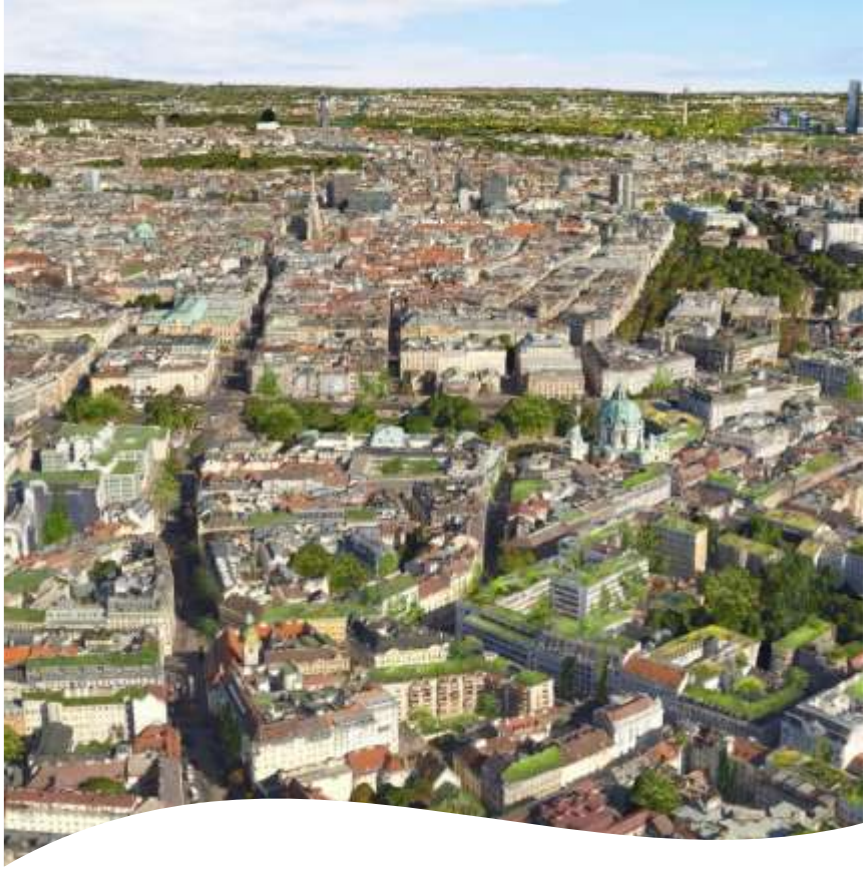
Green infrastructure and Nature based Solutions on Buildings:

Benefits and Co-benefits of green roofs and walls to the urban climate and energy efficiency



© GSG; Vienna, Rendering

Vera Enzi (AT)

Vice-President
European Federation of Green Roof and Wall Associations- EFB
vera.enzi@efb-greeenoof.eu
M: +43 650 / 35 22 973

soGreen GREENER CITIES IN EUROPE

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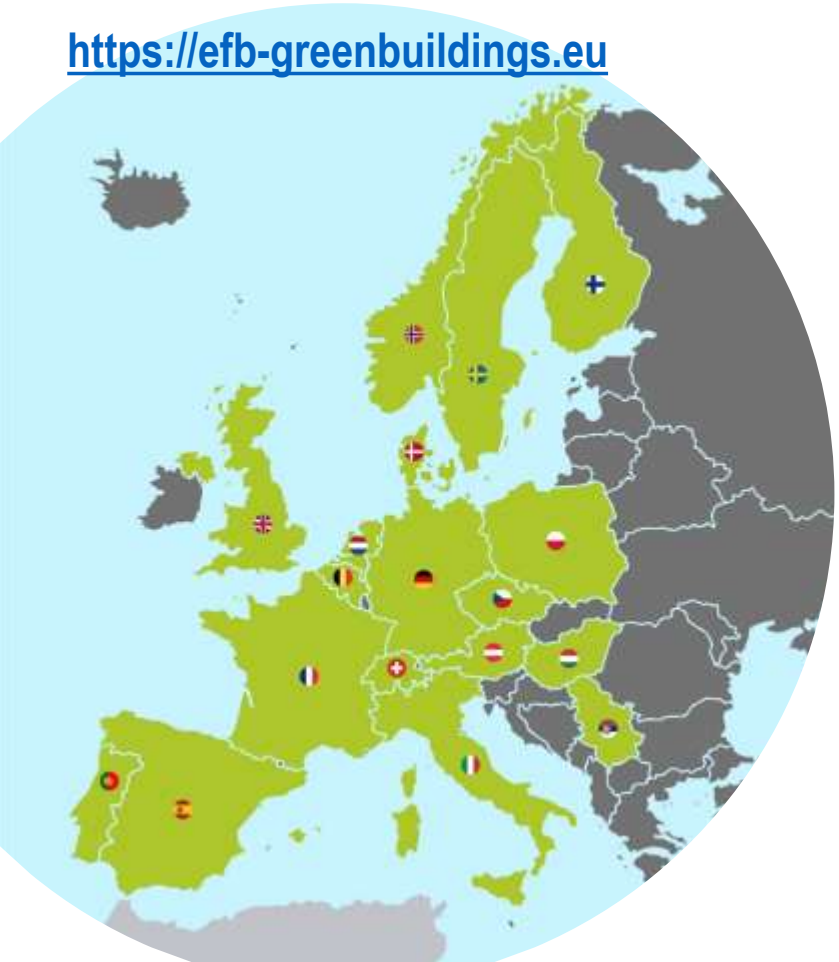
https://efb-greenbuildings.eu



