 (49%)	84 (43%)	137 (72%)	149 (77%)
Facade greening								
Facade greening bylaws	-	-	-	-	-	6 (3%)	-	8 (4%)
Subsidy programme (direct grants)	32 (6%)	30 (5%)	25 (5%)	28 (7%)	34 (17%)	41 (21%)	45 (24%)	65 (34%)
Determinations in development plans	188 (32%)	187 (33%)	172 (34%)	135 (34%)	89 (45%)	74 (38%)	77 (40%)	106 (55%)
Ecopoints	-	-	-	-	-	15 (8%)	-	13 (7 %)

Note: (=n) = number of responses to which the percentage results for the individual subsidy instruments refer.

Results of the city surveys on the subsidy of Green Roofs and Facades 2010 - 2021

Tab. 8 shows the results of the city surveys on the subsidy of green roofs and facades from 2010 to 2021. While FBB and NABU included all German cities with more than 10,000 inhabitants (E) in the survey, the BuGG limited the survey to all cities with more than 20,000 E. Within a questionnaire the various instruments were requested from the cities contacted and the responses received were subsequently analyse.

The table is completed by the results of the research carried out in 2019/2020 and 2021 about the municipal subsidy of all German cities with more than 50,000 E (column 3).
For the instrument of design statutes (green roof and facade greening statutes), data can be published for the first time in the 2021 survey. Furthermore, a question about the allocation of eco-points for the facade greening within the framework of the intervention regulation was supplemented.

Comparison and insights

When comparing the survey results, it should be noted with regard to the subsidy programmes that

- the proportion of cities that offer direct subsidies for green roofs has increased (2019: 19 %, 2021: 30 %).
- an increase can similarly be seen for direct subsidies for the direct subsidisation of facade greening.
- the share of cities with directly subsidies with more than 50,000 inhabitants in Germany is even higher in 2021 (roof: 42 %, facade: 34 %).

In the field of binding urban land-use planning, it can be seen that

- the proportion of cities that have specified green roofs (2019: 67%, 2021: 60%) or green facades (2019: 45%, 2021: 38%) in development plans decreased slightly.
- in contrast, the instrument is increasingly used by cities with more than 50,000 inhabitants for green roofs (2019: 72%, 2021: 83%) and for facade greening (2019: 40%, 2021: 55%).
- the specification of green roofs is carried out more frequently compared to green facades.

As a result of the survey for the instrument of design statutes, it can be seen that

- 6 % of the cities have green roof bylaws and 3 % have green facade bylaws.
- the proportion of cities with more than 50,000 inhabitants is higher (roof: 12 %, facade: 4 %).
- the instrument is only used sporadically for green roofs and facades.

With regard to the application of the impact regulation, it should be noted that

- the proportion of cities awarding eco-points for green roofs remains at a similar level (2019: 21 %, 2021: 20 %).
- for cities with more than 50,000 inhabitants the share is slightly higher (2021: 25 %).
- the share of cities awarding eco-points for green facades is 8%.

With regard to the fee reduction for the split wastewater charge, it has been shown that

- the proportion of cities that promote green roofs through a reduction in charges has remained at a similar level since 2012 (2012: 49%, 2021: 43%).
- The share of cities with more than 50,000 inhabitants has increased slightly to 77 %.

2.5 Research and Education

Building greening is receiving more and more attention in the context of climate protection and climate adaptation. The federal and state governments are increasingly supporting research projects on roof, facade, and interior greening. A large number of German universities and research institutions are already participating in the research work. In addition to this, the focus is on education. As an interdisciplinary issue, building greening affects various professional fields, including architecture, landscape architecture, civil engineering as well as urban and spatial planning. Accordingly, there is a wide range of higher education institutions dealing with roof, facade, and interior greening. Every year, the Bundesverband GebäudeGrün e.V. (BuGG) receives numerous requests from students for theses from a wide range of degree programmes. Current research projects and teaching experiences of BuGG members and other universities or research institutions in the field of building greening are presented below.

