Passive House standard and its practical applications

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Passive House Institute
www.passivehouse.com | www.passipedia.org

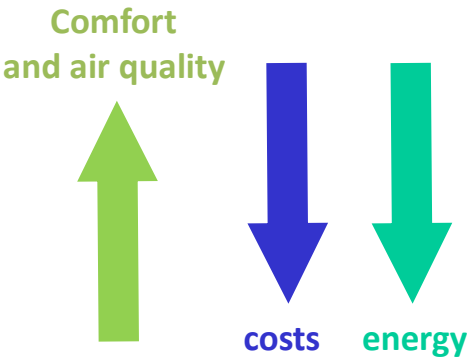
A presentation for
Training Seminar on High-Performance Energy Efficiency Standards in Buildings in the UNECE Region
September 6, 2018, St. Petersburg

Agenda

1. What is “Passive House”
2. History and current trends
3. Policy uptake
4. The role of the Passive House Institute

What is “Passive House”?

Passive House - in words



A performance based standard
for highly energy efficient buildings.

→ Optimize the building components to the extent that you can:
→ Use simple & robust heating / cooling systems

Pioneer project, Darmstadt, Germany,
1991 photo: Peter Cook

ZhuoZhou, Hebei, Central China
Contractor: Hebei Xinhua Curtain Wall Co. Ltd.

„Bahnstadt“ quarter, Heidelberg, Germany
© City of Heidelberg, photo: Kay Sommer

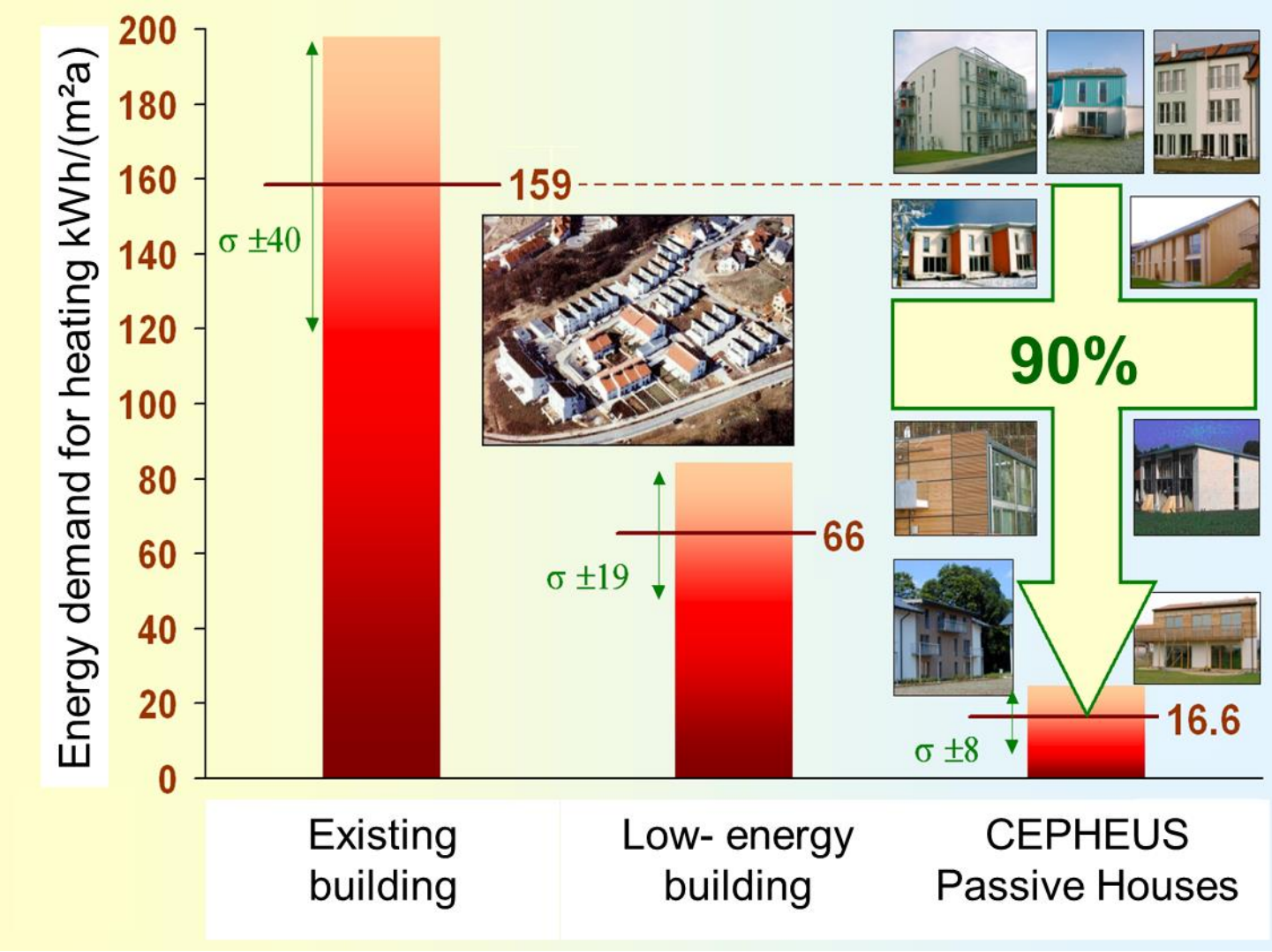
Want to know more? Check out our Passipedia article on the Passive House definition.

Passive House – in numbers

		criteria	or	alternative criteria	
Heating demand	≤	15		-	kWh/m²a
Heating load	≤	-		10	W/m²
Cooling demand	≤	15 + dehumidification allowance		climate dependent	kWh/m²a
Cooling load	≤	-		10	W/m²
Airtightness	≤	0.6			ACH_{50}
Primary energy	≤	120		renewable energy rating Classic | Plus | Premium	kWh/m²a

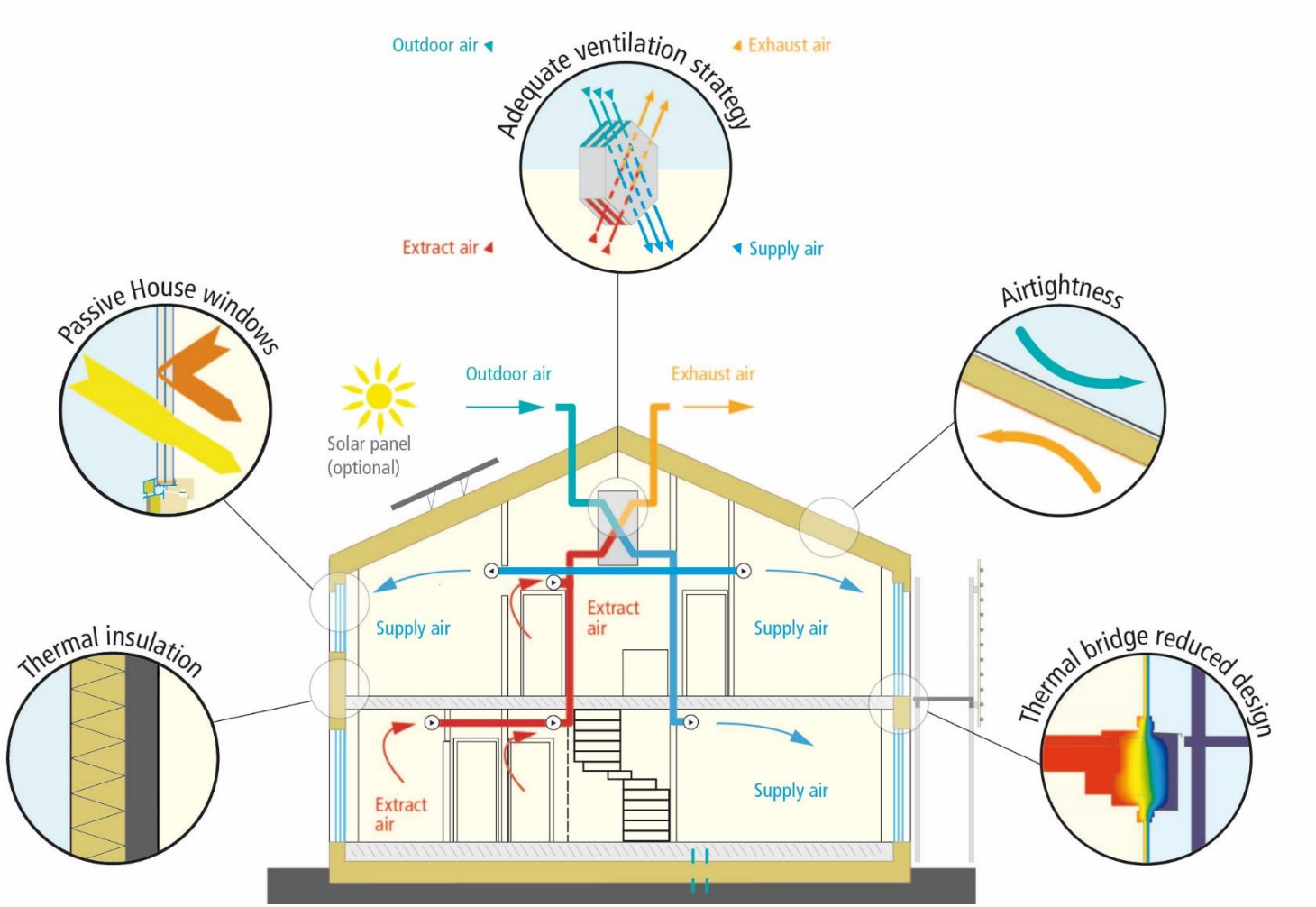
The complete Passive House criteria is available in the website of the Passive House Institute.

Passive House – measured performance



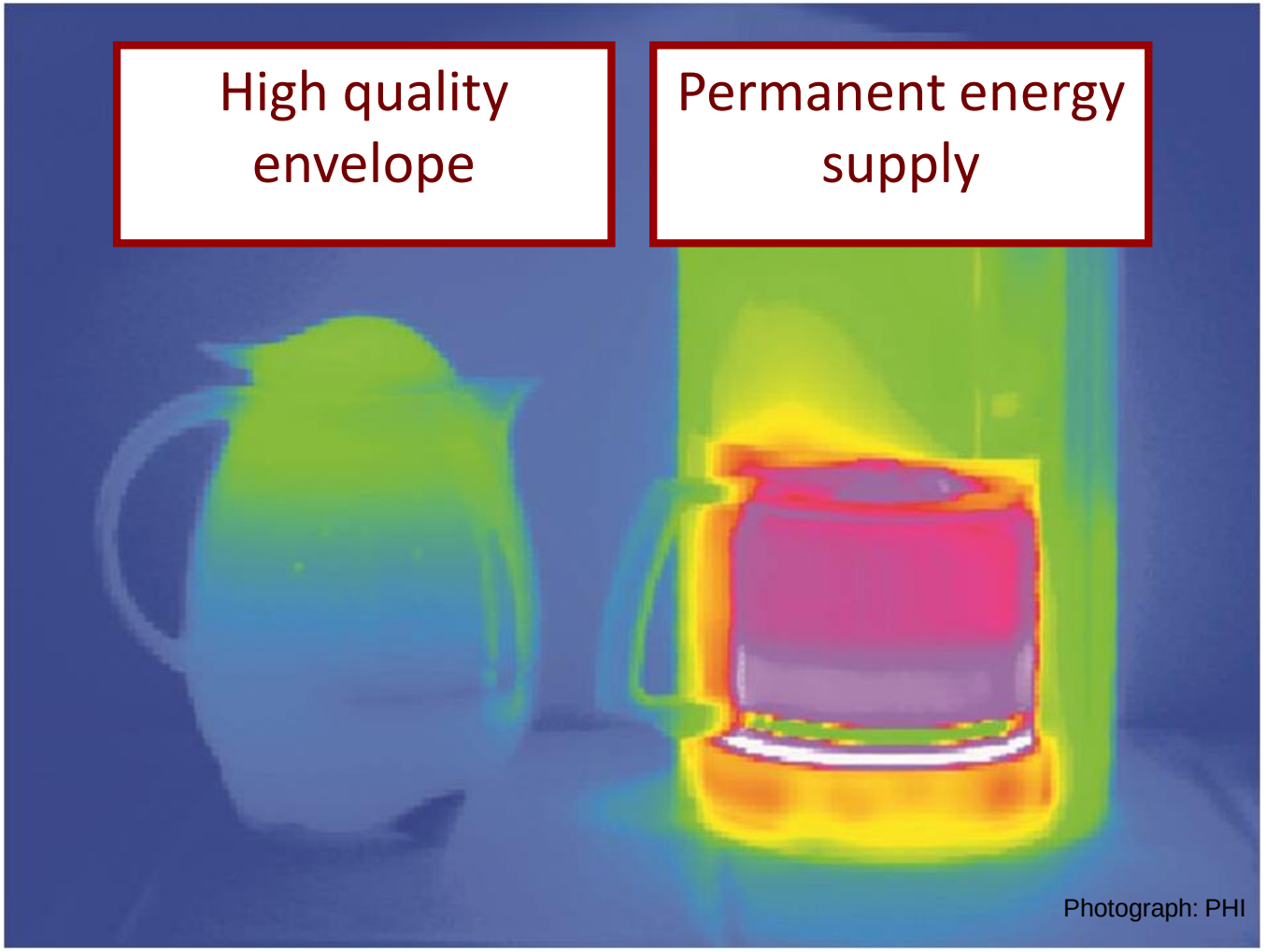
Read more about CEPHEUS and other EU-Projects here.

The main Passive House principles



Find more details about how a Passive House works.

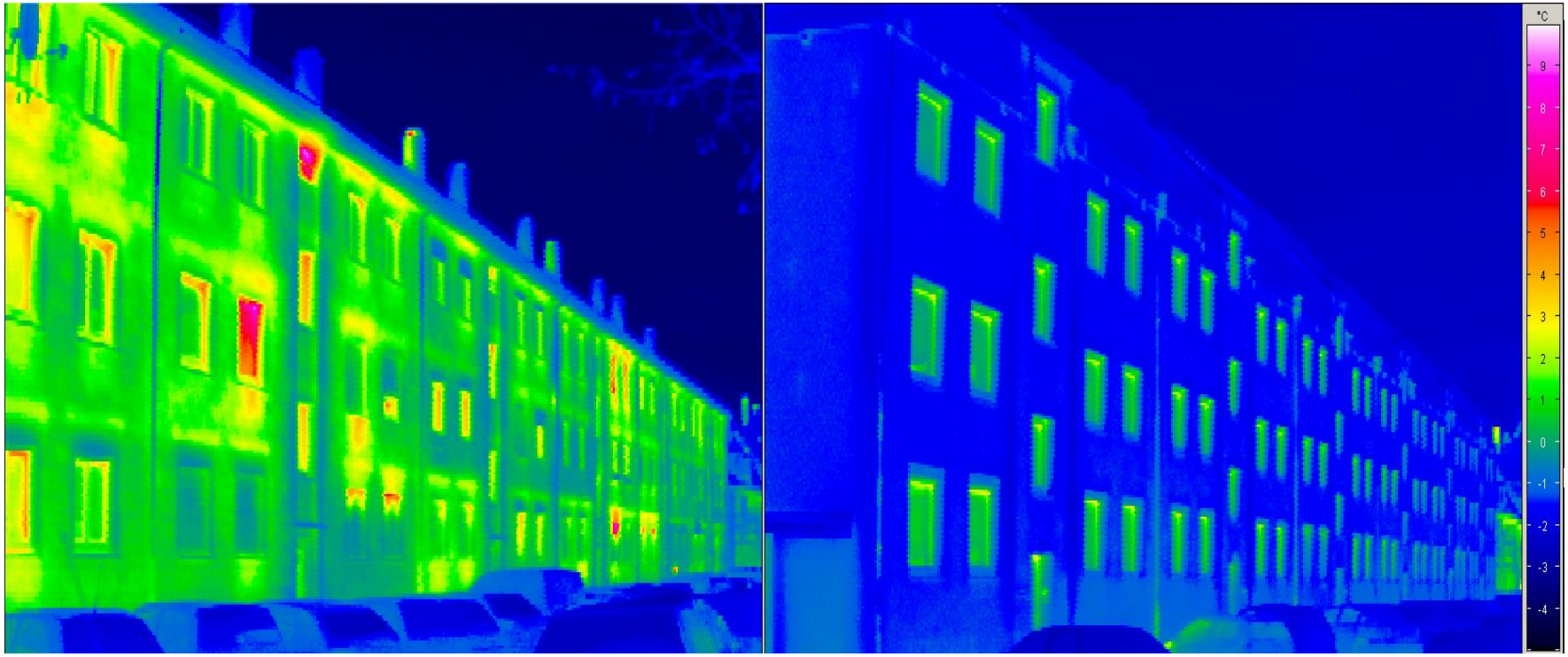
Essential #1 – Thermal insulation



passive active

Read more about insulation and insulating materials in Passipedia.