ABOUT THE EFB:

European Federation of Green Roof and Wall associations (NPO established 1997)

17 National Associations

-Green Roof and Wall suppliers

-Green Roof and Wall manufacturers

-Green Roof and Wall contractors

+Value Chain: Planners/Engineers, Municipalities, RTO´s, Universities, etc.

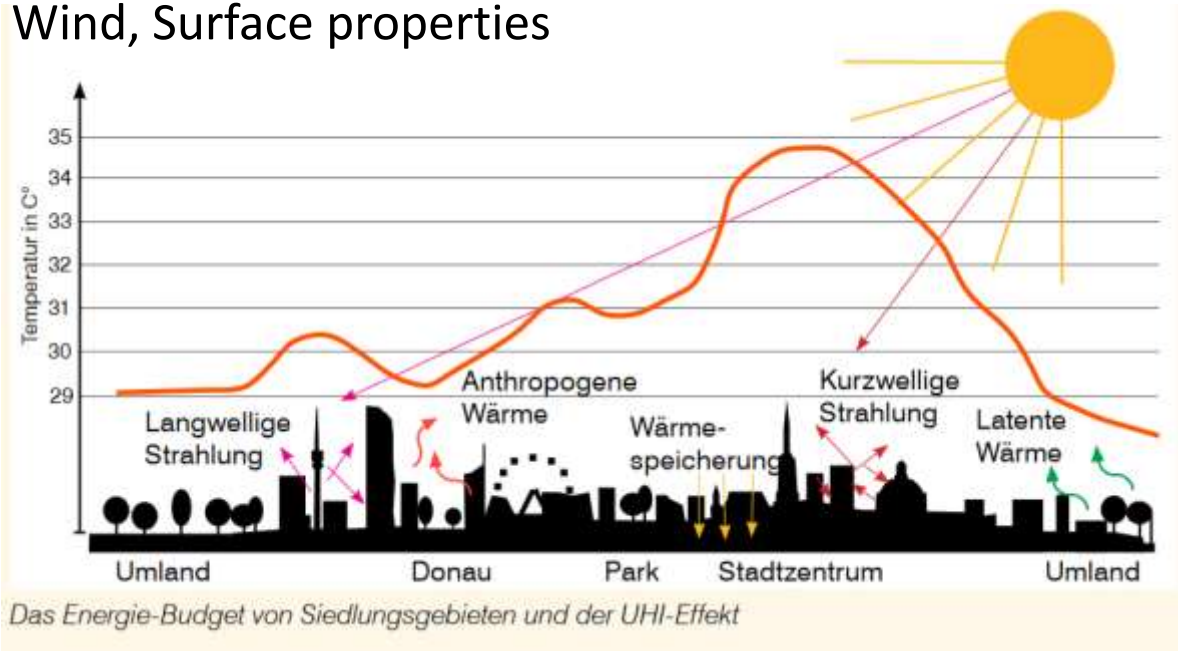
+Extended Networks: WGIN, ELCA, IFLA, etc.

The Urban Heat Island effect- a question of Energy balance.

Radiation, Wind, Surface properties

Reasons:

- **Sealed surfaces** (Evaporation/Water missing)
- **Storing surfaces** (Energy storage and heat transmission)
- **Ventilation** (limited natural wind cooling)