Fig. 25: Universities and research institutions that address the issue of building greening. Source: BuGG

Universities in the BuGG

Prof. Dr Nicole Pfoser is Professor for Object Planning at the Faculty of Landscape Architecture, Environmental and Urban Planning at the University of Nürtingen-Geislingen since 2018. Her research focuses on the energetic, climatic and aesthetic potentials, as well as the interactions of buildings, building greening and the building environment. Green roofs and facade greening is intensively discussed in her lectures and research projects. The "VertiKKA" project is concerned with vertical climate treatment plant as a model solution for increasing resource efficiency and the quality of life in urban areas. Strategies and adaptation measures to increase the resilience in Saarlouis are currently being developed in the "STARK" project. Moreover the "Citytunnel Darmstadt" project is investigating the contribution of wall-bound facade greening to the urban climate and air balance.

Prof. Dr. Ferdinand Ludwig is holding the Professorship for Green Technologies in Landscape Architecture at the Technical University of Munich (TUM) since 2017. His fields of research include Construction Botany, Vertical Open Spaces and Living Bridges. In addition, there are topics of grey water utilisation, Green Architecture and New Vegetation Techniques. The greening of buildings is an integral part of his lectures and his five current research projects. The development of a green facade for the year-round cultivation of vegetables behind the windows of commercial buildings is the aim of the "Agricultural Lighting Facade" project. In the project "Baumfassade" (trees at facades), the potential of trees at building facades to improve the microclimate is investigated. The project "KlimaKübelBäume" (climate bucket trees) is also looking at the use of trees in pots as an effective urban climate adaptation measure. The abbreviation "INTERESS-I" stands for the project " Integrierte Strategien zur Stärkung urbaner blau-grüner Infrastrukturen"(Integrated Strategies for strengthening urban blue-green infrastructures), in which concepts for the optimisation of settlement and building structures are being developed. The EU-funded project "ECOLOPES" was launched in 2021. It will develop planning and design technologies for a new, integrated ecosystem approach in architecture. The Faculty of Civil, Geo and Environmental Engineering of the TUM began the year 2021 with the research project "Fire protection for green facades" with the aim of finding fire protection solutions for the application of green facades in high-rise buildings.

Fig. 26: The "INTERESS-I" project in Stuttgart with facade greening and service water utilisation. Source: BuGG

Furthermore, the Institute for Urban Horticulture and Plant Use of the Geisenheim University (HGU) run by Prof. Dr. Alexander von Birgelen should be mentioned. The research focus of the institute is on ornamental plants and urban greenery. The greening of buildings was taken over in January 2021 by Ms Maren Stollberg as a research assistant. There is a test facility about wall greening at the campus of the HGU, which is used for teaching and research projects. In the Bachelor's degree programme in horticulture, the module "Building Greening" is offered. In various Master's degree programmes at the HGU the module "Plant and Architecture" is available for selection. In addition to the courses students have joined together in a voluntary working group, the "Facade greening working group". They work on their own initiative with systems and planting variants for facade greening.

Prof. Dr. Manfred Köhler, senior professor since March 2021, is a long-standing member of the BuGG at the University of Applied Sciences in Neubrandenburg. His research focuses in particular on building greening and ecological building, but also on nature conservation issues. In various Bachelor's and Master's degree courses, he teaches in the area of plant science and urban ecology with a focus on building greening. Since already 35 years (1986) Prof. Dr. Köhler has been conducting studies with project partners about the long-term development of extensive green roofs in the area of Berlin.

Prof. Dr. Swantje Duthweiler, Professor of plant use at the University of Applied Sciences in Weihenstephan-Triesdorf (HSWT), has been researching the building greening since many years. She is also researching on historical plant use and urban vegetation concepts. At the Institute for Ecology and Landscape, she is currently leading the project "Grünes Hochhaus Arabella 26" (high-rise building Arabella 26), in order to illustrate the microclimatic effects of climbing plants on buildings and their surroundings. Furthermore, she is working under the direction of Prof. Dr. Elke Meinken on a project at the Institute of Horticulture entitled "Adaptive and sensor-supported irrigation of extensive green roofs to optimise urban water management with regard to precipitation retention and evaporative cooling". Together with ZAE Bavaria, Dr. Annette Bucher is working within the "green4indoor" project on energy-efficient indoor climate control with vertical greening. The building greening is taught at the HSWT as part of the module "Object Greening". According to Dr Bucher, the students are very interested in this topic.

