Passive House Institute

Passive House:

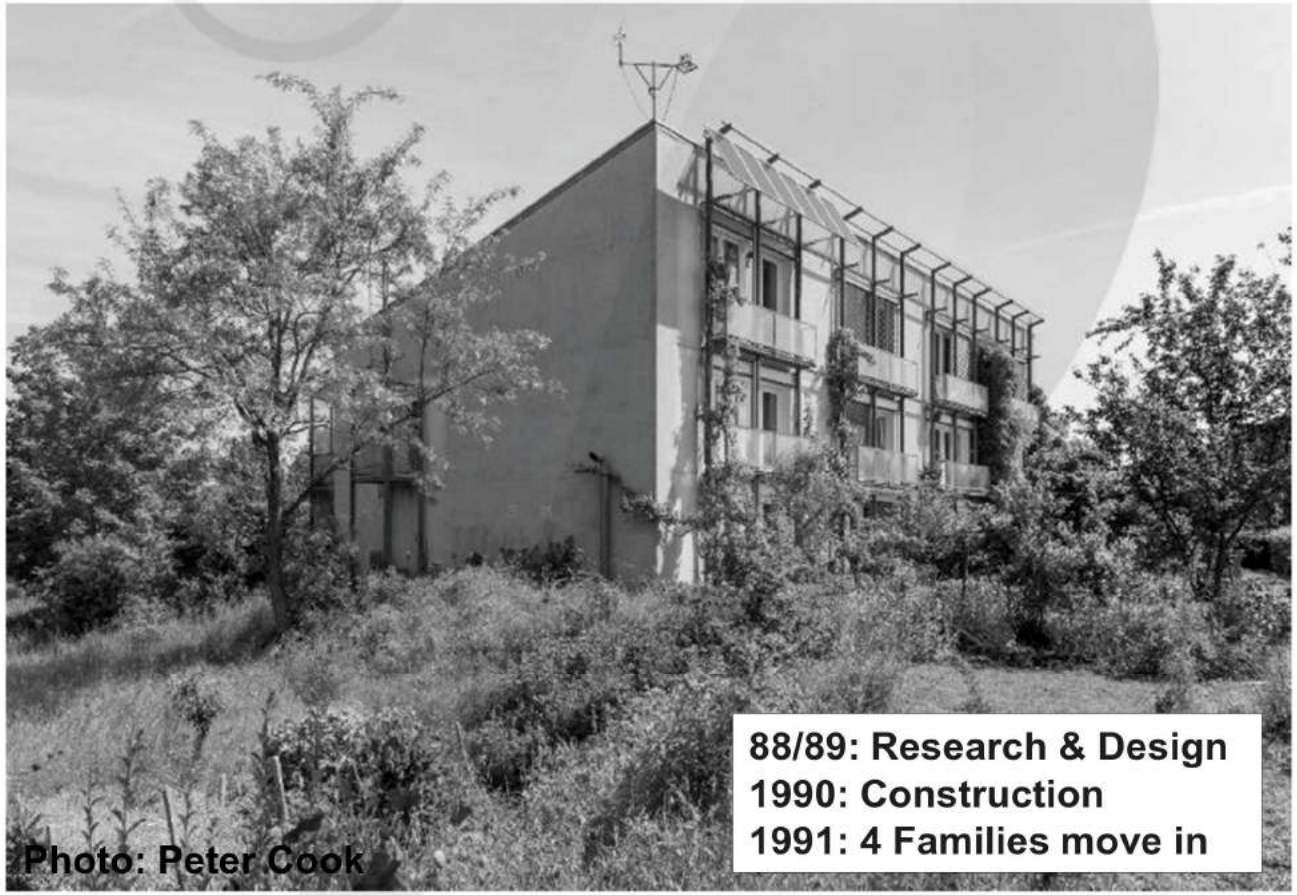
25 years on

& the new step-by-step EnerPHit retrofit plan

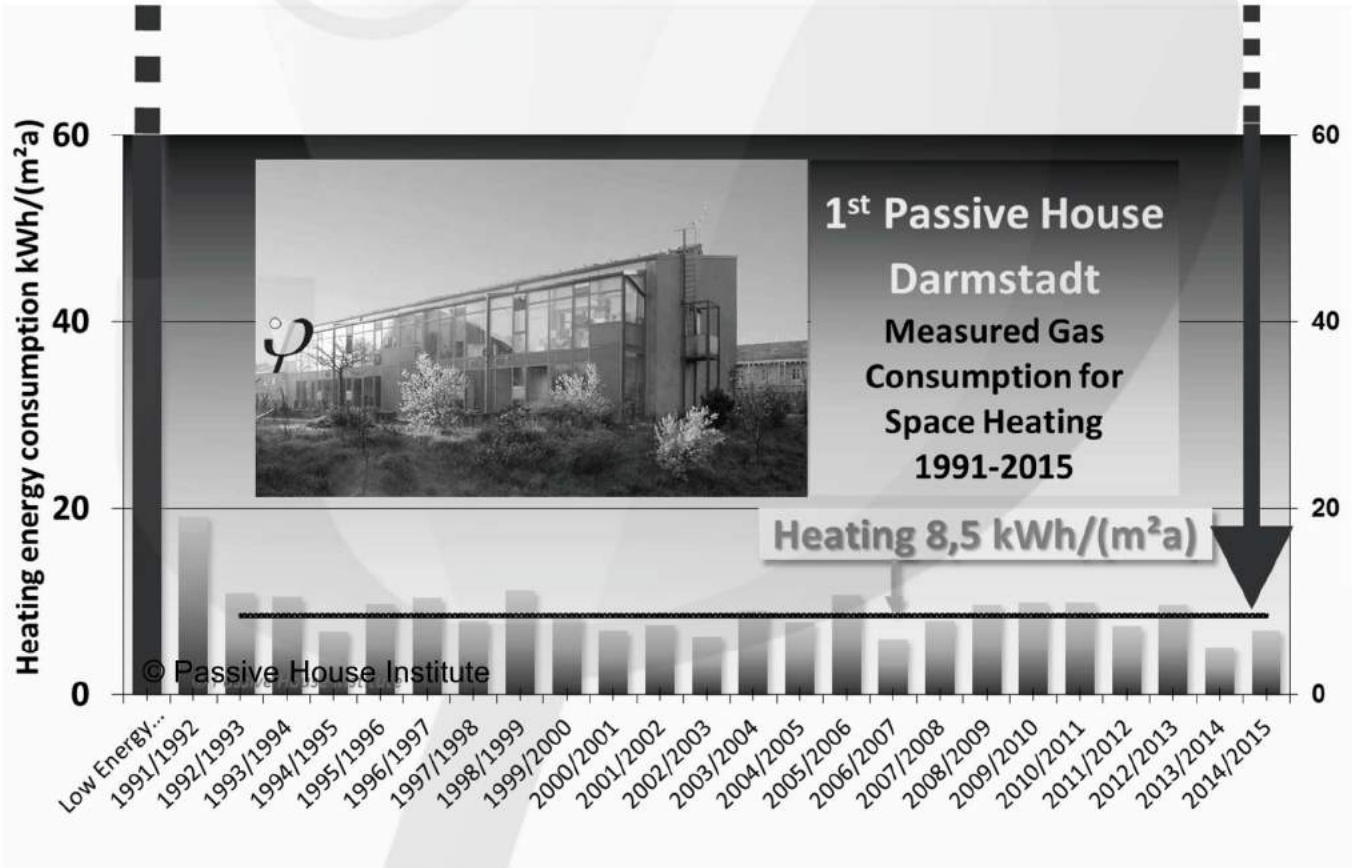
Jessica Grove-Smith
Passive House Institute, Germany
www.passivehouse.com

South Pacific Passive Hous Conference, #SPPHC17