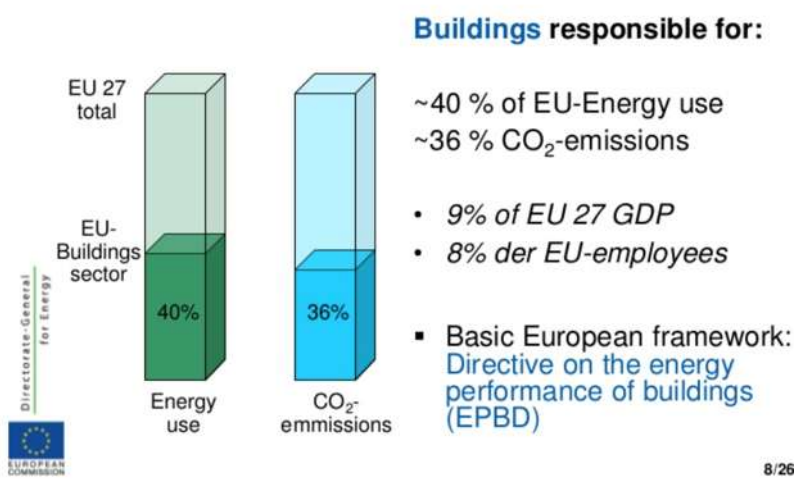


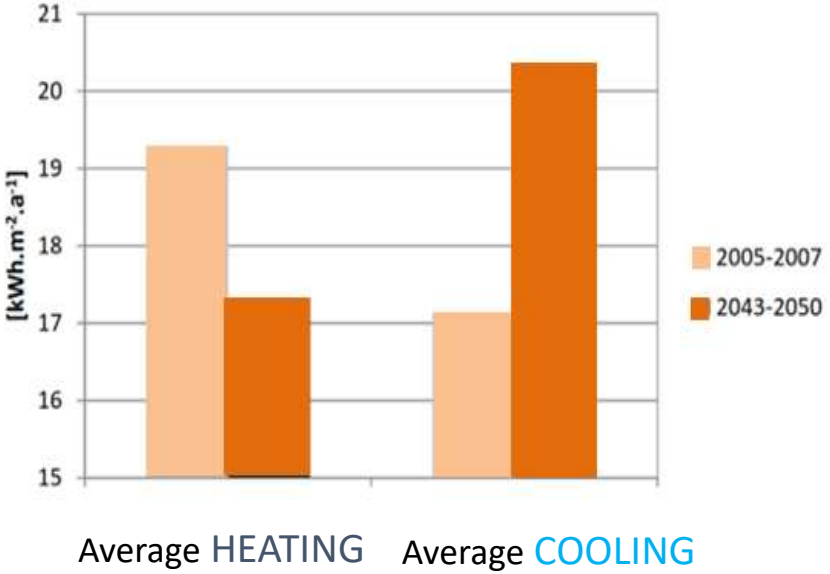
Das Energie-Budget von Siedlungsgebieten und der UHI-Effekt

source: Urban Heat Island guideline, city of Vienna

2024 45 Heat days in Vienna, 2015 a record of 46 and in average 1981-2010 only 21.

Building sector and increasing energy demands





Building energy demand EU (source: EC)

Prognosis of heating and cooling need (source: AIT)