Essential #1 – Thermal insulation



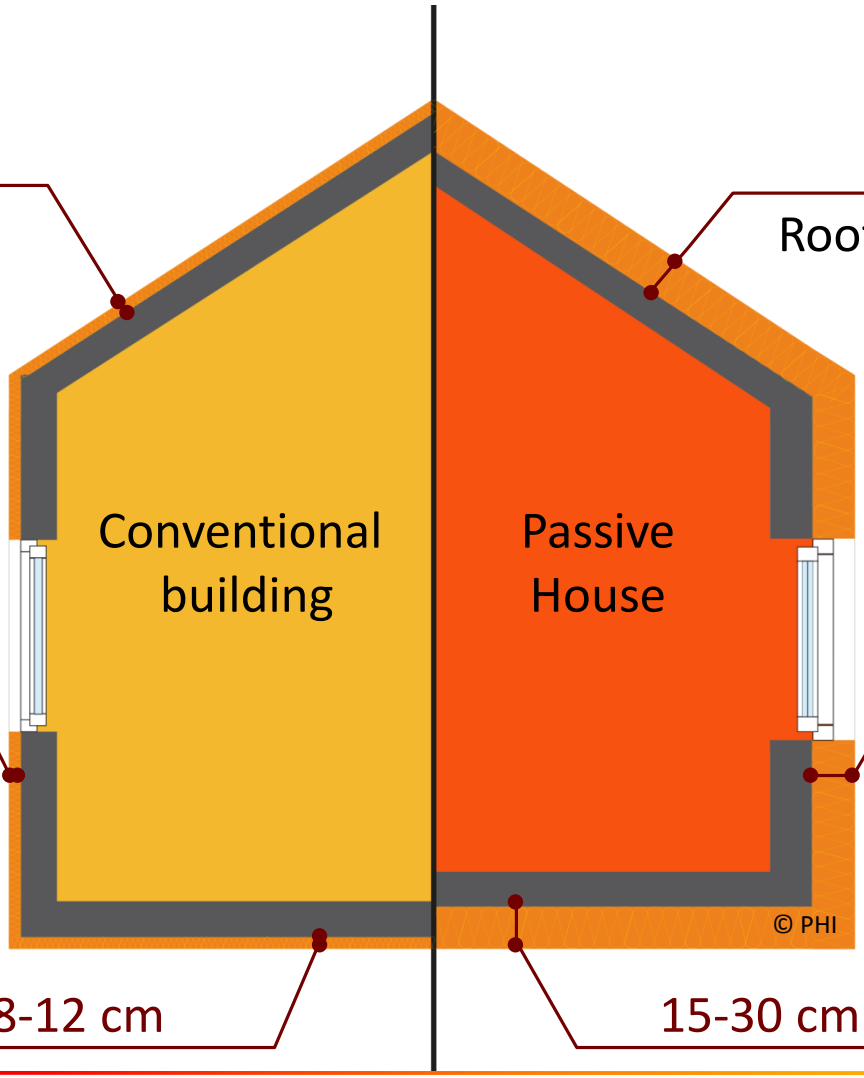
Before:
290 kWh/(m²a)

After:
17 kWh/(m²a)

Refurbishment project Tevesstraße FF/M; Client: ABG Frankfurt Holding; Architects: faktor10, Darmstadt
Scientific Monitoring: Passivhaus Institut, Darmstadt
Financial support: Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung, Wiesbaden

Essential #1 – Thermal insulation

Typical values PH in cool-temperate climates (Central Europe)



15-20 cm

Roof 0.20 W/(m²K)

30-40 cm

Roof ≤ 0.15 W/(m²K)

12-16 cm

Exterior wall 0.28 W/(m²K)

24-30 cm

Exterior wall ≤ 0.15 W/(m²K)

Floor slab 0.35 W/(m²K)

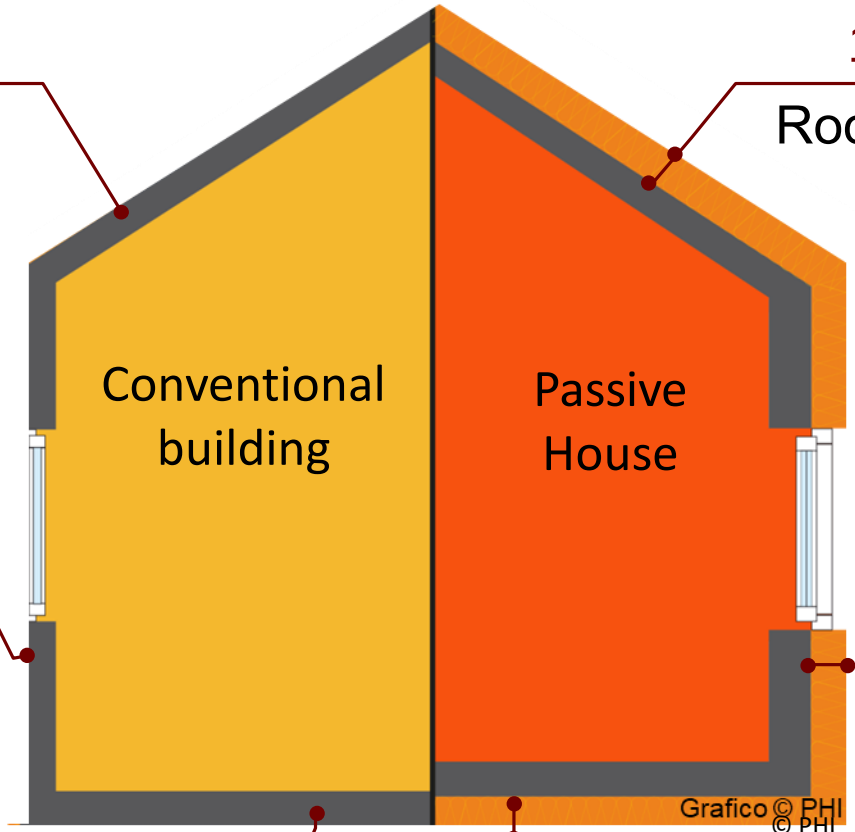
8-12 cm

15-30 cm

Floor slab ≤ 0.25 W/(m²K)

Essential #1 – Thermal insulation

Typical values PH in hot climates:



No insulation

Roof ~ 4.5 W/(m²K)

15 - 20 cm

Roof ≤ 0.25 W/(m²K)

No insulation

Exterior wall ~ 4.5 W/(m²K)

20-25 cm

Exterior wall ≤ 0.25 W/(m²K)

Floor slab ~ 4.5 W/(m²K)

No insulation

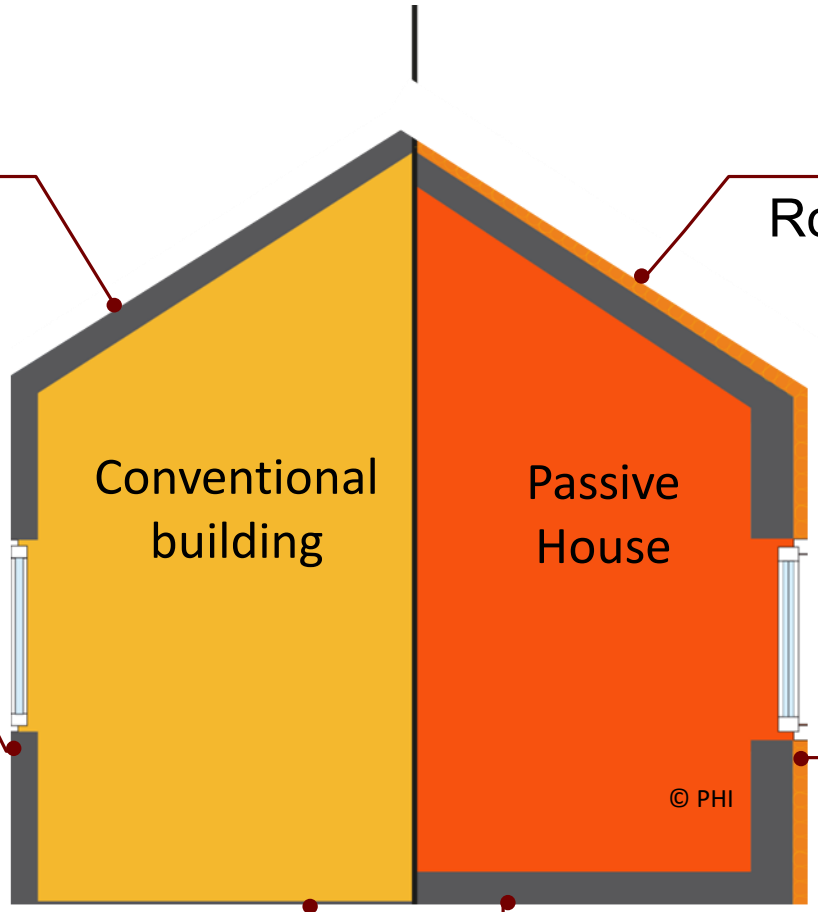
7.5 - 20 cm

Floor slab ≤ 0.25 W/(m²K)

Example: Cancún and Hermosillo, Mexico

Essential #1 – Thermal insulation

Typical values PH in temperate (milder) climates:



No insulation

Roof ~ 4.5 W/(m²K)

5 – 20 cm

Roof ≤ 0.55 W/(m²K)

No insulation

Exterior wall ~ 4.5 W/(m²K)

5 -20 cm

Exterior wall ≤ 0.55 W/(m²K)

Floor slab ~ 4.5 W/(m²K)

No insulation

0 – 10 cm

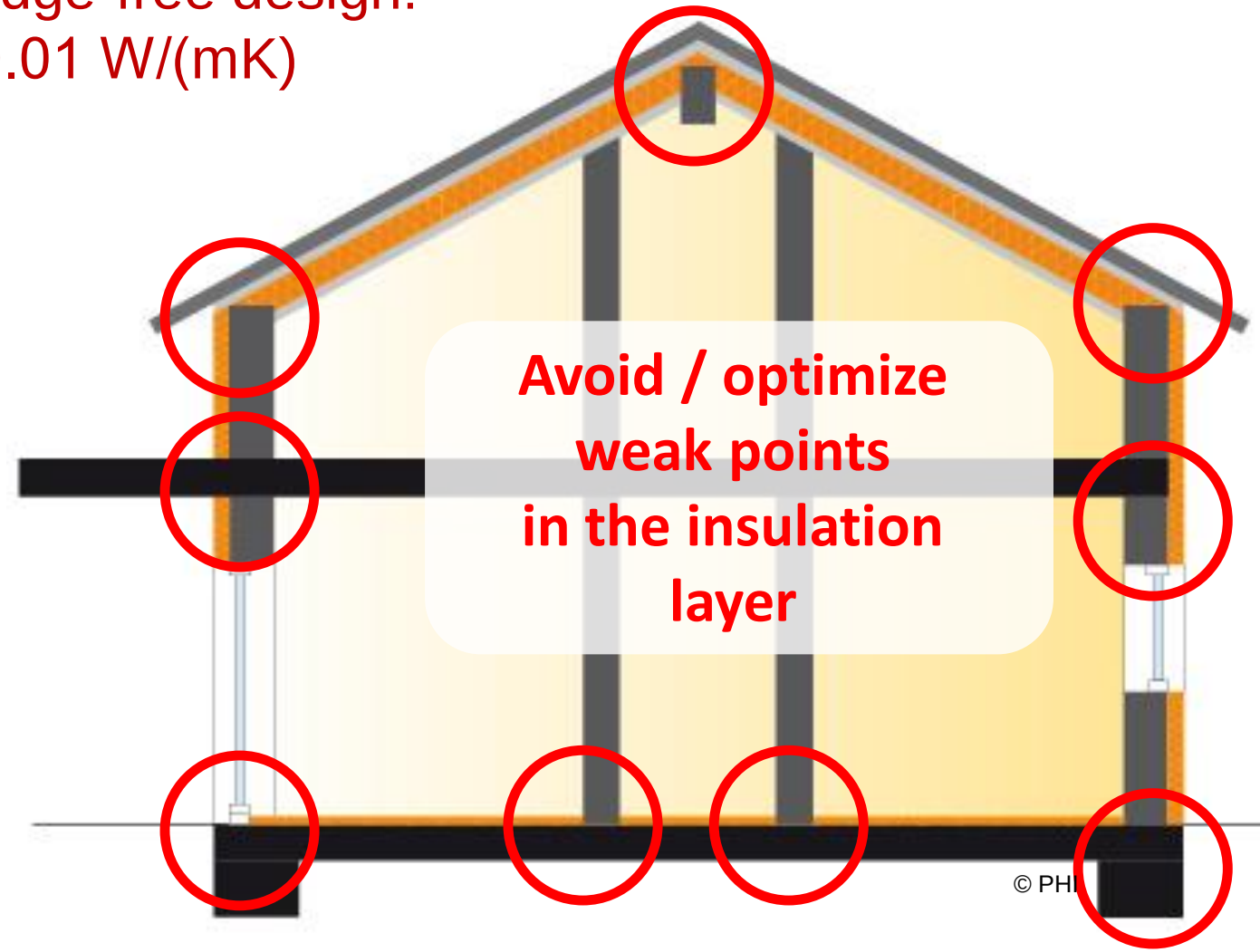
Floor slab ≤ 0.55 W/(m²K)

Example: Guadalajara, Mexico

Essential #2 – Thermal bridges

Thermal-bridge-free design:

$\Psi_e \leq 0.01$ W/(mK)