Prof. Dr. Nina Kloster teaches and researches indoor greening at the Faculty of Plants, Energy and Machine Systems at the Institute for Technical Building Equipment at the Cologne University of Applied Sciences (THK). She is the laboratory manager of the GreenING Lab, which deals with the possible use of biosystems in technical building applications. In cooperation with partners of practical work, the THK is running a research project about "Vertical indoor greening in timber construction": The effects of greening on the quality of indoor air and the wood moisture content of adjacent building components are being investigated. In the previous year the project about investigation of the acoustic properties of vertical interior greenings was completed.

Prof. Dr. Roland Krippner is Professor of Construction and Technology at the Faculty of Architecture at the Nuremberg Institute of Technology. He is currently leading the research project "GreenFaBS", in which the usage of green facades for reducing the cooling energy demand in school and administration buildings is being investigated. In addition, he is researching in the project "GreenPV" on the possibility of combining green facades and photovoltaics as a facade solution for climate adaptation and climate neutrality.

Another BuGG member is the Technical University of Applied Sciences in Bingen with Prof. Dr. Elke Hietel, head of the Department of Landscape Ecology and Biodiversity and leader of the Hermann Hoepke Institute. Within the institute there is research in the fields of energy, informatics, technology, agriculture, and environment. Since 2019 Prof. Dr. Elke Hietel has been researching the potential of semi-intensive green roofs in the project "Efficient, innovative building greening - EffIN-Green".

Fig. 27: The "EffiN-Green Project" covers various aspects, including the evaporation performance of extensive greening.
Source: BuGG

Other cooperating universities are the Technical University of Berlin with the Department of Landscaping and Object Construction of the Institute of Landscape Architecture and Environmental Planning (ILaUP), the Beuth Hochschule für Technik Berlin with Prof. (ret.) Dr. Karl-Heinz Strauch and the University of Applied Sciences in Dresden with Prof. Dr. Henning Günther.

Activities of other universities

The Department of "Environmentally Friendly City and Infrastructure Planning" at the HafenCity University Hamburg (HCU) with Prof. Dr. Wolfgang Dickhaut forms an interface between technical infrastructure planning, spatial and urban planning, and landscape and open space planning. The research focuses on sustainable rainwater management and water-sensitive urban development. Two long-term measurement projects (RISA pilot projects) on rainwater management with green roofs for the City of Hamburg are taking place. In many Bachelor's and Master's degree programmes, the department is involved in several courses like Urban Water Management, Vegetation and Infrastructure, Water Sensitive Urban Development, Urban Water Cycle, Technologies of Sustainable Water Management or Sustainable Urban Development. All of these courses are related to building greening.

Fig. 28: Hafen City University Hamburg has conducted long-term studies on retention green roofs "Am Weißenberge". Source: BuGG

The "Integrative Research Institute on Transformations of Human-Environment Systems (IRI THESys)" at the Humboldt University of Berlin (HU Berlin) was founded in 2013. It conducts research in inter- and transdisciplinary projects in relation to land, water and energy use as well as food production and consumption in the context of climate change. The EU-supported innovation project "EdiCitNet - Edible Cities Network", in which the BuGG is also involved, edible city solutions are being researched and tested in order to systematically use urban landscapes for food production. The aim is to make cities more sustainable, liveable, and healthy, to develop new green business models and to strengthen the social cohesion.

Fig. 29: Hafen City University Hamburg has conducted long-term studies on retention green roofs "Am Weißenberge". Source: BuGG

Prof. Gilbert Lösken is leading the department of Technical-Constructive Fundamentals of Open Space Planning at the Institute of Landscape Architecture at the Leibniz University of Hanover (LUH). The research focus is on vegetation engineering issues related to the cultivation of artificial vegetation sites. Important topics are the water retention capacity and the drainage retardation of green roofs. In two research projects together with the Institute for Hydrology and Water Management of the LUH, "Evaporation simulations of thin-layer green roofs" and "Runoff simulations in single-layer green roofs as a function of the slope and flow length" are currently being carried out.

Prof. Dr. Mathias Uhl teaches and researches in the field of water management and hydrology in urban areas at the department of civil engineering at the Münster University of Applied Sciences. In the current research project "R2Q RessourcePlan in quarters", a planning tool is being developed. The aim of the tool is to enable the efficient management of resources at a district level. Two research projects on green roofs are currently taking place at the Institute of Geoecology at the Technical University of Braunschweig in the Department of Climatology and Environmental Meteorology. Prof. Dr. Stephan Weber is investigating the "surface-atmosphere exchange of an extensive green roof" with reference to the surface energy balance and carbon exchange in Berlin and Braunschweig.