Buildings owners and users: the private perspective

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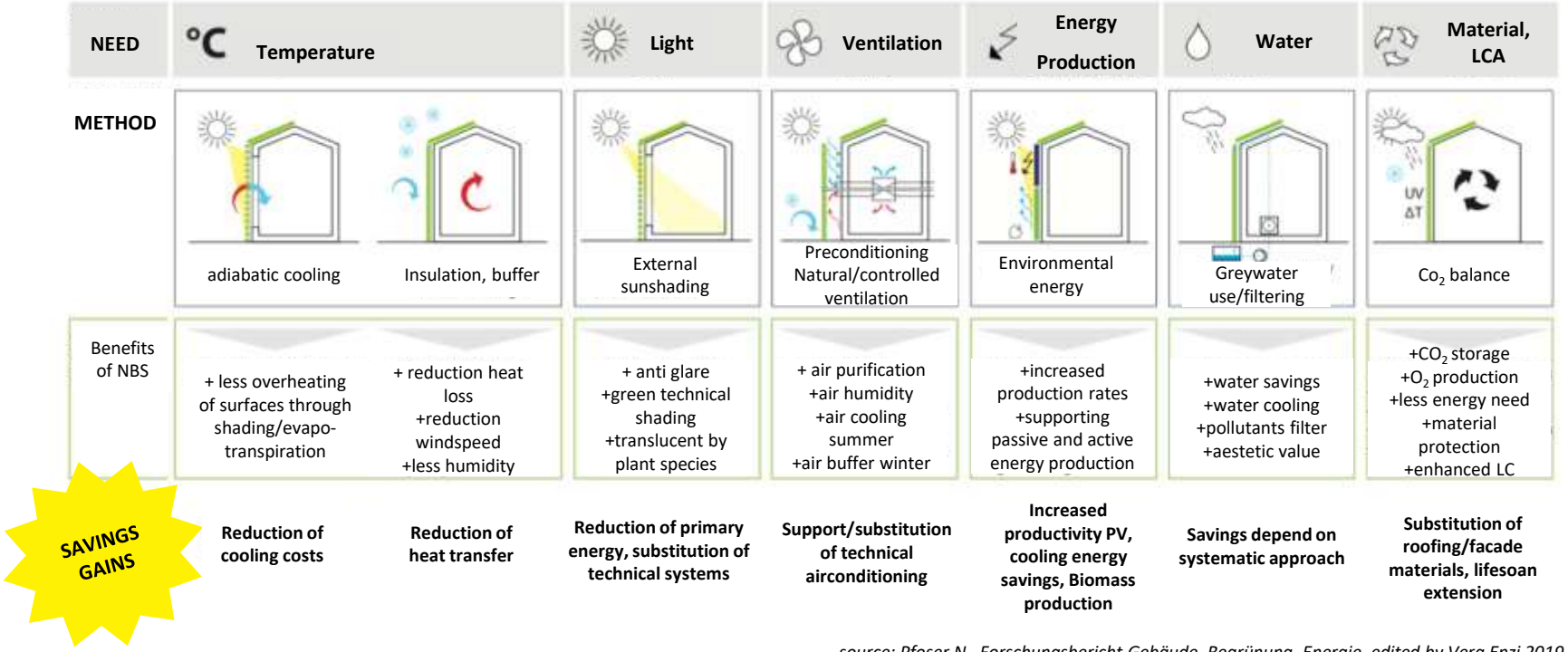
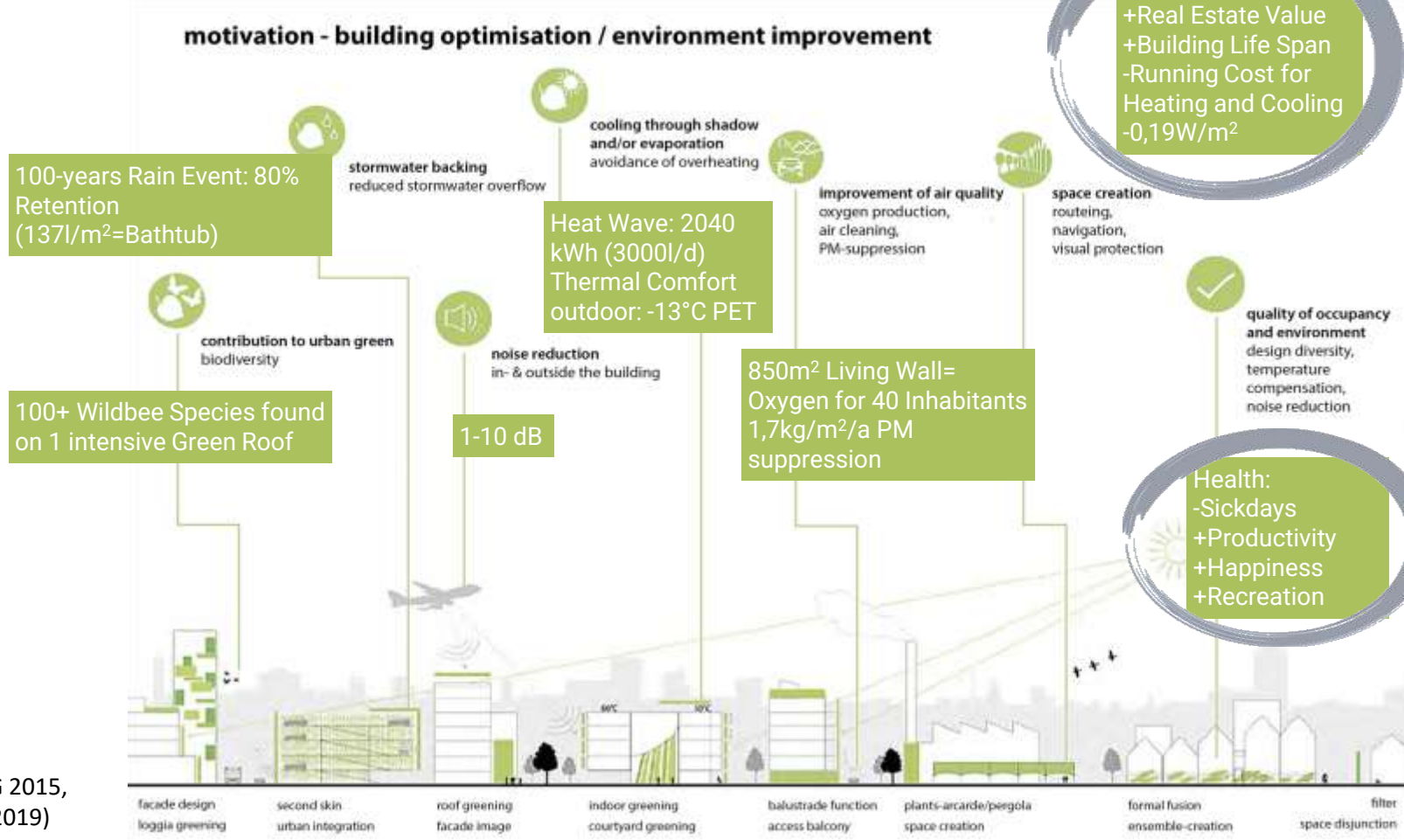