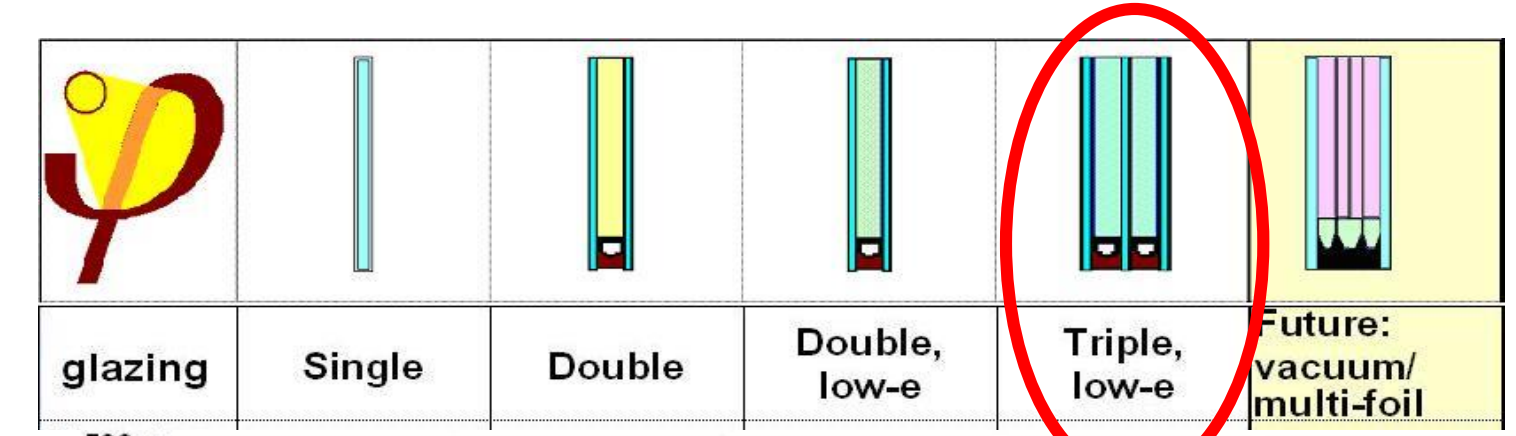


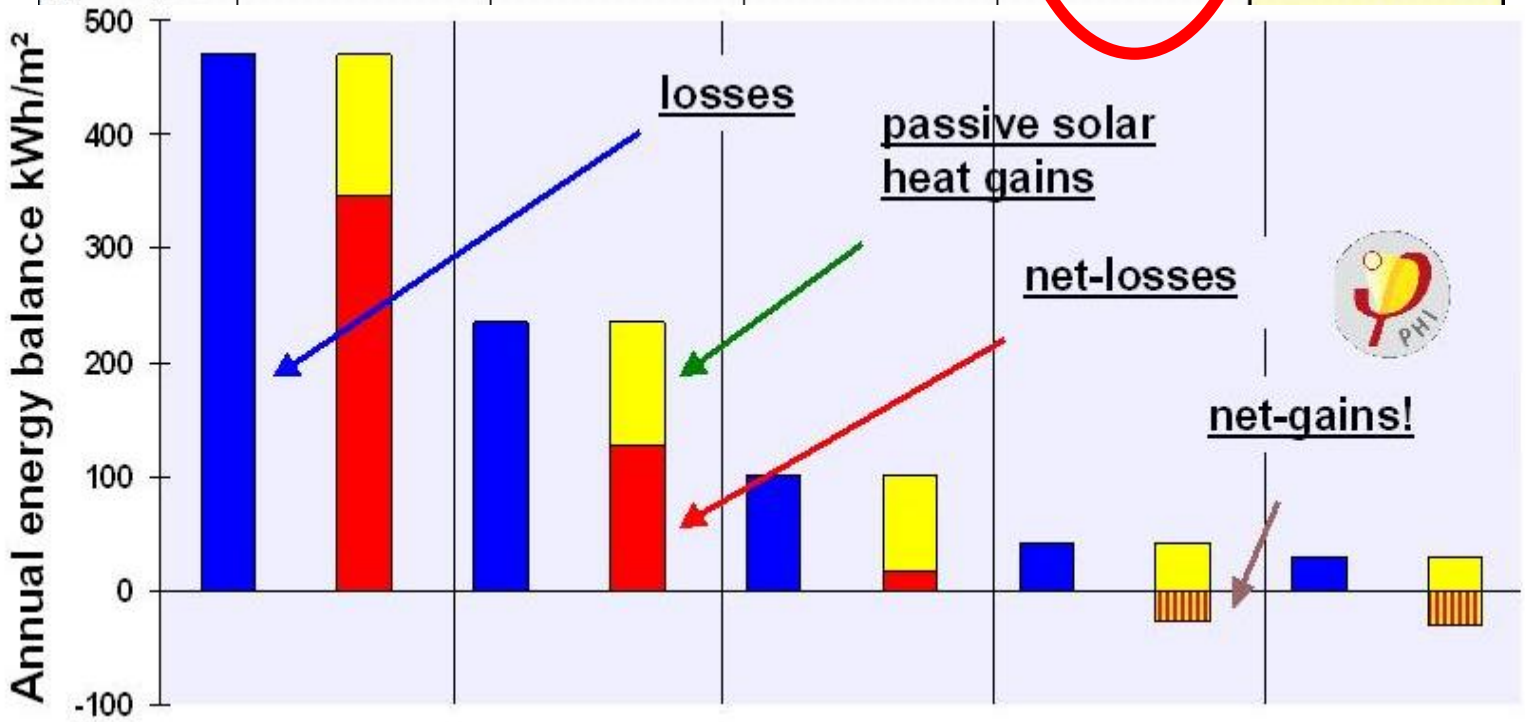
Essential #2 – Thermal bridges

Essential #3 – Appropriate windows

Let the sunshine in

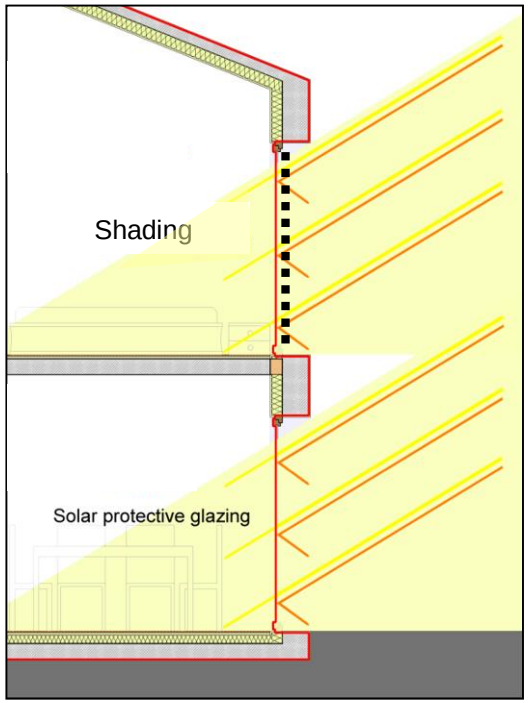
Winter





Essential #3 – Appropriate windows

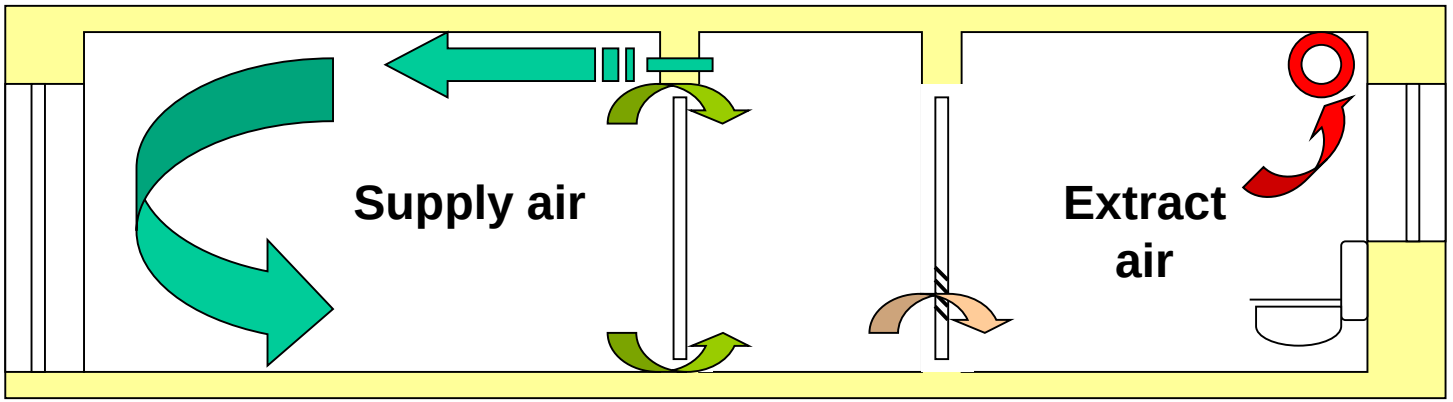
Summer Keep the solar load out



- Suitable window size & orientation
  (Also important in winter)
- Exterior shading
  fixed elements and/or blinds
  → daylight redirection

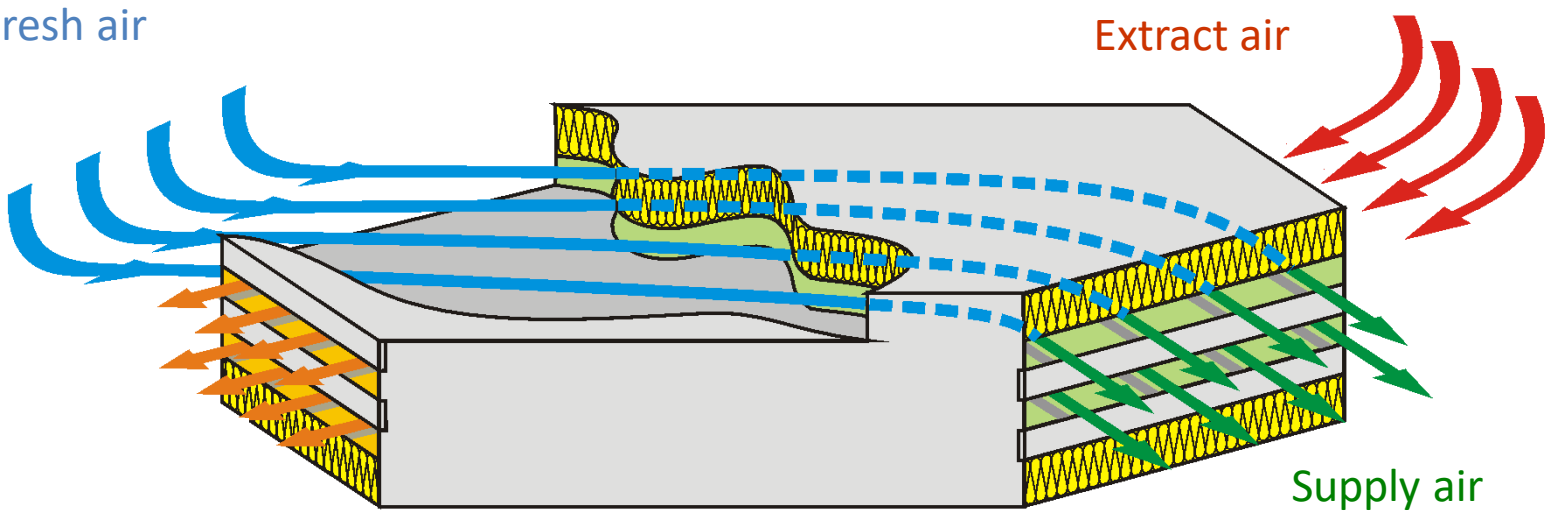
Essential #4 – Controlled ventilation

High air quality: 30 m³/h per person [DIN 1946]



Division into zones:
High air quality in every room: Supply, transfer and extraction – each with suitable airflow rate.

Essential #4 – Controlled ventilation



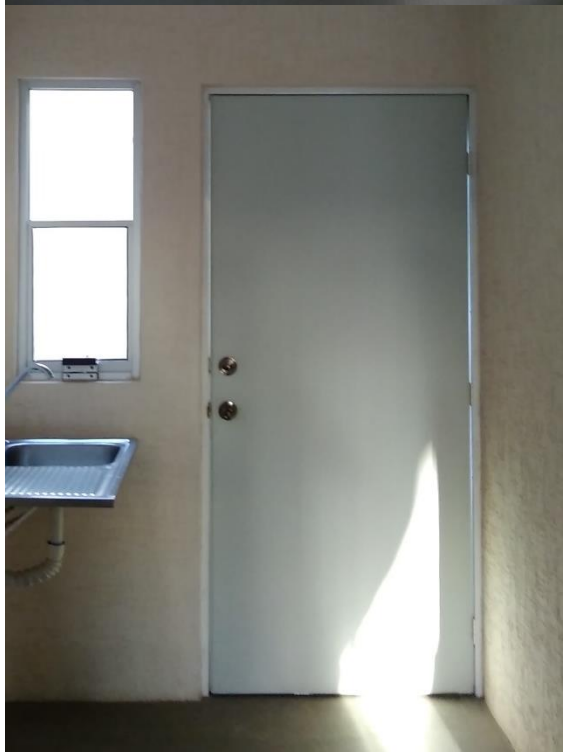
Reduce ventilation heat losses
with highly efficient heat / energy recovery !

Essential #5 – Airtightness

- ⇨ energy saving
- ⇨more comfort: no drafts
- ⇨ improved sound insulation
- ⇨avoid humidity related damage to the construction
- ⇨ important for controlled ventilation to work effectively

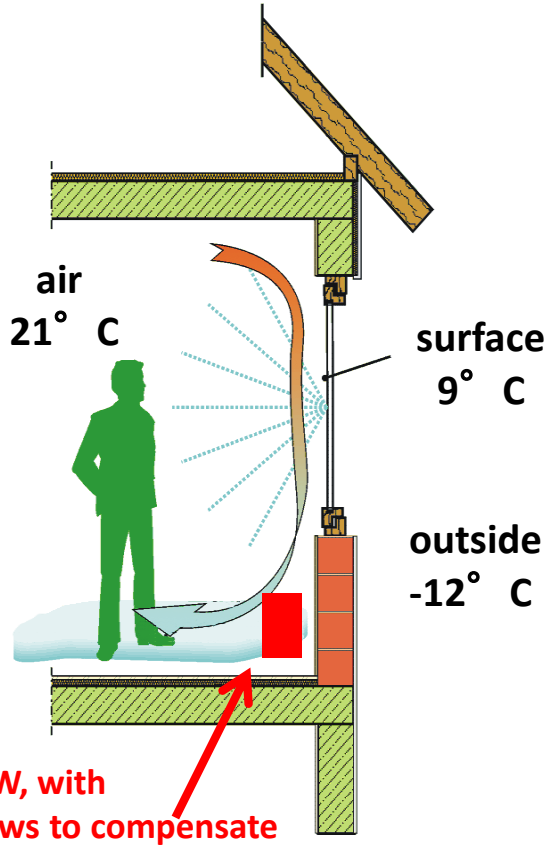
n_{50} max. 0.60 h^{-1}

Essential #5 – Airtightness

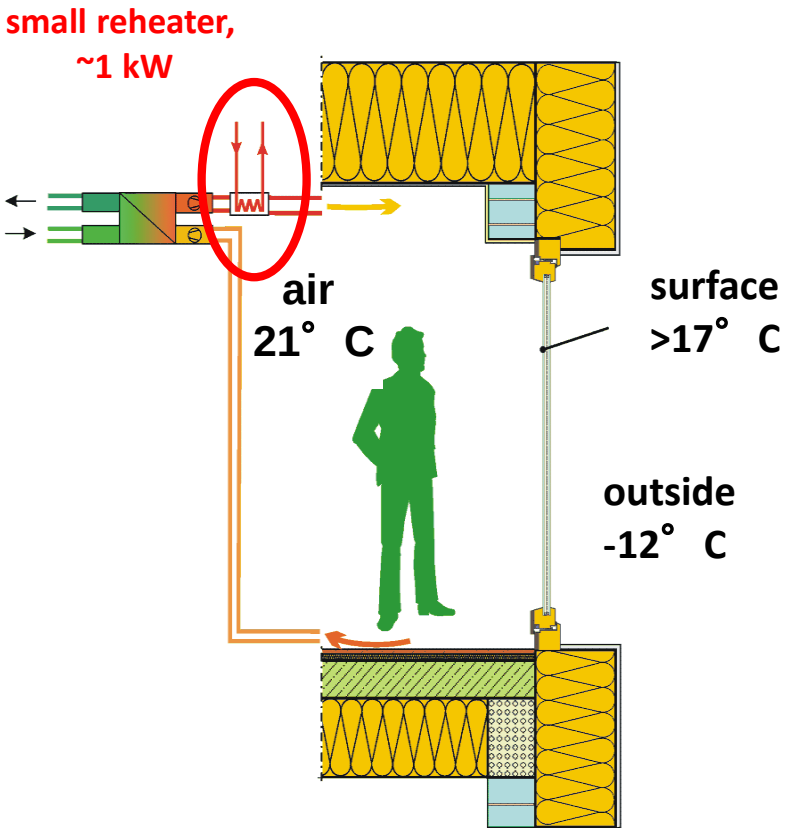


Results: Heating

Building stock:

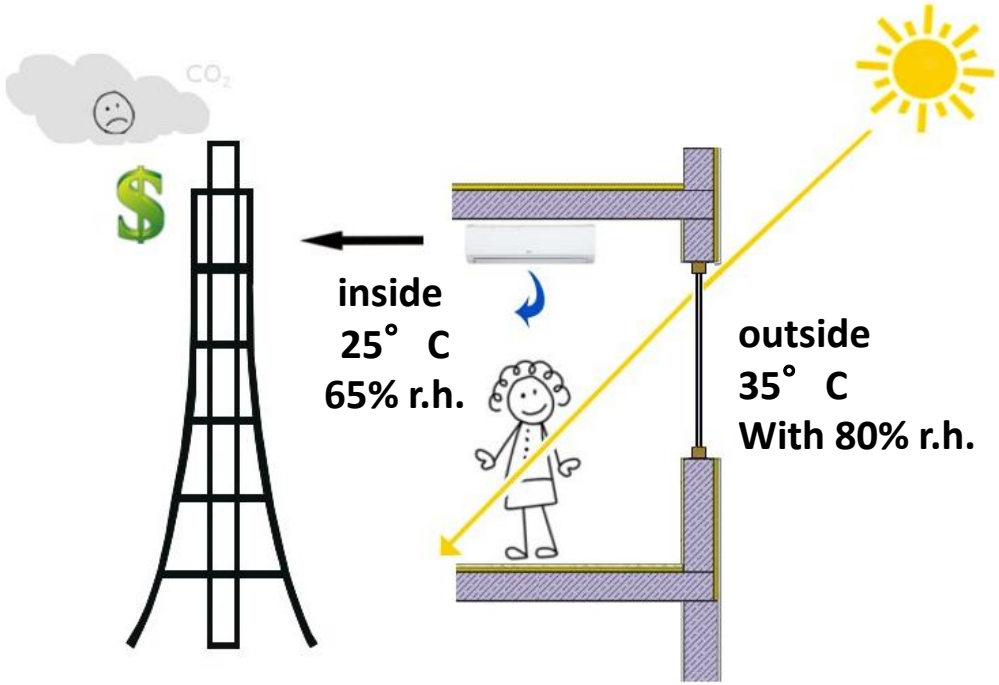


Passive House:

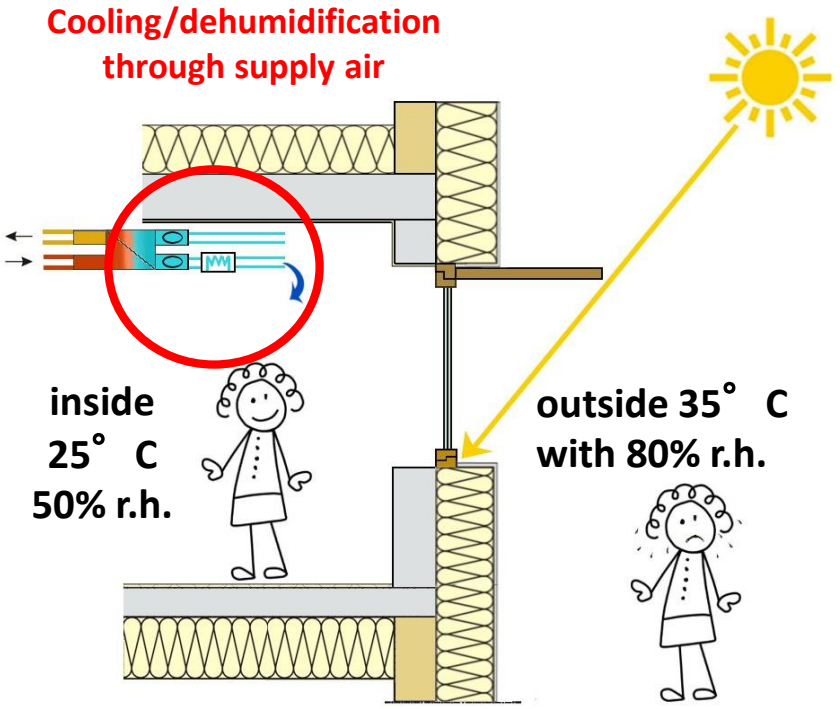


Results: Cooling

Building stock:

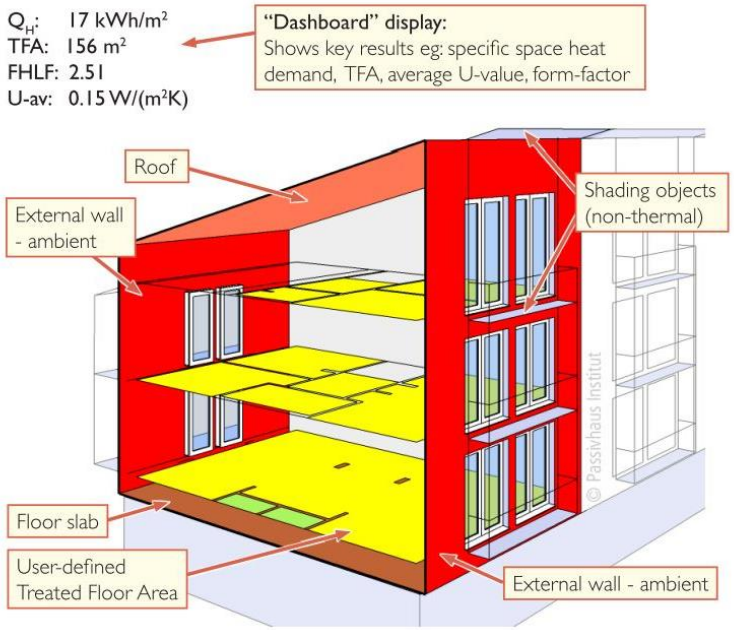


Passive House:



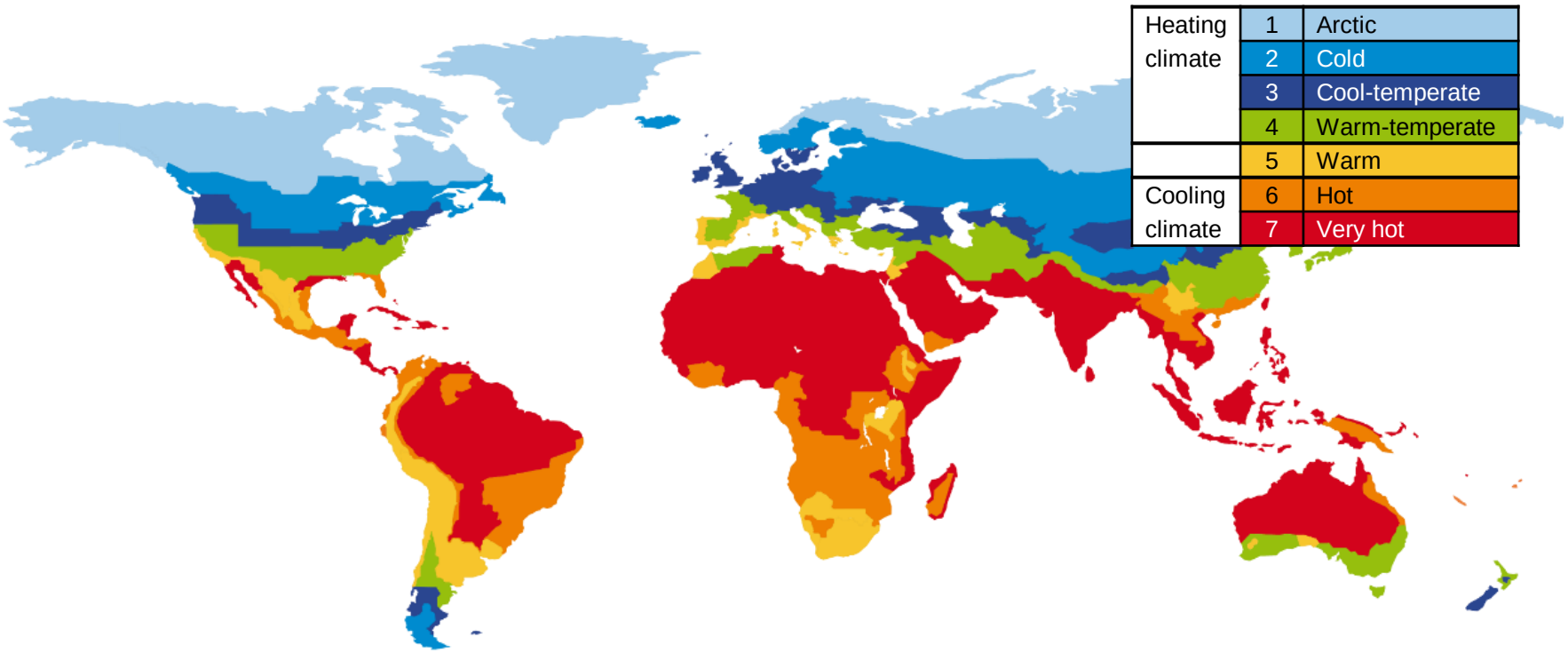
Appropriate design for the local climate

Design – it‘s too late to try to implement the concept on the building site if you don‘t have a well-planned and well-documented design.



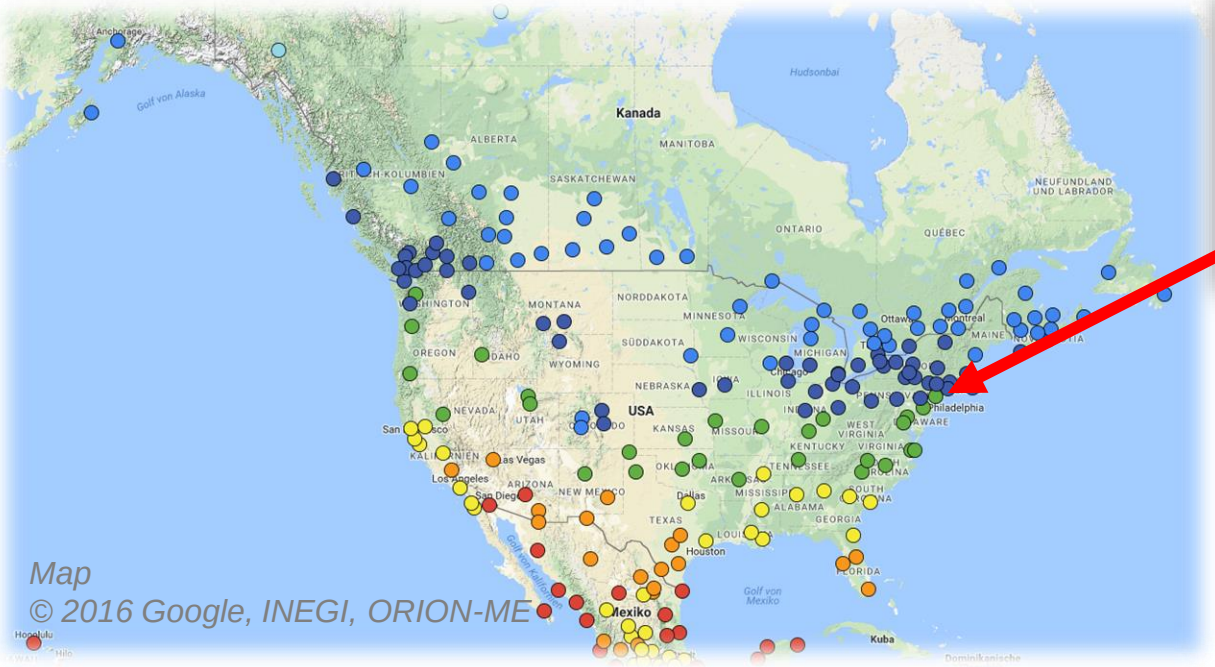
Want to know more? Check more features of PHPP and DesignPH here.

Appropriate design for the local climate

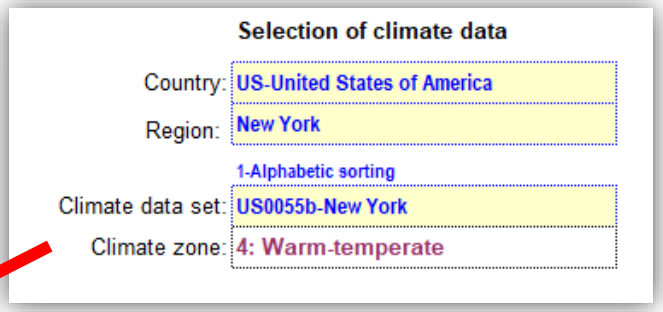


→ Climate zones for initial component recommendations

Appropriate design for the local climate



PHPP climate datasets and corresponding climate zones (September 2017)

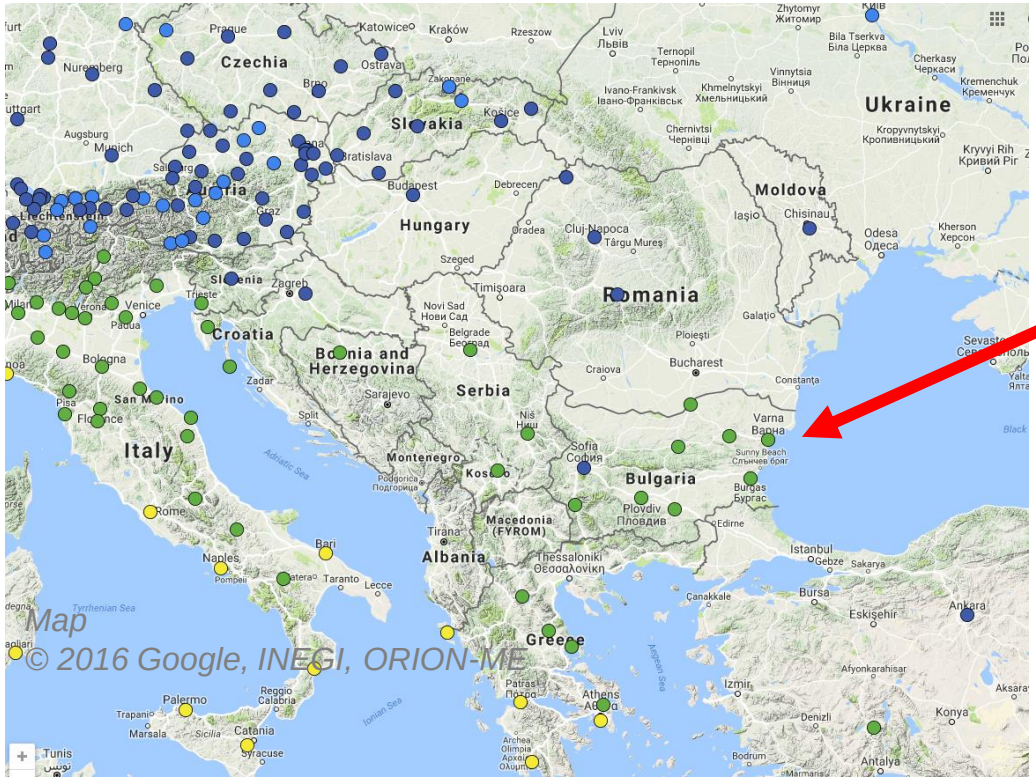


Screenshot of climate selection in PHPP

→ Climate zones for initial component recommendations

→ **Actual design optimization through energy modelling with Passive House Planning Package: PHPP**

Appropriate design for the local climate



Selection of climate data

Country:	BG-Bulgaria
Region:	All
	1-Sortierung: Alphabetisch
Climate data set:	BG0001a-Varna
Climate zone:	4: Warm-temperate

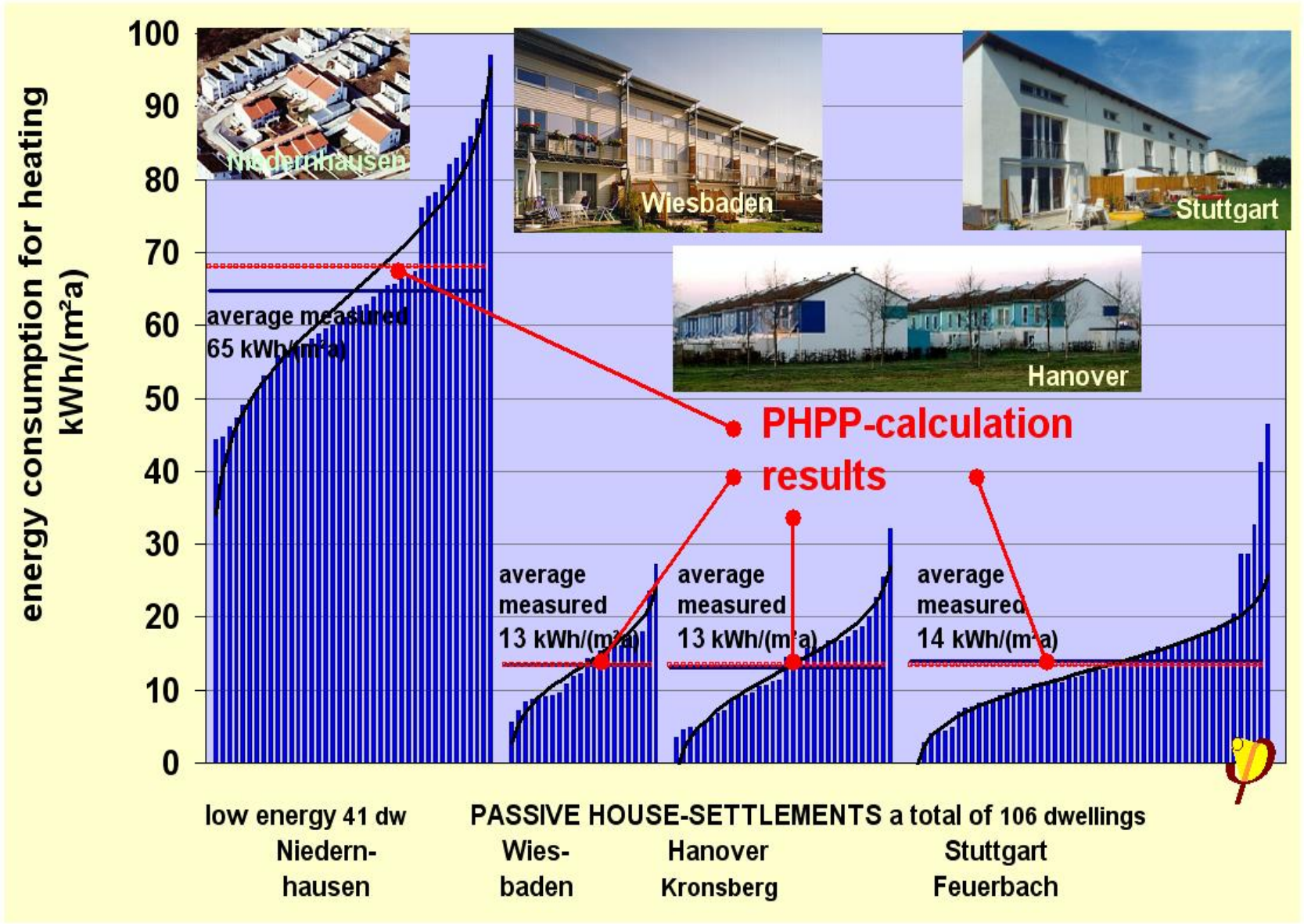
Screenshot of climate selection in PHPP

PHPP climate datasets and corresponding climate zones (September 2017)

→ Climate zones for initial component recommendations

→ **Actual design optimization through energy modelling with Passive House Planning Package: PHPP**

… and it pays off



Summing up

The Passive House Standard:

→ Affordable solution for long-term sustainable high quality buildings

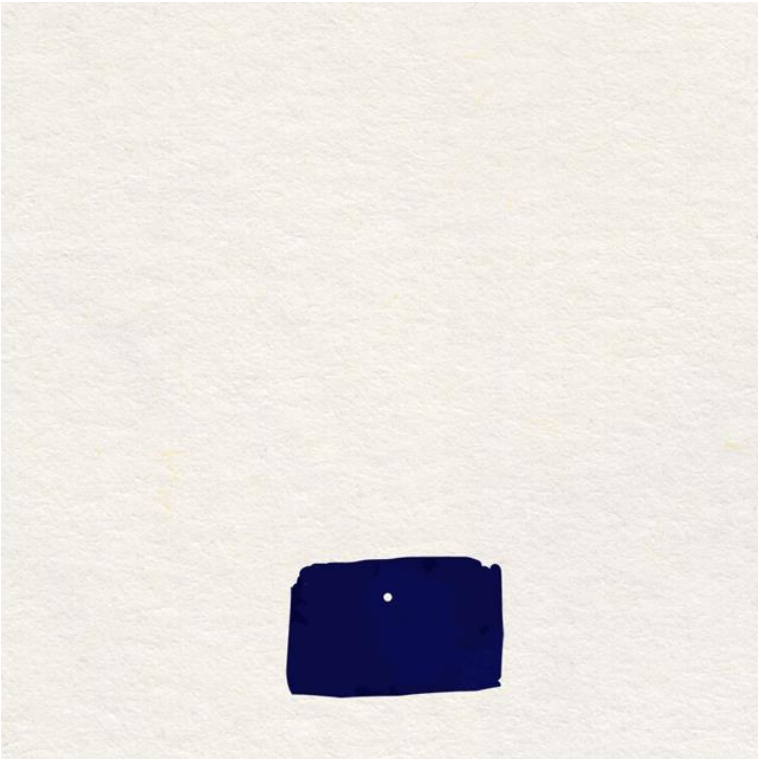
→ Achieved with simple yet effective and reliable technologies for Energy Efficiency

→ Comfortable and versatile, performance-based standard applicable all around the world

History & current trends

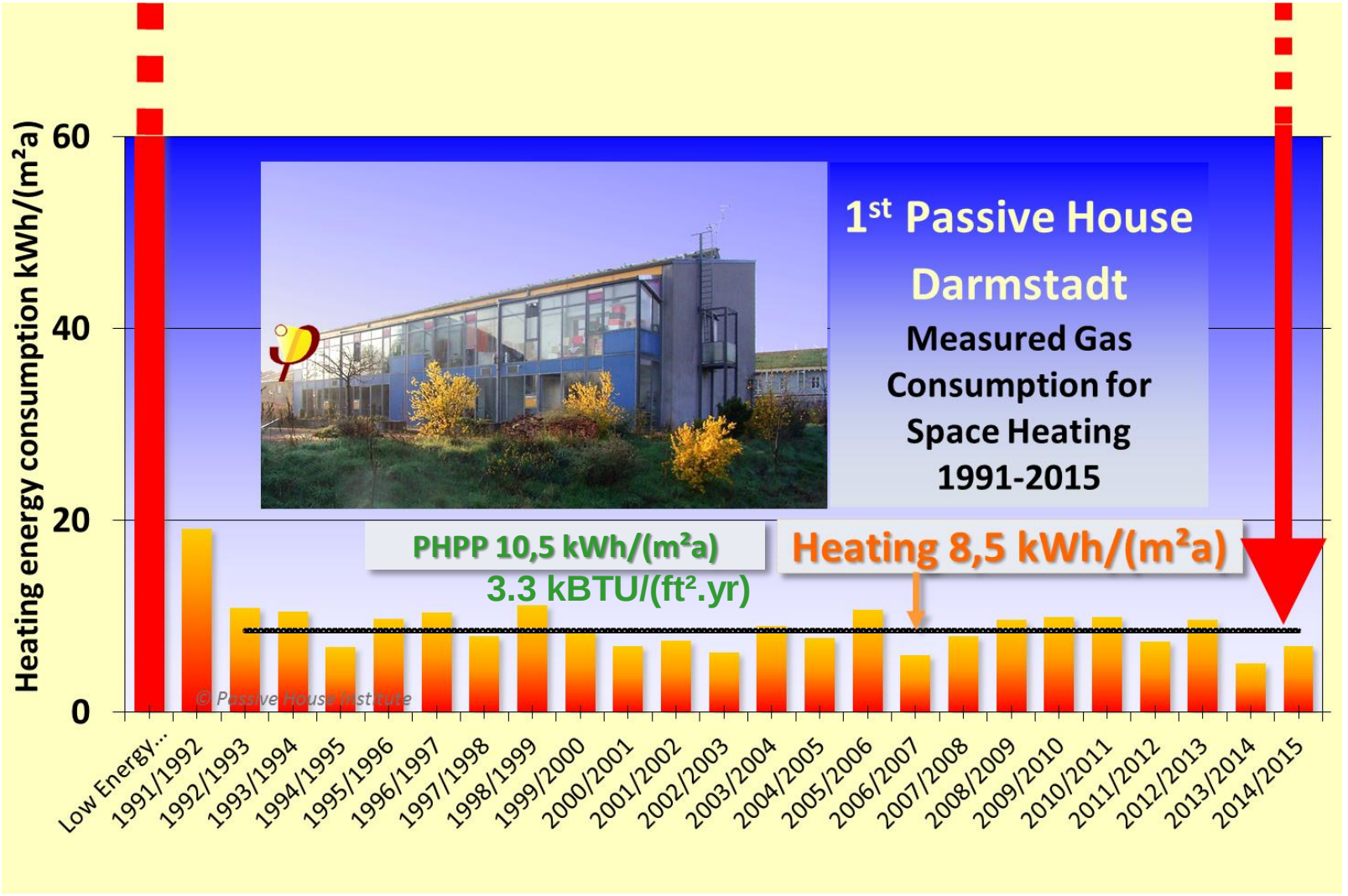
Passive House: From a research project …

Photo: Peter Cook



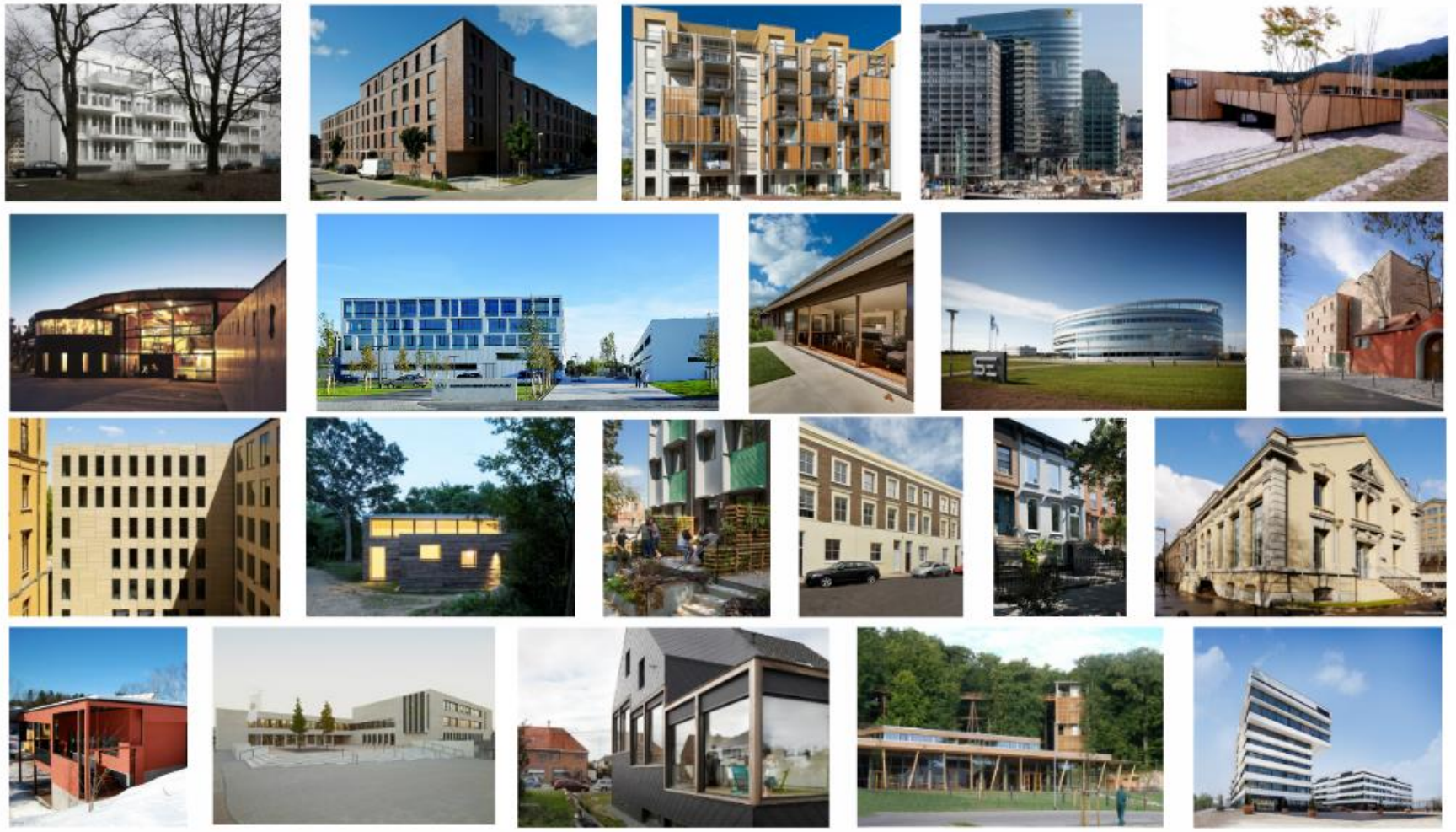
www.stephaniebrittnacher.de

Still performing as predicted ¼ century later



Passive House: From a research project …

… to an international journey



From single family to larger projects

. Offices,
. Apartment buildings

2015, TFA = 14.824 m²
Office building, Frankfurt
ID: 4524

2015, TFA = 8.488 m²
Student residence, Vienna
ID: 4452

… hotels, schools, supermarkets, archives …

… in various climate zones

'Bruck' PH building, Changxing, south China
contractor: Landsea
architect: Ruge
building physics: PHI
more information www.passivhausprojekte.de

'Xingfubao' Urumqi, north west China
contractor: Dacheng
architect: Hennecke CBA
building physics: PHI
www.passivhausprojekte.de ID 4246

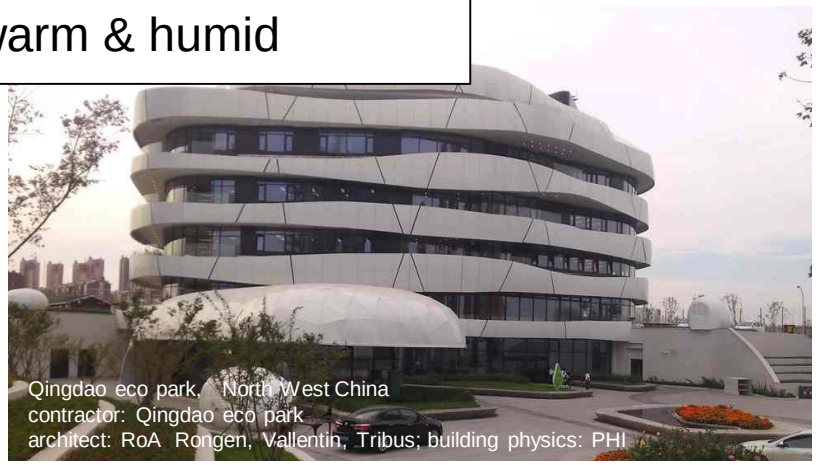
Changxing - hot&humid

Urumqi, - cold & dry

ZhuoZhou - moderate

Qingdao - warm & humid

'ZhuoZhou' Hebei Central China
Contractor: Hebei Xinhua Curtain Wall Co. Ltd.
building physics: Dawid Michulec www.schoeberlpoell.at and PHI



Qingdao eco park, North West China
contractor: Qingdao eco park
architect: RoA Rongen, Vallentin, Tribus; building physics: PHI

… in the Black Sea region

Holiday villa, EnerPHit Retrofit in Bansko, BG
EKSA art, SolAir Architects, HES Bulgaria Ltd.
ID: 2087

Kindergarden, Passive House in Calarasi, Moldovia
Axis Mundi S.R.L. / RoA RONGEN ARCHITEKTEN PartG mbB
ID: 5361

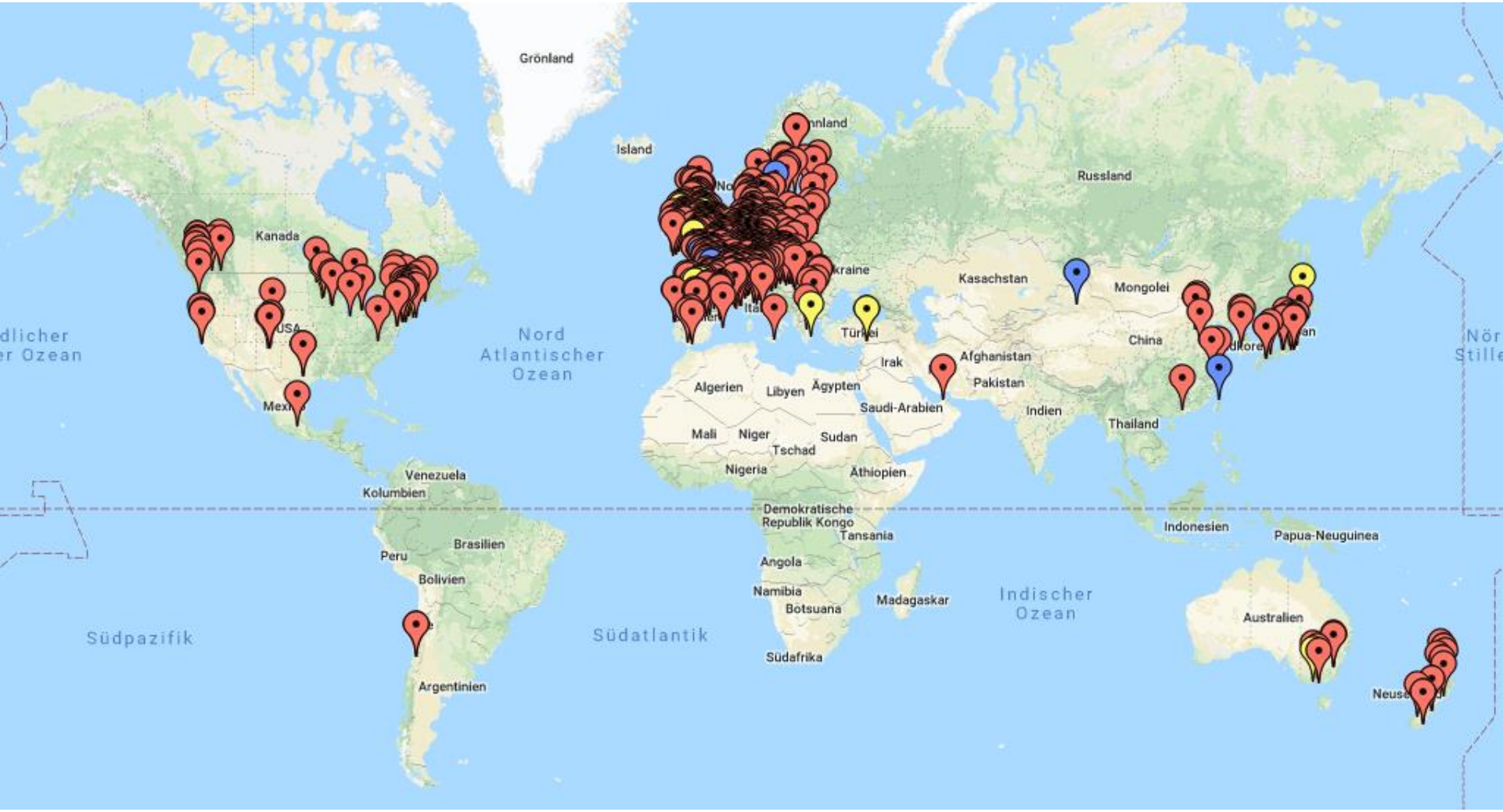
Apartment building, PH Low-energy building in Volos, Greece
ID: 4992

Administration building, Passive House in Anatolia, Turkey
Gaziantep Metropolitan Municipality
ID: 4976