The Technical University of Darmstadt (TUD) is involved with the department of design and open space planning at the Faculty of Architecture in the joint project "Green instead of grey - commercial areas in transition". The project is already in its second funding phase and focuses on climate adaptation and the improvement of the quality of stay in existing commercial areas. Since 2018, several seminars have been held at the TUD in connection with the joint project and many seminars on the topic of building greening and student design work for companies have been developed. Dr. Sandra Sieber reports, there is a great interest in the topic and the students consider climate adaptation, biodiversity, and sustainability as important fields of action for architecture and urban planning.

Prof. Dr. Irene Lohaus, Professor of Landscape Architecture at the University of Dresden, is currently leading the "Model Project Integral Water Management with simple intensive roof greening". The interdisciplinary research project aims to optimise the effects of a green roof through irrigation with grey water.

The Faculty of Agricultural Sciences and Landscape Architecture at Osnabrück University of Applied Sciences has been working since 2020 under the leadership of Prof. Dr. Kathrin Kiehl on the research project "DALLI - extensive green roofs in urban landscapes as a habitat for insects". The research focuses on the creation of extensive green roofs of high conservation value.

Prof. Dr. Mathias Kaiser is Head of the Department of Water Systems at the Chair of Resource and Energy Systems at the Technical University of Dortmund. The topic of "Green Roofs in Existing Buildings" in connection with the BMBF joint project TransMiT focuses on the development of integrated and open-minded planning for sustainable and resource-optimised transformation of existing drainage systems in existing inner-city buildings.

At Koblenz University of Applied Sciences (HSK), Prof. Georg A. Poensgen is head of the Master's degree programme in Architecture in the faculty of building-art-materials. He is discussing green roofs and facades within the topic of "Future Living". Building greening also plays an important role in students projects. At excursions, the students are able to visit internationally known greening projects like the "High Line Park" in New York City in 2018.

Fig. 30: View of the predecessor project ("RooBi") of the current project "DALLI" in Osnabrück - it is about the usage of regional seeds.
Source: BuGG

Research institutions in the BuGG

The Bavarian Centre for Applied Energy Research (ZAE Bayern) is an energy research institute, which focuses on energy-optimised construction, the monitoring of building greening and the energetic evaluation and assessment of building physics measurements. On the premises of ZAE Bayern, the Climate Research Station was installed as an outdoor measuring stand in 2018. It combines highly innovative building technologies with different greening systems to research within the project "InnoGeoTherm". The research regards the effect and, in particular, the energy efficiency of green climate facades. Furthermore, the ongoing research project "green4indoor" under the leadership of Dr. Michaela Reim and in cooperation with the HSWT deals with the subject of energy-efficient indoor climate control with vertical greenery. Dr. Reim also coordinates the joint project "U-green", which was launched in 2021 together with the BuGG and other project partners. The project is developing standardised measurement procedures and parameter records to take account of green building structures in the energy design of buildings.

The Bavarian State Institute for Viticulture and Horticulture (LWG) in Veitshöchheim is distinguished by its practice-oriented research in the field of horticulture and landscaping. Under the direction of Dr. Katja Arand and in cooperation with ZAE Bavaria, the research project "Climate Research Station - Species-rich Green Building Envelopes" was launched this year. The aim is to investigate the compatibility of energy-efficient building technologies with species-rich and climate-impacting habitats in the facade. In the project "Biodiversity in Vertical Greening", perennials and small shrubs are tested with regard to their long-term suitability on sun-exposed wall-bound greening modules. In cooperation with authorities, educational institutions, and initiatives, the LWG runs "Urban Gardening Demonstration Gardens" in Bavaria to show people a wide variety of cultivation methods. In the field of green roofs, long-term observations are being carried out on "mixed perennial and grass plantings, habitat from open space to rocky grassland habitat". The project "Climatic moderation of single-layer green roofs with extensive and intensive planting" investigates the climatic impact on the environment.