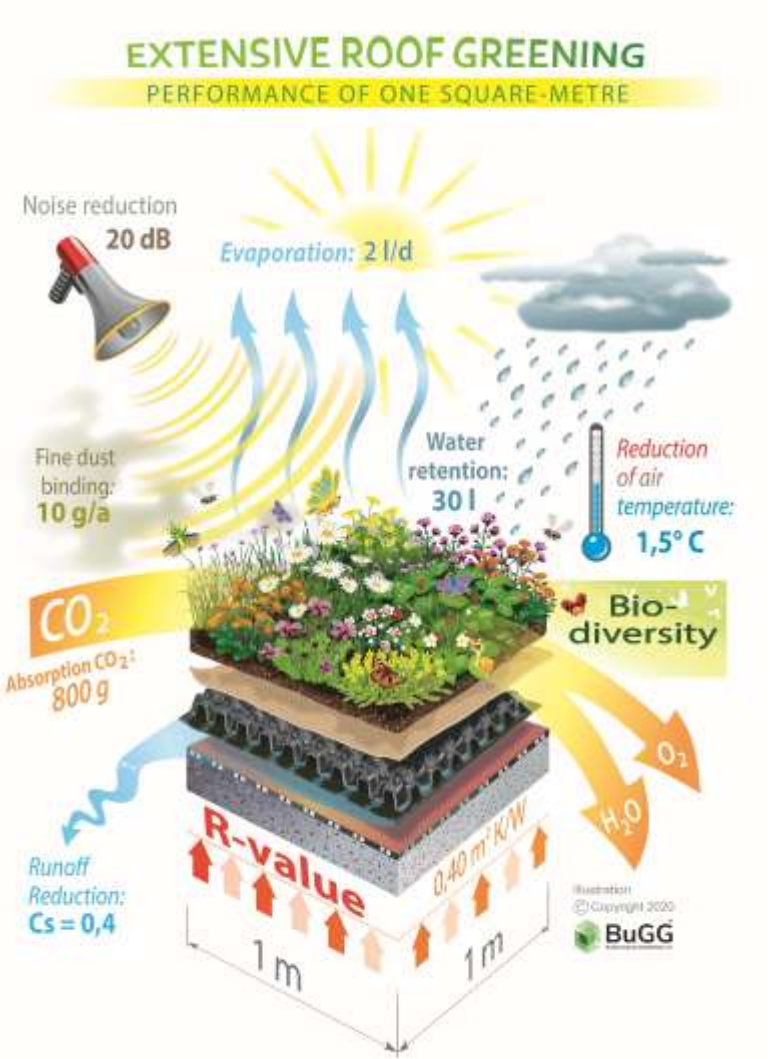
source: Pfoser N., Forschungsbericht Gebäude, Begrünung, Energie, edited by Vera Enzi 2019

The scaling areal Impact from a city quarter perspective:



(© Pfoser, Jakobs AG 2015, edited by Vera Enzi 2019)

What is the **minimum** performance of green roofs witch changing seasons and weather conditions (MVP: extensive, 1m²)?



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Source: R. Fritthum

..older than you think.

150+ years tradition!

Measurable performance of green roofs

© EFB; SZUZ, Dostal

- **Surface-temperatures** *(reduction up to 17°C)*
- **Evaporation** *(41%-48% (90% Retention) of the annual precipitation)*
- **Heat-island-effect** *(-3°C air temperature on extreme heat-days)*
- **Humidity** *(20-40% higher rel. air humidity in summer)*

Measurable performance of green roofs

© Verband für Bauwerksbegrünung; Bauder

- **biomass** *(extensive: energy value 13 MWh/ha a, intensive: energy value up to 23 MWh/ha a)*
- **Air purification/pollutant containment** (0,5kg/m^2/year carbon-absorpton, 10-20% higher filter functionality compared to conventional roofs)
- **Insulation** (3-10% heat loss reduction*)*
- **Noise protection** *(noise from above reduced by 8dB(dry)-18dB(wet), noise from aside reduced max. 6dB)*