Single-familiy house, Passive House Plus in Romania
ID: 4893

… and worldwide

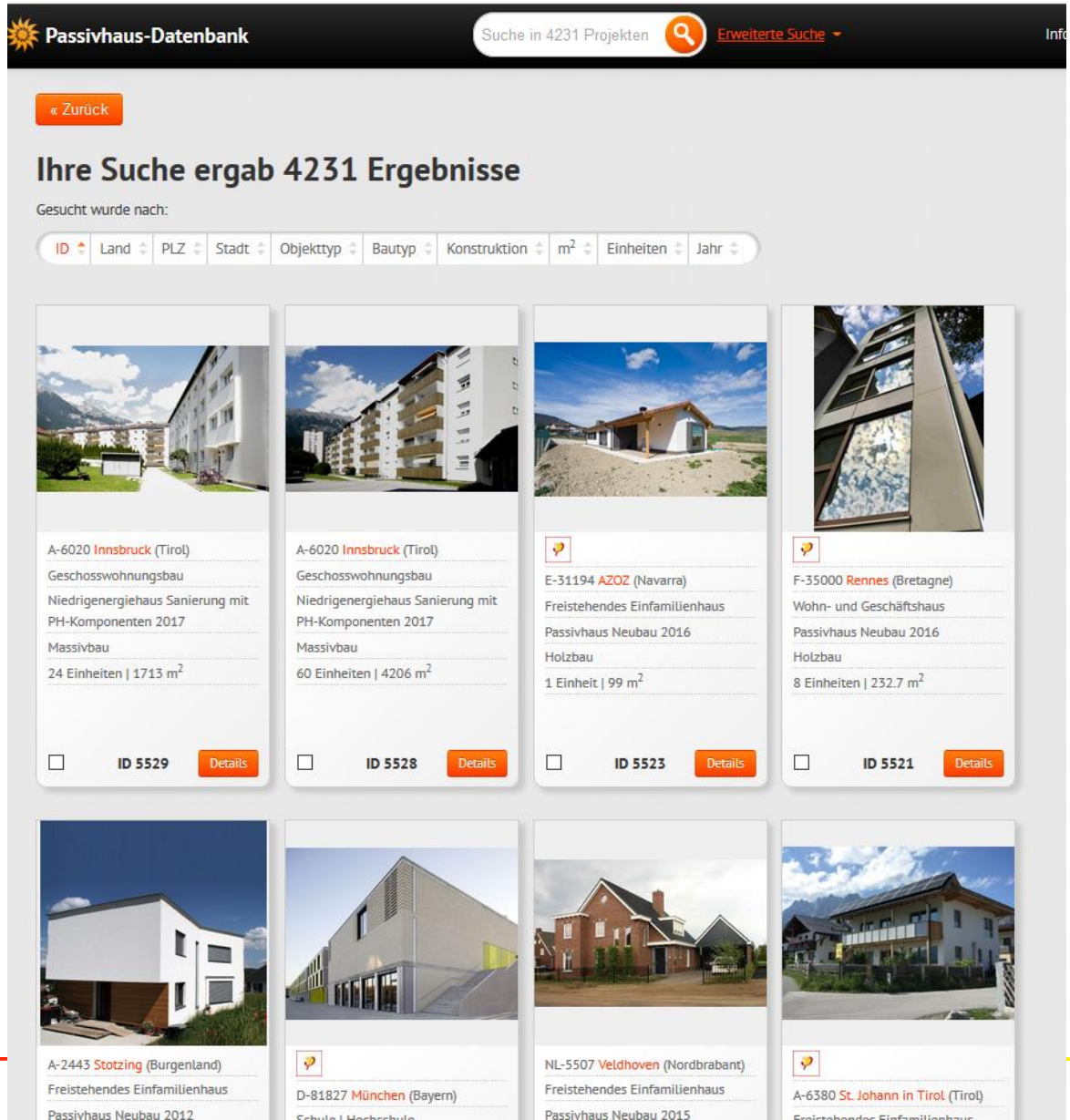
approx. 1.8 Mio m² TFA of *certified* Passive House projects worldwide



Open the map here.

Get inspired from projects worldwide

www.passivehouse-database.com

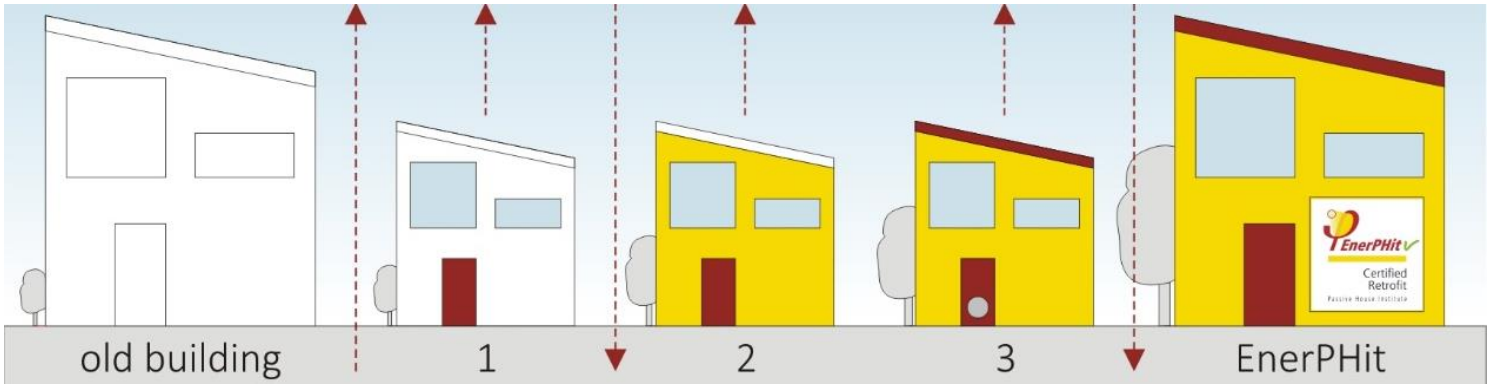


Hot topic: Retrofitting

Renovation with Passive House components = EnerPHit

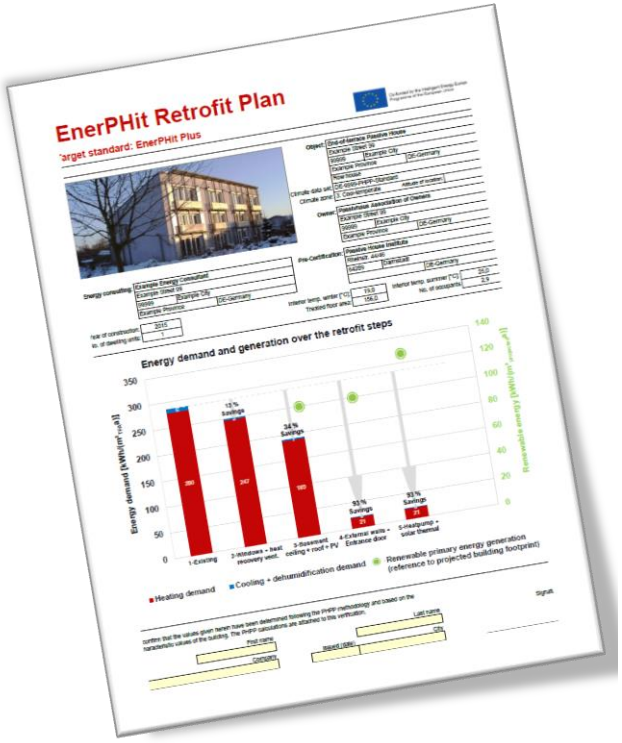
EnerPHit
Zertifizierte Modernisierung
Passivhaus Institut

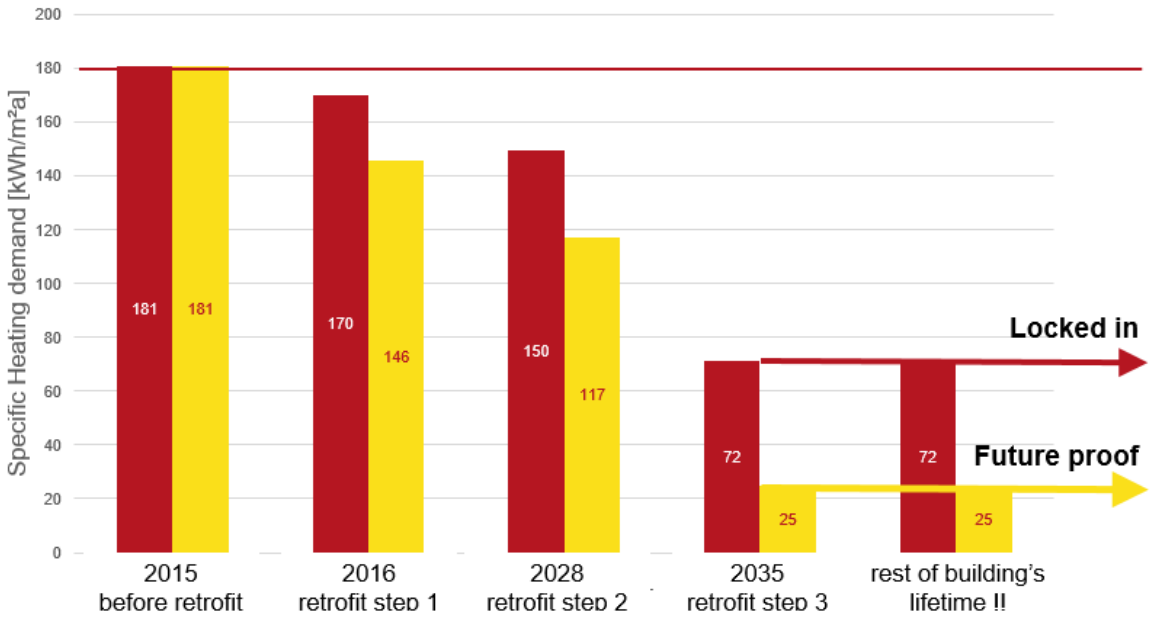
EnerPHit Retrofit Plan to prevent „lock-in“



EuroPHit

www.europhit.eu

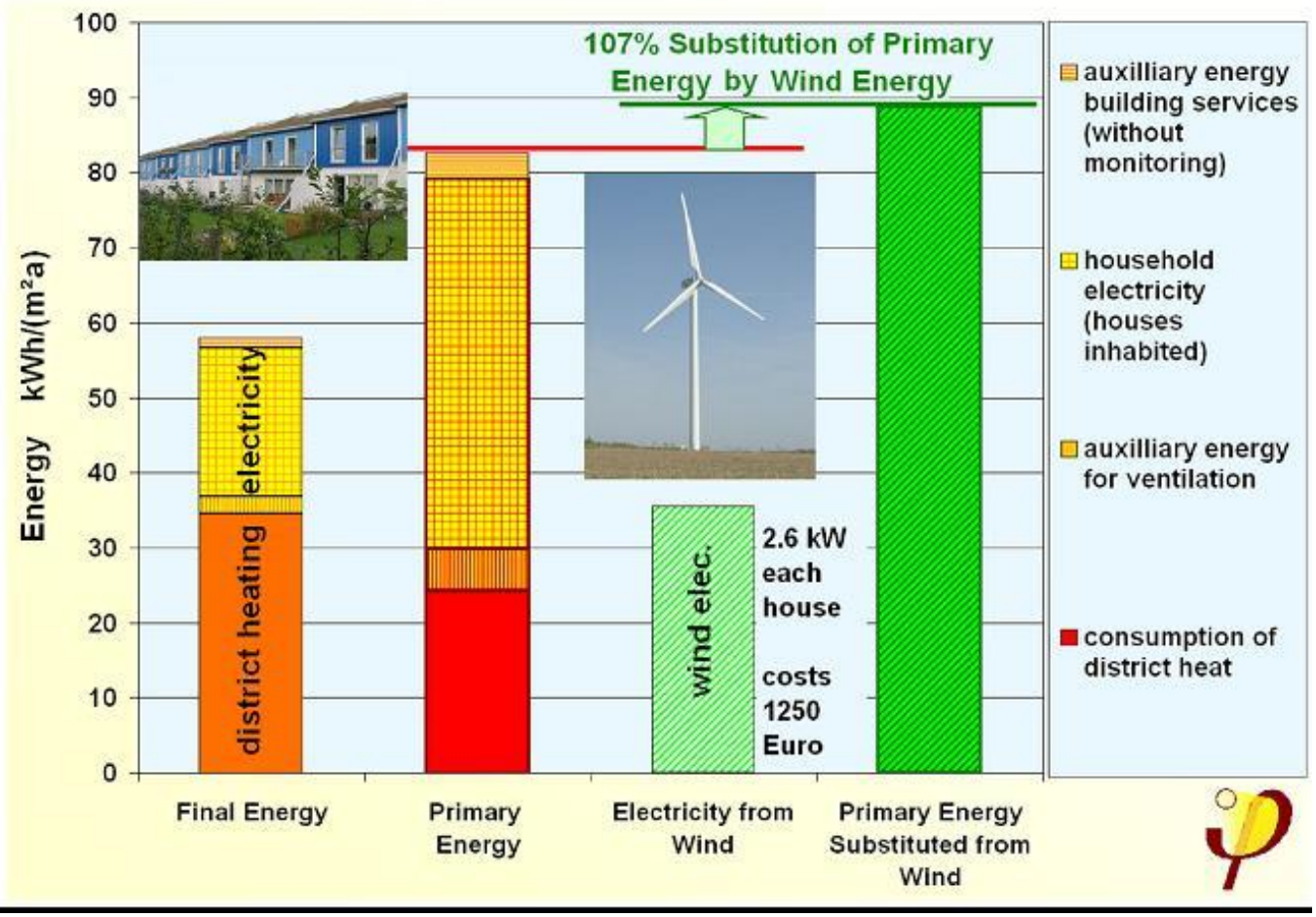




Hot topic: Integration of renewables

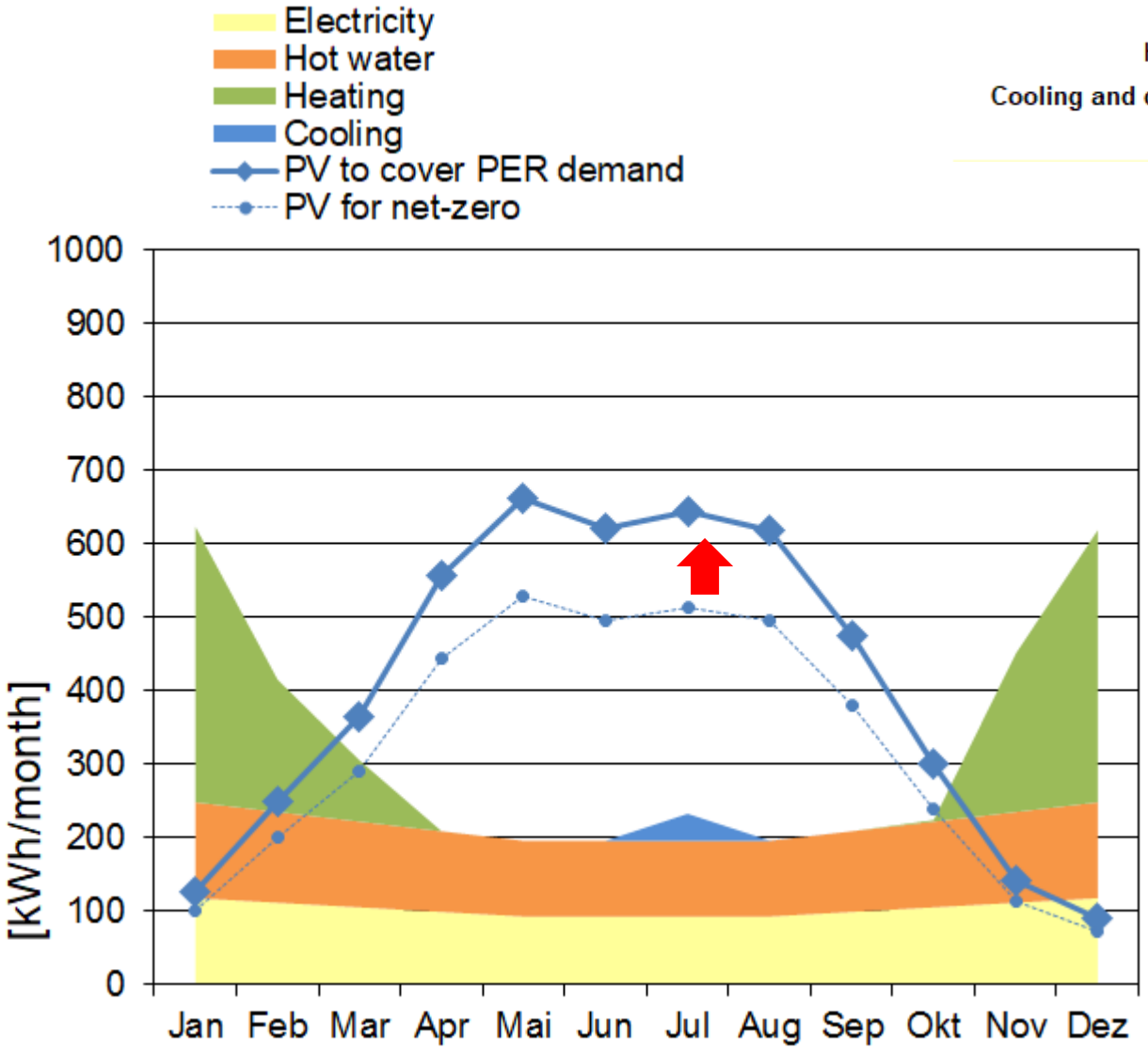
Energy efficiency + Renewables = Dream Team

The low energy demand of a PH can easily be covered by on-site or nearby renewables



Passive Houses Hanover Kronsberg (2000): wind electricity

zero-energy?