Fig. 31: The Bavarian Center for Applied Energy Research (ZAE Bayern) has conducted and continues to conduct various research projects on green roofs and facades. Source: BuGG

In addition, the LWG teaches at the State Master and Technical school for Viticulture and Horticulture Veitshöchheim in the field of gardening and landscaping. The greening of buildings is taught in the subjects "Technique of green space construction" and "plant use" based on the relevant FLL guidelines. The topic is integrated into practice-oriented project work. According to Mr. Rainer Berger, the experience and teaching evaluations show that the interest of the students in building greening is very high, and the majority of students consider the topic to be of high to very high importance and relevance for professional practice.

The Education and Research Institute for horticulture and arboriculture (LVGA) Großbeeren is a certified vocational training centre for the green sector in Berlin and Brandenburg. A variety of seminars are offered for specialists and managers as well as those interested in horticulture, arboriculture, gardening, and landscaping. In the field of greening buildings, intensive courses about roof and facade greening are offered on the one hand. On the other hand, excursions are organised to greened buildings in Berlin.

The Institute for Agroecological and Urban Ecological Projects (IASP) at the Humboldt University of Berlin is also represented in the BuGG for many years with Susanne Herfort. Its field of work includes the usage of renewable raw materials for innovative vegetation mats for green roofs and embankments, the promotion of green roofs and facades in Germany, as well as studies on indoor greening. In addition to the research project "Care and maintenance of extensive green roofs", a new project called "Facade Protection" is being launched this year in cooperation with the BuGG. The aim is to carry out a technical inventory of green roofs.

Fig. 32: The Institute for Agricultural and Urban Ecological Projects (IASP) at the HU Berlin and the BuGG are currently carrying out the "FassadenSchutz" project. Source: BuGG

Activities of other research institutions

Founded in 1929, the Fraunhofer Institute for Building Physics IBP researches, develops, tests, and advises nationally and internationally in the fields of building physics and building technology. Its locations are in Stuttgart and Holzkirchen. A total of six ongoing research projects refer to green roofs and facades. The improvement of the data basis for vertical and extensive roof greening is the goal of the "Green Follows Function Attributes" project, which is being carried out in cooperation with the BuGG.

In addition, the development of urban building physics models at IBP enables the simulation of city-wide positive effects of green roofs and facades. In a further project, the performance portfolio for the evaluation of green roof constructions will be expanded for simulation tools with regard to water retention capacity and urban climatic effect. In the project "ProPolis: Fundamentals for the operationalisation of PALM-4U", a practical model is being developed which can be used to calculate the effects of greening measures on the urban climate, so future urban climatological aspects can be adequately considered in urban planning.

The suitability and efficacy of nature-based solutions and blue-green infrastructure is being investigated in the "Morgenstadt Global Smart Cities" project. Its aim is to increase climate resilience in three pilot cities. The abbreviation "BUOLUS" stands for the collaborative project
"Building Physics Design of Urban Surfaces for Sustainable Quality of Life and Environment in Cities". The aim of the project is to determine the physical potential of urban surfaces (including green spaces) in order to support the municipal demand for space efficiency and social acceptance.

Fig. 33: In the "Green Follows Function Attributes" project of the Fraunhofer Institute in cooperation with the BuGG, different properties of green roof and facade plants are collected. Source: BuGG

At the Educational and Research Centre for Horticulture (LVG) of the Thuringian State Office for Agriculture and Rural Areas, questions of facade greening are the focus of the key topic "Thuringian agriculture and horticulture in climate change". The aim is the development of guidance for high-quality building greenings and the evolution of planting and maintenance concepts. Under the leadership of Dr. Gerd Reidenbach, various plant species for vertical greening in central Germany are being tested in the project "cityLam system greening as facade greening".

The German Weather Service (DWD) is involved in a wide range of climate research projects. The focus of the project "ADAM" is on urban climate and climate adaptation. Together with the BuGG and other project partners, computer-based urban climate modelling is being carried out in order to analyse the thermal effect of green roofs on the neighbourhood and the city as a whole.

Fig. 34: In the "ADAM" project of the German Weather Service (with other partners, including the BuGG), urban climate modelling is carried out with green roofs. Source: BuGG

Conclusion and outlook

In summary, it can be noted that a large number of German universities and research institutions are conducting research projects on building greening. The topics of climate adaptation and sustainable rainwater management are focused, followed by biodiversity, energy and resource efficiency, urban gardening and farming, and construction issues.
The offer of building greening in education is increasing and some universities have already included modules on green architecture in the curricula. There is a great interest of students in green roofs and facades.