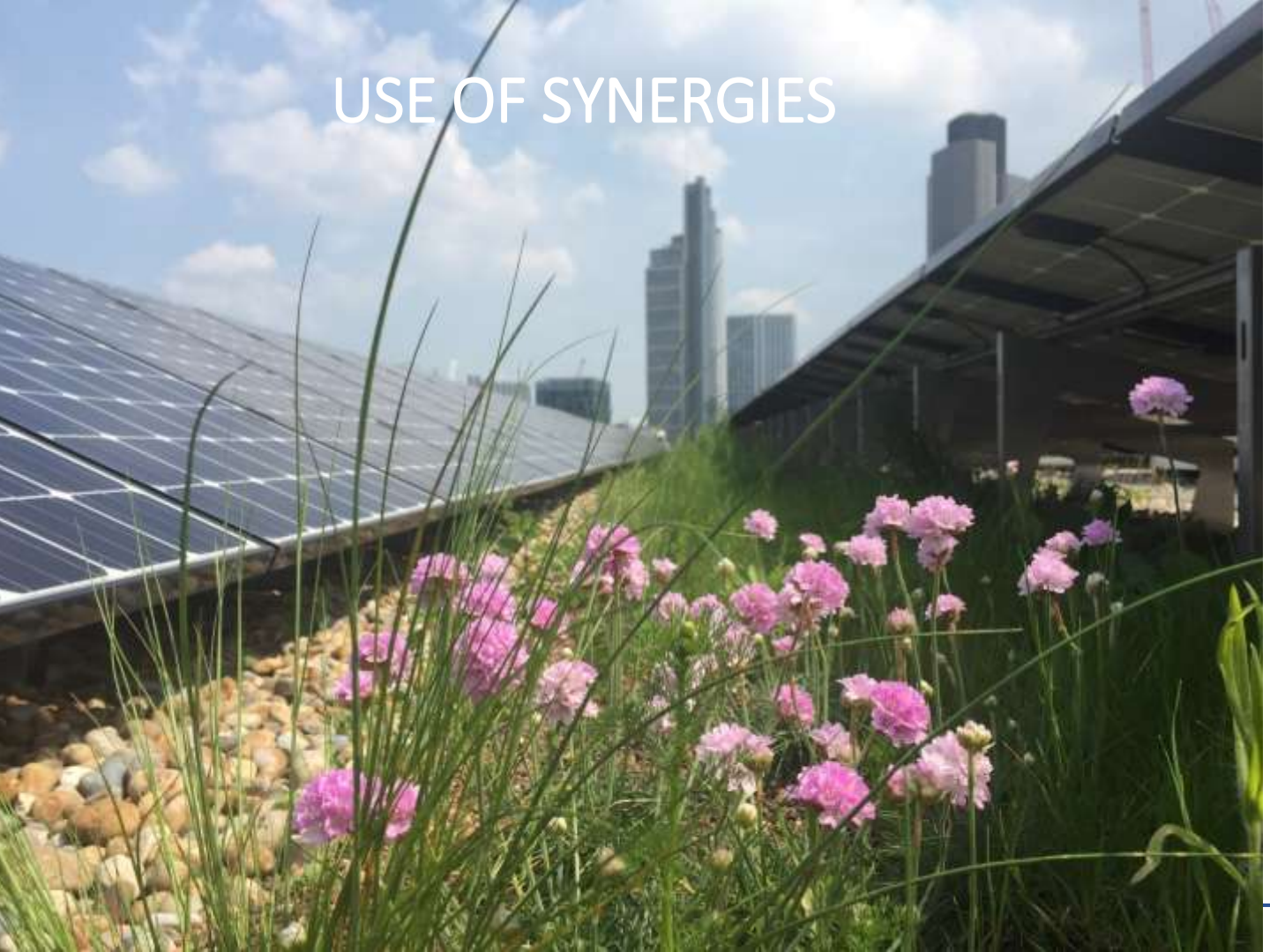
Measurable performance of green roofs

© Verband für Bauwerksbegrünung; Optigrün

- **Sun protection** *(dependent on vegetation up to 50%absorbtion and 30% reflection of solar rays, extending live expectancy of roof sealing 10-20 years)*
- **Biodiversity** *(birds, insects (bees) take profits)*
- **economic viability** *(5.000 m2 multifunctional green roof can reduce electricity bill up to 6.000€/year by using rainwater to cool the building)*
- **Enhanced PV performance** *(3-5%)*


The built-up matters!
© Verband für Bauwerksbegrünung; Enzi

USE OF SYNERGIES



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BUSINESS, PRODUCTION

USE ^{3}

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PUBLIC, RESEARCH

Forms of Green Walls

Statics, soil & rootspace availability, facade surface material/built-up, targeted performance, building &city architecture

TECHNICAL STANDARDS examples:

- **AT ÖNORM L1136**
- **DE FLL Guideline Green walls 2018**
- **AT Green Wall guideline City of Vienna (2019)**

Measurable performance of green facades

© UNIQA; Enzi

- **Surface-temperatures** *(reduction between 8- 19°C)*
- **Evaporation** *(280 kWh/day/250m²)*
- **Heat-island-effect** *(-5°C air temperature on extreme heat-days)*
- **Humidity** *(20-40% higher rel. air humidity in summer, 2-8% in winter)*

Measurable performance of green facades

© BuGG

- **biomass** *(leaf fall ground-based twiners (climbing plants) energy value 23 MWh/ha)*
- **Air purification/pollutant containment** (2,3 kg CO_2/m^2a 2 t CO2 per year containment by ivy, 1,7 kg O_2/m^2a oxygen, 4-6g/m2 contained fine particulates after 1 vegetation period=71% respirable substances)
- **Insulation** (*system-dependent: +7°C BVS, +3°C ivy, heat flow reduced by 50%- MA 48)*
- **Noise protection** *(2,7-5 dB from ivy and boston ivy (parthenocissus tricuspidata), 4-9 dB from facade-based (integrated) systems)*

Measurable performance of green facades

© Dachgrün, Oberbichler; Enzi

- **Sun protection/shading/economic viability** *(40-80% solar radiation absorbed or reflected, shading rate from deciduous climbing plants 70-95%, cooling cost savings 43%, primary energy savings 26% compared to konv. sun protection)*
- **Biodiversity** *(bats, birds and insects take profits, focus: ivy)*
- **acceptance** *(84% of the residents of green buildings and 68% of non-green buildings have a positive view on green facades, local identity, conscious of nature, remembrance of nature)*