Heating demand	kWh/(m²a)	15
Cooling and dehum. Demand	kWh/(m²a)	1
PER demand	kWh/(m²a)	31

PER approach takes into account losses
→ „honest“ zero-energy

Required PV area
(German climate)
Net-zero = 32 m²
PER-zero = 40 m²

zero-energy?

- Net-zero / net-plus energy often misleading
  e.g. multistory buildings are discriminated despite their advantages

- PH approach: Independent rating of RE and efficiency.

  → Building's footprint area as a reference for renewables.
  → Take off-site production into account.

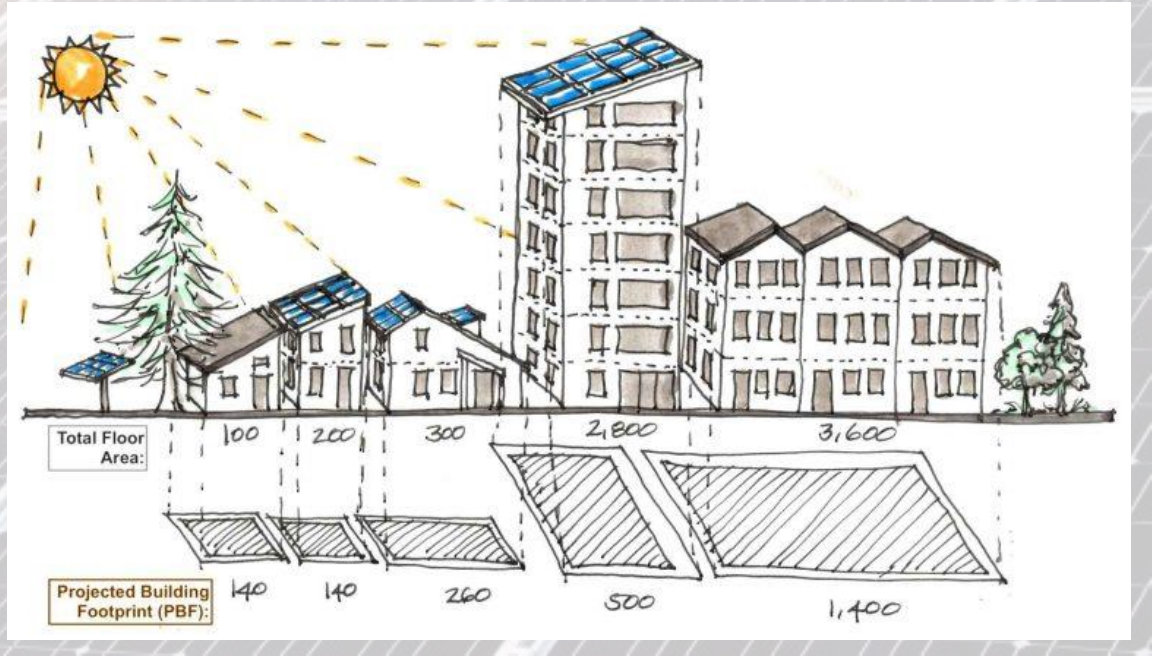
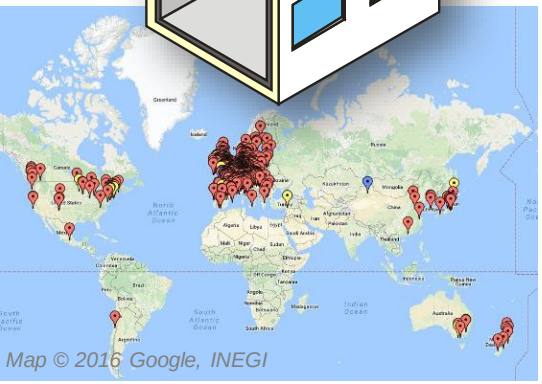


Illustration by Bronwyn Barry, Passive House California

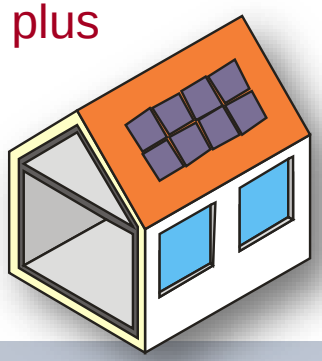
Passive House + Renewables

Basic requirement: Efficiency first
→ PH performance criteria: very low heating and cooling demand

classic

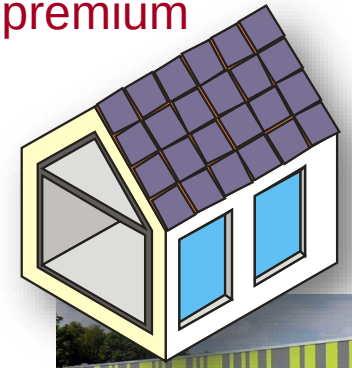


plus



Vienna |
aap.architekten ZT-GmbH

premium



bg architektur

Keck Architekten GmbH

...

+ Renewable energy generation (PER supply)
+ increased overall efficiency (PER demand)

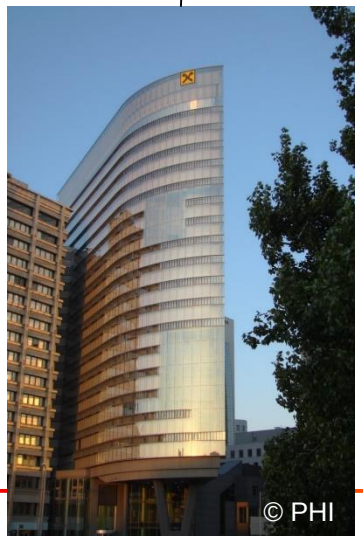
Hot topic: The tallest!

2010
Freiburg, DE
Residential retrofit
16 floors
58 m

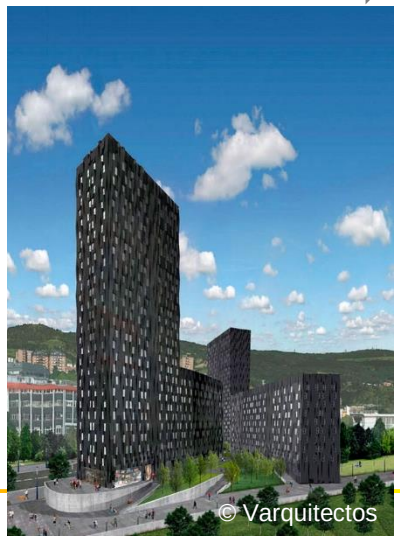
2017
New York, US
Student residents
26 floors

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018

2012
Vienna, AT
Office building
23 floors
77 m



2018
Bilbao, ES
Residential
28 floors



… and more to come

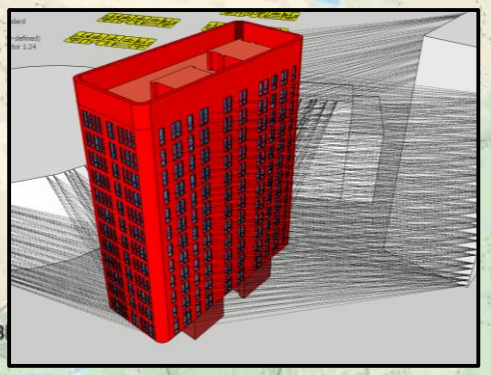
Passivhaus Institut

Winthrop Square, Boston

Vancouver

Sendero Verde, New York

… and more to come



Hot topic: Passive House districts

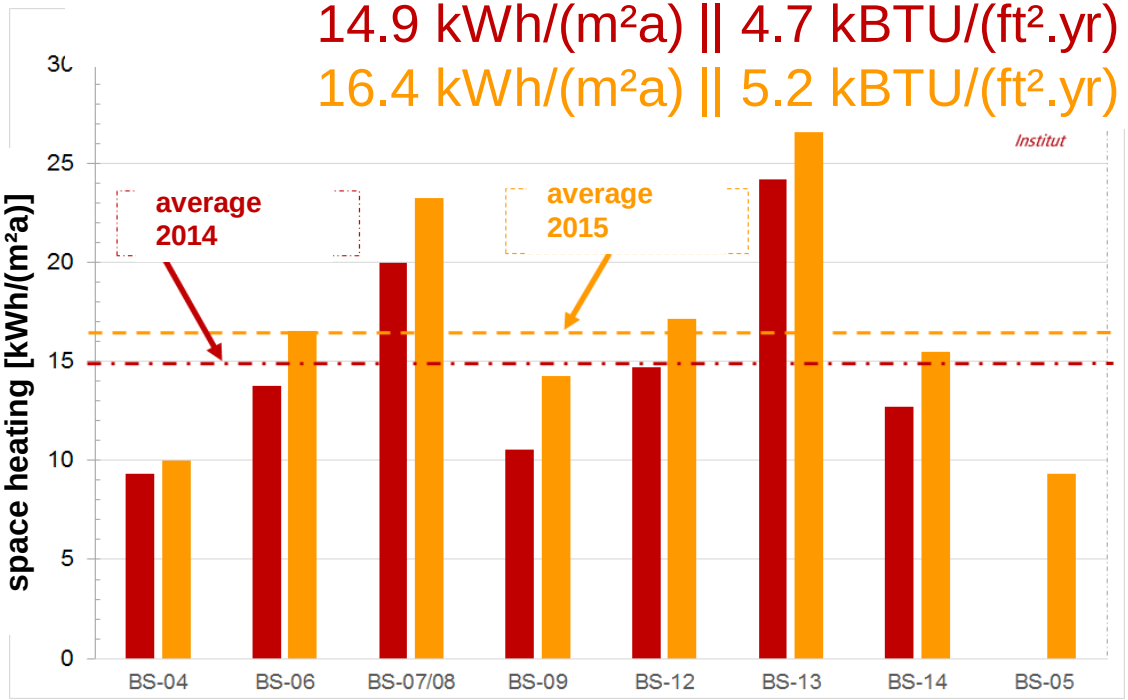

„Bahnstadt“ quarter, Heidelberg, Germany © City of Heidelberg, photo: Kay Sommer

Monitoring:
~ **900 000 ft²**
~ **1 400** appartments

Success due to good quality assurance process:

PHPP

14.9 kWh/(m²a) || 4.7 kBTU/(ft².yr)
16.4 kWh/(m²a) || 5.2 kBTU/(ft².yr)



Source: [Peper 2016]

Bahnstadt Heidelberg

Railway City Gaobeidian

Summing up

The hot topics / trends:

→ Retrofits: EnerPHit + EnerPHit Retrofit Plan

→ Renewables: efficiency first, then renewables, considering when and where

→ Larger scale: whether tall buildings or entire districts, it's possible!

Policy uptake

Hot topic: Policy uptake

www.passivehouse-international.org

Policy examples: Frankfurt

- → Level: **local, city**
- → Type: **building code**
- → Targets: **public buildings**
- → Basis: **EU Energy Performance Buildings Directive**

2003 - School buildings to be built to Passive House standard.

2005 - Wrote PH into the building code

2005 - Guidelines for Economical Construction were developed for the City of Frankfurt. Passive House is recommended as one possibility for economical construction.

2007 - all municipal buildings must be built to much stricter energy requirements than those under federal law to anticipate the EU EPBD

Present - 79 new construction projects have been built to Passive House Standard and 8 refurbished using Passive House certified components. 16 projects are currently in the planning phase or under construction.

Policy examples: Vancouver

→ Level: **local, city**
→ Type: **non-financial incentives, code improvement**
→ Targets: **all buildings**
→ Basis: **Vancouver's Greenest City Action Plan**

- Inspiration: Lost Lake House built for the Winter Olimpics in 2010
- Removing barriers for Passive Houses:
  - extra floor area, height and depth;
  - openness to resolving code compliance issues
  - Fee reductions
  - Bringing the code closer to the Passive House standard
  - Rezoning policy favoring Passive Houses
- Quality assurance aligned to Passive House:
  - using PHPP and Passive House plans to apply for a development permit
  - a PHI Building Certifier approved "Passive House Commissioning Plan"
  - applying for Passive House certification once the building is complete.

Policy examples: Vancouver

Moving forward

- Next steps: training and code improvements to include a retrofit policy
- UNECE launched one of its (Zero Emissions Buildings) Centers of Excellence in Vancouver.
- Passive House has also spread to further provincial governments such as Toronto and has resulted in Passive House projects for First Nation people in Southwestern British Colombia (B.C.).
- In B.C. at large, the BC Step Code 5 has been brought closer in line with the Passive House Standard.

Policy examples: Brussels

→ Level: **local, city**

→ Type: **building code, capacity building, financial incentives**

→ Targets: **all buildings**

→ Basis: **EU Energy Performance Buildings Directive**

- as of 1 January 2015 the “Brussels” Passive requirements apply to new buildings and any major renovation in housing, offices or schools
- Accelerating Passive House uptake:
  - Public outreach and education campaigns,
  - free consulting services from the Brussels Passive House Platform
  - financial incentives (100€/m2 for residential - max. 15 000€, 50€/m2 for non-residential)
  - “Exemplary Buildings” call for projects in 2007 offering selected projects +100€/m2 in subsidies
  - Training programmes for stakeholders
  - Employment-Environment Alliance to promote engagement with and in the sustainable construction sector and share industry expertise.
  - Energy fund: electricity supplier gives back 1,95 % of the consumption revenue and offers a tax break.

Policy examples: Luxembourg

→ Level: **national**
→ Type: **building code, subsidies**
→ Targets: **all buildings**
→ Basis: **EU Energy Performance Buildings Directive**

- After an implementation process of 8 years, as of January of 2017 all new buildings must be constructed to the modified Luxembourg Passive House standard
- Subsidy for buildings with additional sustainability features such as ecological materials and end-of-life-cycle management
- training courses were devised by energieagence and the IFSB, Luxembourg's association for training in the construction sector, on behalf of the Chamber of Trades. Courses available in French, German and Portuguese
- Construction sector was involved in the development of regulations
- Carrot and stick policy: incremental requirements and incentives