However, further efforts are needed to create a nationwide range of courses on building greening in the various study programmes. In 2019, the BuGG organised a "BuGG-Day of research and teaching" for the first time to network all institutions that are involved in the field of building greening.
At the Federal Congress Building Greening 2021, there was also an exchange of experience between universities and research institutions in Germany. The aim of the BuGG is to continue this format in the coming years and thus contribute to the growth of building greening in research and education.

3 Summary and Outlook

3.1 Summary

Building greening market

The building greening market is growing continuously - this can be said primarily for green roofs and also, to a certain extent for facade greening. Reliable figures are available for both, even if the recording methods for green facades are not fully developed yet. Although the year 2020 was marked by the Corona pandemic, around 7,800,000 m² of roof area was newly greened in Germany in 2020 - 600,000 m² more than in the previous year. It corresponds to a growth of 7.2 %. The increase from 2018 to 2019 was 4.2 %.

Even though significantly more green roofs were built in 2020 than in 2019, the proportion of green roofs on new flat roofs remained the same - at around 8 %.

In addition, about 55,000 m² of facade surfaces were developed in 2020 as ground-bound facade greening with climbing aids (approx. 45,000 m²) or as wall-bound facade greening (approx. 10,000 m²). The current figures are more "reliable" than the values from 2019, as it was possible to make greater use of manufacturer information this time.

There is no method for presenting figures about the different types of interior greening in square metres yet. The development of methods for this is a task for the next few years.

Green Roof National League

There are no changes at the top of the BuGG Green Roof National League, although Hamburg has joined. Munich is leading in the category of green roof area (excluding underground car parks) with 3,148,043 m². Stuttgart is on top in the category of green roof index (square metres of green roof per inhabitant) with 4.1. The average green roof index is 1.3 - still a slight increase compared with the previous year.

Welfare effects of green roofs in figures

In Germany, the total amount of greened roof areas over the years is about 130.000.000 m². With an assumed extensive form of greening this means for the various welfare effects (see Fig. 35)

... a water storage capacity of about 3,900,000 m³.
... an evaporation capacity of about 260,000 m³ per (summer) day.
... an annual precipitation water retention of about 56,940,000 m³.
... a CO_2 storage of about 104,000 t.
... a fine dust storage of about 1,300 t.

The performance of intensive greenings are significantly higher.

Municipal subsidy instruments

Green roofs and facades are more and more accepted as an important adaptation measure to climate change: Rainwater management (flood protection), heat prevention (evaporative cooling), species protection/biodiversity and health prevention. More and more cities are implementing this knowledge into their municipal subsidy instruments, as shown by the current city survey and additional researches of the BuGG:

42 % or rather 34 % of the cities with more than 50,000 inhabitants promote green roofs and facades and provide financial subsidies. In 2019 it was only 25% for green roofs and 24% for facade greening. The development and increase of the number of cities is therefore worthy of note! It can be traced back in large part to the funding support and initiative of the state of North Rhine-Westphalia. According to BuGG findings, 106 cities nationwide (from 20,000 inhabitants or more) provide subsidies for green roofs and 81 cities grant subsidies for green facades.

77 % of the cities with more than 50,000 inhabitants promote green roofs indirectly and reduce the rainwater charge for the presence of green roofs. This is a small development compared to the previous year (72%), but we are already at a high level in this area.

5.2 Outlook

Your own roof garden - it has never been as valuable as it is today!

Additional usable and recreational areas for people - the in-house roof garden are a crisis-proof leisure, recreation, and cultivation area. If we consider the figures from 2008 to 2020, the trend is moving clearly in the direction of "intensive greening" (roof garden). Whereas in 2008 only 11.4 % of the green roofs were intensively greened, this figure has increased to 17.9 % in 2020.

Greening in existing buildings

Many cities promote green roofs and facades in existing structures, in order to literally disarm "Hot Spots" and to use the cooling capacity of the greenery in a targeted manner. In many cases it cannot be realized due to the building statics, or only to a limited extent. Innovative solutions (e.g. lightweight construction with/without irrigation) are in demand and provide product and system manufacturers possibilities for further application areas.