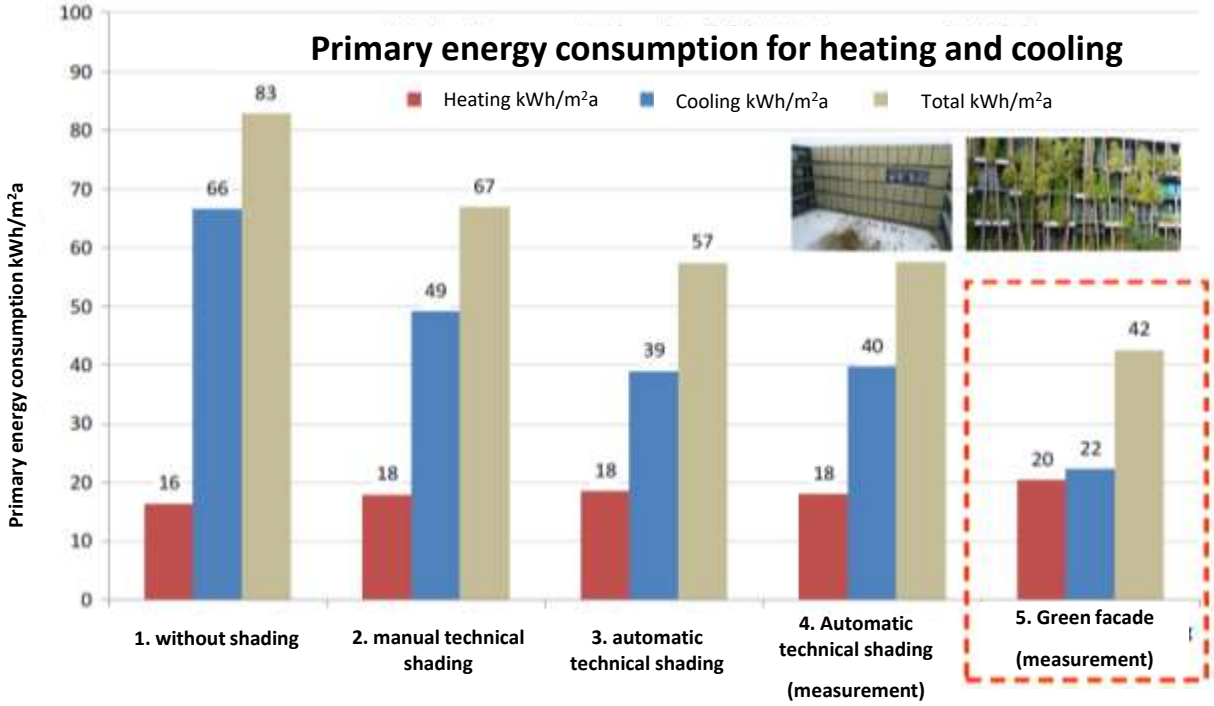
EXAMPLE TU BERLIN ADLERSHOF, INSTITUTE of PHYSICS

© Marco Schmidt, **BBSR II 7: energy efficient construction; TU Berlin: Institute for architecture**

PROJECT TARGETS:

- **Rainwatermanagement** 100% on own property
- **Using rainwater harvest for cooling of buildings** (adiabate cooling and green facades)
- **Reduction of running cost** in comparison to traditional shading
- **comparisons** (over 10 green facades in different expositions)

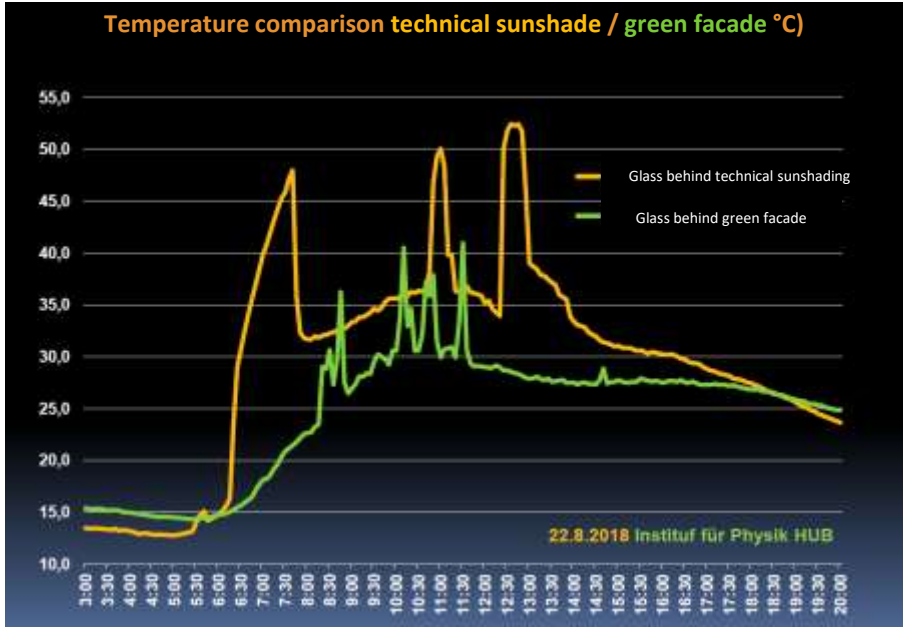
PRIMARY ENERGY CONSUMPTION HEATING/COOLING