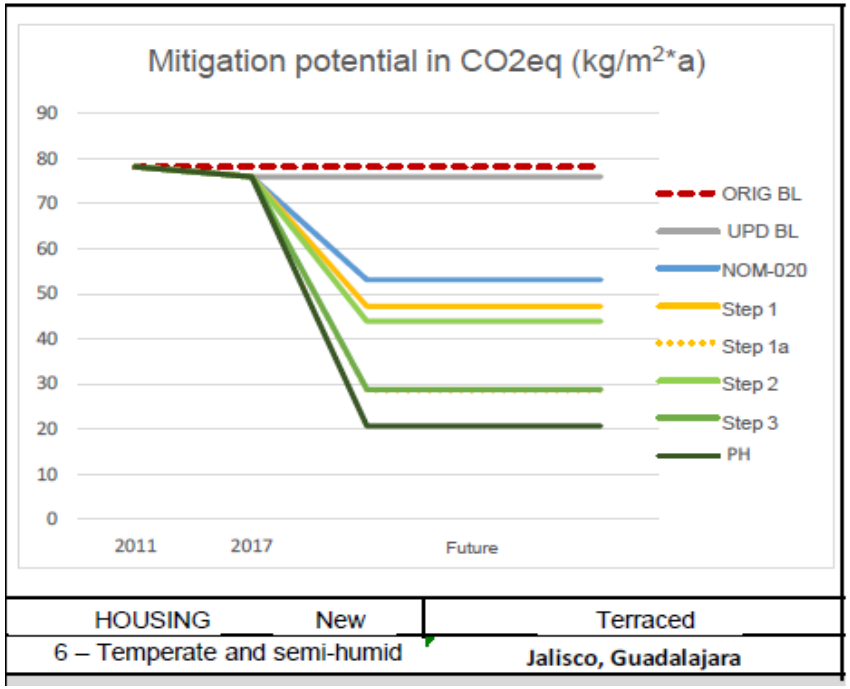
Policy examples: Mexico

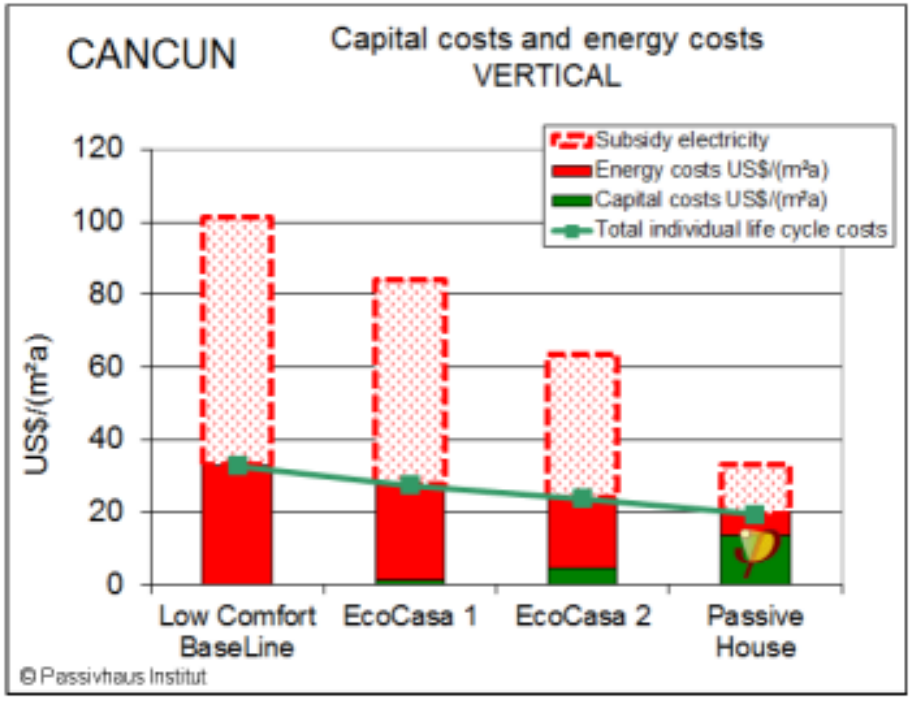
→ Level: **national**

→ Type: **policy concept, measurement tools**

→ Targets: **residential buildings**

→ Basis: **Mexico's mitigation commitment**

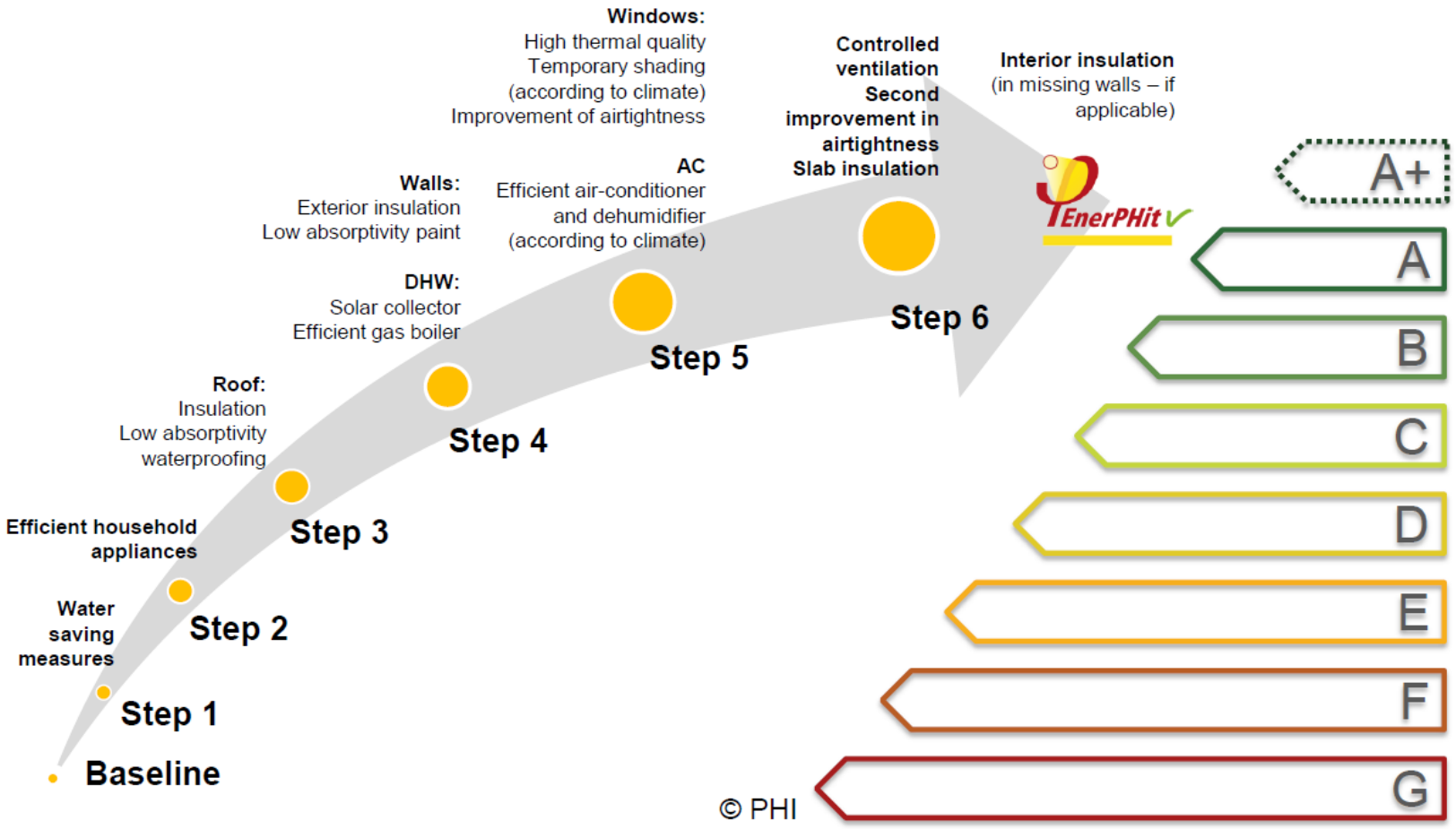




Source: Original and updated NAMA for sustainable housing in Mexico, Passivhaus Institut for GiZ

The Technical Annex of the NAMA is available online.

Policy examples: Mexico



Source: NAMA for sustainable housing in Mexico, Passivhaus Institut for GiZ

Summing up the policy examples

→ **Frankfurt:** PH into the building code, starting 2007 all public buildings must be Passive Houses.

→ **Vancouver:** started by removing barriers through incentives and improving the building code, has resulted into the Center of Excellence and the inclusion of Passive House into the code of BC and other provincial governments

→ **Brussels:** dissemination, free consulting, exemplary projects, training programmes, energy fund and buildings to Brussel's passive code.

→ **Luxembourg:** subsidies to buildings built to the Passive House standard

→ **Mexico:** concept for the gradual increase of requirements for energy efficiency, tools for the performance evaluation system

The role of the Passive House Institute (PHI)

PHI = research, capacity building & quality assurance

Founded in 1996 as an independent institute to bridge the gap between researchers and building professionals

Passive House – an open standard

Not a brand but an open concept.
Certification schemes as means of quality assurance.

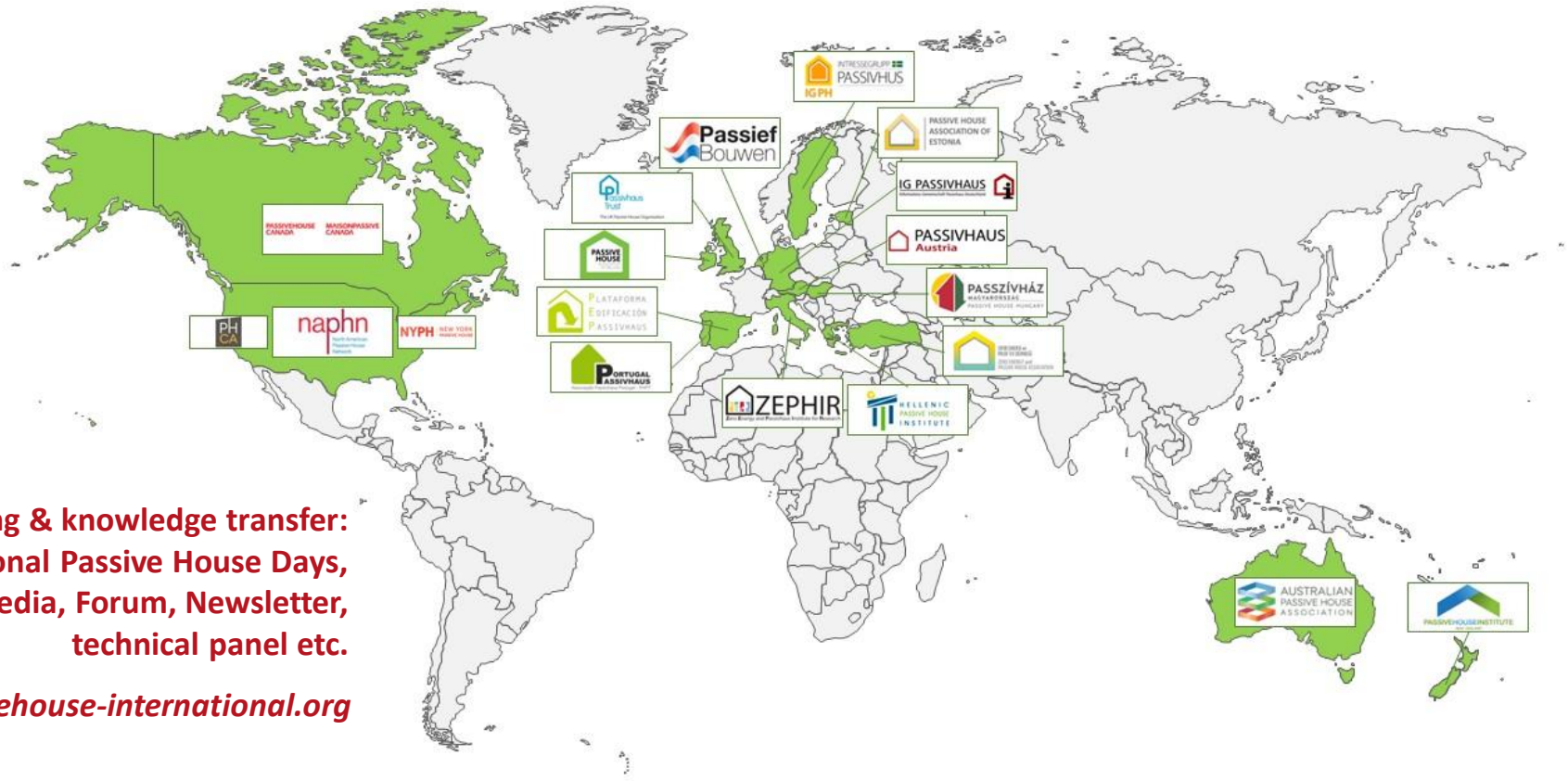
56% Residential
40% Non-Residential
4% Mixed use

It’s a team sport!

Passivhaus Institut

Passive House Institute

International PASSIVE HOUSE Association iPHA



Networking & knowledge transfer:
International Passive House Days, Passipedia, Forum, Newsletter, technical panel etc.

www.passivehouse-international.org

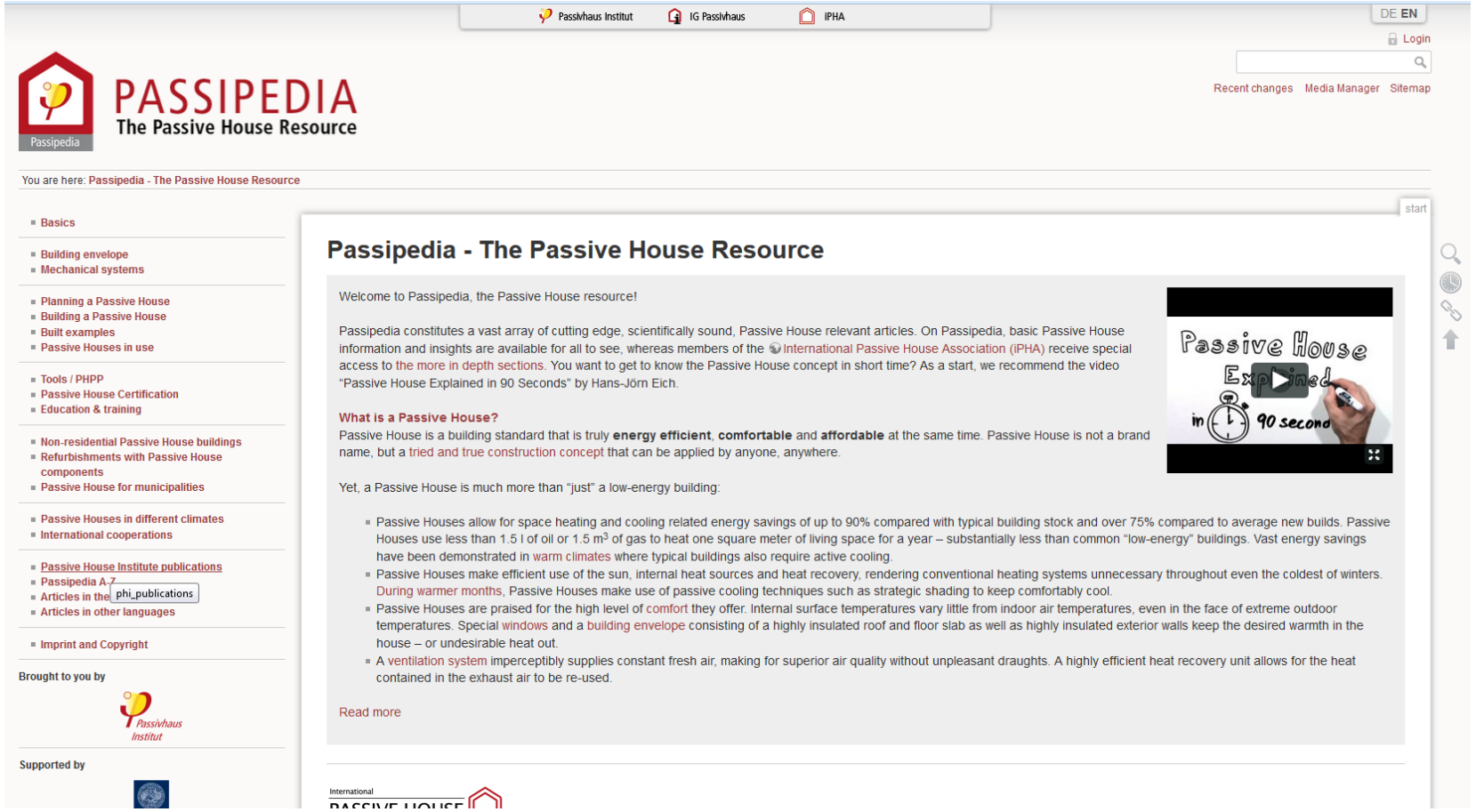
International outreach

Education

Publications

Education

www.passipedia.org



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Events

Experience the comfort for yourself!

International Passive House Open Days

PASSIVE HOUSE BUILDINGS WORLDWIDE OPEN THEIR DOORS

Doing more with less:

- Superior comfort with minimal heating and cooling costs
- Fresh air around the clock
- Easily combined with renewable energy
- For new builds and retrofits alike

Learn directly from residents and construction professionals

9 - 11 November 2018

Please visit www.passivehouse-international.org for further information. Participating buildings will be listed as of September on www.passivehouse-database.org

International PASSIVE HOUSE Association iPHA

SINFONIA stands for "Smart INItiative of cities Fully cOmmitted to iNvest in Advanced large scaled energy". This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 609019

Sinfonia

23 INTERNATIONAL PASSIVE HOUSE CONFERENCE 2019
国际被动房大会2019

Passivhaus Institut

Gaobeidian, China

21 | 22 September 2019

with exhibition, workshops, excursions

Passivhaus Institut

universität innsbruck

河北省人民政府 THE PEOPLE'S GOVERNMENT OF HEBEI PROVINCE

奥润顺达 ORIENT SUNDAR

Longfor 龙湖地产

中国国际门窗城 China International Windoor City

www.passivehouseconference.org

The necessary infrastructure

Quality Assurance	→ Availability of planning tools → Certification of components and buildings
Education / Knowledge transfer	→ Training for designers and tradesmen-- → Accreditation of certifiers
Events	→ Exchange experience

Passive House: Inspiring transformation

Each individual makes a difference!

The more, the higher the impact ☺

- More awareness and expertise
- More and better components
- Policy uptake
  . compliance pathway for PH projects
  . requirements towards PH efficiency levels

Thank you!

Elena Reyes Bernal
elena.reyes@passiv.de

Passive House Institute
www.passivehouse.com | www.passipedia.org

A presentation for
Training Seminar on High-Performance Energy Efficiency Standards in Buildings in the UNECE Region
September 6, 2018, St. Petersburg