Conflicting goals of photovoltaics and greening

Due to the emerging solar obligation of many federal states, a conflict of objectives "solar" vs "green roofs" seems to arise. Here it is necessary to broaden and communicate the knowledge and the possibilities of "solar green roofs" more widely. Solar green roofs combine climate protection and climate change adaptation and serve, among other things, flood prevention!

Fig. 35: Effects of one square metre of extensive green roof.
Source: BuGG

Trends

For various reasons, the trends of the last few years have strengthened, and they are already more than just "trends" - retention green roofs, biodiversity green roofs and urban farming roofs are quite well known by cities as well as by planners. They are increasingly demanded, well supported, and implemented. Newly added are aspects of preventive health (Planetary Health), which are being promoted through the many welfare effects of green roofs and facades.

Research and Teaching

The basics of building greening have been explored, but now we need to get into the details and ask specific questions. More precise data is requesting, for example characteristics of plants and systems in order to be able to calculate and simulate the effects of greening. It is important to anchor the teaching at universities of architecture, urban planning, etc. firmly with the topic of building greening in their curricula.

Barriers and obstacles

In its comprehensive survey, the BuGG asked various target groups to find out why green roofs and facades have not been implemented more yet. It turned out that the concerns about production and maintenance costs, damages to the building and a lack of (specialist) knowledge are obstacles and barriers.
One of the most important tasks of the BuGG is to educate cities and planners on the basics of greening buildings as well as their properties and effects. The BuGG therefore offers various formats and a comprehensive range of further training courses (including "BuGG-certified consultant for green roofs and facades"). The BuGG attempts in cooperation with other associations, organisations and cities to organise a "Green Building Action Week" in autumn 2020. Within one week, information on green roofs, facades and interiors are imparted in the form of nationwide seminars, lectures, inspections, greening shows, photo competitions, etc.

Bundesverband GebäudeGrün e.V.
About us

The Bundesverband GebäudeGrün e.V. was founded in May 2018, and can look back on a long history of associational activities.

It was founded on 17 May 2018 through the fusion of the established and renowned associations Fachvereinigung Bauwerksbegrünung e.V. (FBB) and Deutscher Dachgärtner Verband e.V. (DDV). By creating one large association, the duplication of work and investments is avoided, energies are bundled, successful components and competences are combined and thereby the impact is increased. Both associations join forces in the BuGG, contributing strengths, contacts and decades of experience - which brings enormous advantages for all involved and for the development of the markets for roof, facade and interior greening.

The Bundesverband GebäudeGrün e.V. (BuGG) is both a professional association and an advocacy group for companies, cities, universities, organisations and all those interested in building greening. The BuGG is one of the few associations that deals primarily and comprehensively with building greening, i.e. with roof, facade, interior and other building greening. The Bundesverband GebäudeGrün e.V. always pursues the overall goal of bringing building greening closer to the widest possible public. In the BuGG, the community of interest offers opportunities that are not available to individual companies to create positive framework conditions for the greening of buildings and other structures in a company-neutral way. The Bundesverband GebäudeGrün e.V. focuses its activities on the following three areas:

Our profile

Trades
Urban development, urban planning, urban ecology, architecture, landscape architecture, gardening and landscaping, roofing

Activities
Building greening (green roofs, green walls and interior greening) and associated trades (e.g. hydroisolation, thermal isolation, rainwater management, leak detection, fall protection), primarily in Germany.

Objectives
- Public relations and image improvement for building greening
- Central information platform on building greening: expert information, events, branch and market news, research, networking
- Networking and exchange of experiences

Founded: 17.05.2018
Employees: 13
Member: 440
Office: Berlin
Administration: Saarbrücken

Inform and Educate
- Brochures, technical information, seminars, ...
- www.gebaeudegruen.info

Support and Research
- Supporting research projects

Contacts and Networking
- „Network managers" for cities and universities, Connecting industry, contractors, planners and cities
- Members: e.g. producers (roofing, facade, interior), planners, contractors, cities, universities

BuGG®
Bundesverband GebäudeGrün e. V.
Dach-, Fassaden- und Innenraumbegrünung

Bundesverband GebäudeGrün e.V. (BuGG)
Albrechtstraße 13
10117 Berlin
Tel. +49 30 40054102
Fax +49 681 9880572
E-Mail: info@bugg.de
www.gebaeudegruen.info

BuGG-Marktreport Gebäudegrün 2021
Stand: 09/2022