- **Impact of technical vs. Green sunshading on the primary energy consumption for heating and cooling south-oriented offices (IBP:18599) in kWh/m2/year**
- **Measurement frame: 10.7.2007- 9.7.2013, 1536 days**

COMPARISON standard sunshading versus facade greening

- INDOOR



Calculation IBP:18599:

Static assumption, equilibration indoor & outdoor temperature

Not included: evapotranspirative cooling and athmospheric counter radiation

	tech.	green
06:00 - 18:00 h	34,5 °C	27,0 °C
Diff to 26°C Target	8,5 K	1,0 K

OPERATIONAL COST

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- Difference factor: 12

RESULT: Win – Win – Win - Win

- **Less investment cost**
- **Less operational cost**
- **Better performance for building**
- **Better for the environment**

EXTENSIVE = LIVING WALL

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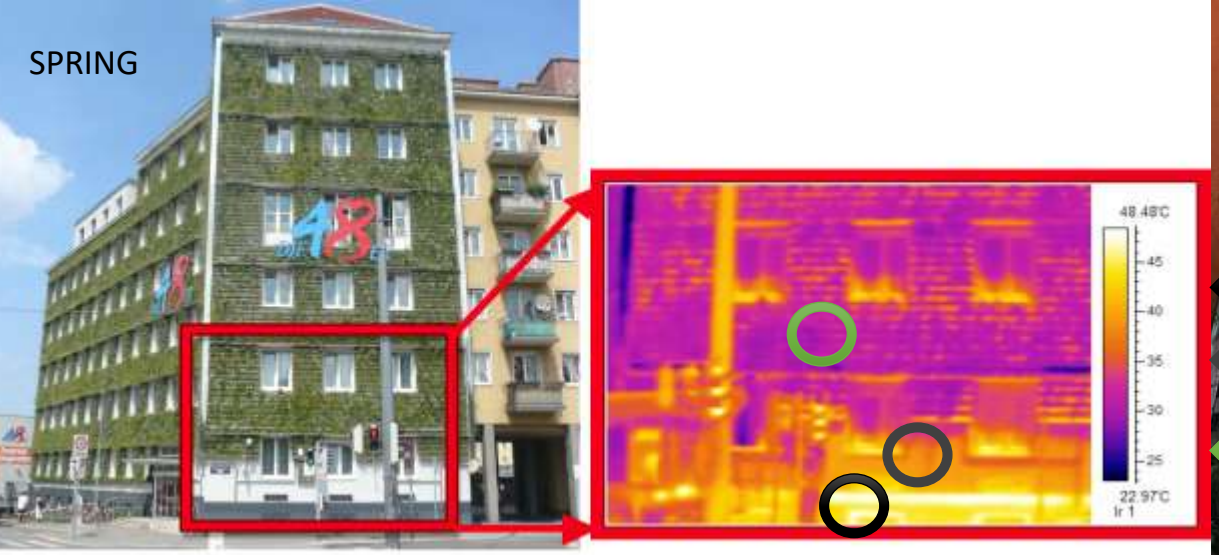
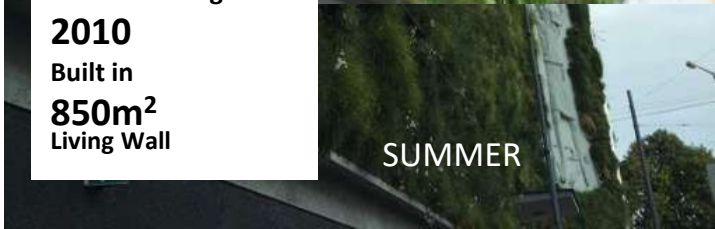
© DI Jürgen Preiss





45

38

28

MA 48
Public Building
2010
Built in
850m²
Living Wall

PROJECT RESULTS:

- Heat Loss in Winter **Reduction up to 50% (Cost savings)**
- **Summer Cooling rate comparable to 57 Aircondition Units** *(3000 Watt, 8 Hours per Day),* **Water consumption Heat Wave: 3000l/day (2040 kWh)**
- Evapotranspiration Performance = **4 100-year old FAGUS TREES**
- Surface Temperature **up to -15°C, individually expirienced temperature reduced by 13°C PET (human)**

Source: University of life science Vienna BOKU (DI Bernhard Scharf)

QnA

Vera Enzi (AT)

Vice-President
NbS Consultant
vera@veraenzi.com
https://veraenzi.com
M: +43 650 / 35 22 973

Main Sources:
BuGG summary of Studies:
https://www.gebaeudegruen.info/fileadmin/website/downloads/bugg-fachinfos/PositiveWirkungen/BuGG-Fachinfo-Positive_Wirkungen_Gebaeudebegruuenung_20230604.pdf
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EFB EUROPEAN FEDERATION GREEN ROOFS & WALLS

https://efb-greenroof.eu
office@efb-greenroof.eu

General Office

European Federation of Green Roof & Living Wall Associations – EFB
VIENNA, AUSTRIA
M: +43 660 / 40 23 927