Christchurch, 3-5 February 2017

25 years ago, completion of first Passivhaus

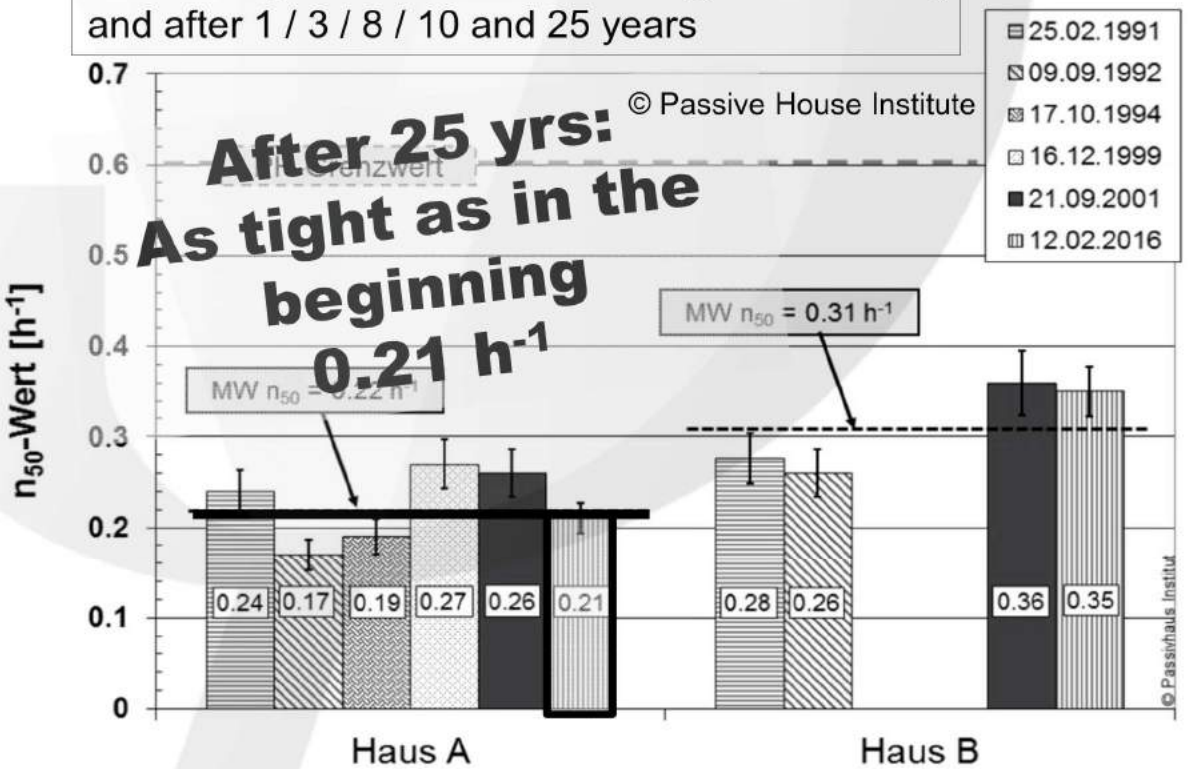


Still performing as predicted ¼ century later



Showcasing durable airtightness

Results of pressurisation test during construction, and after 1 / 3 / 8 / 10 and 25 years

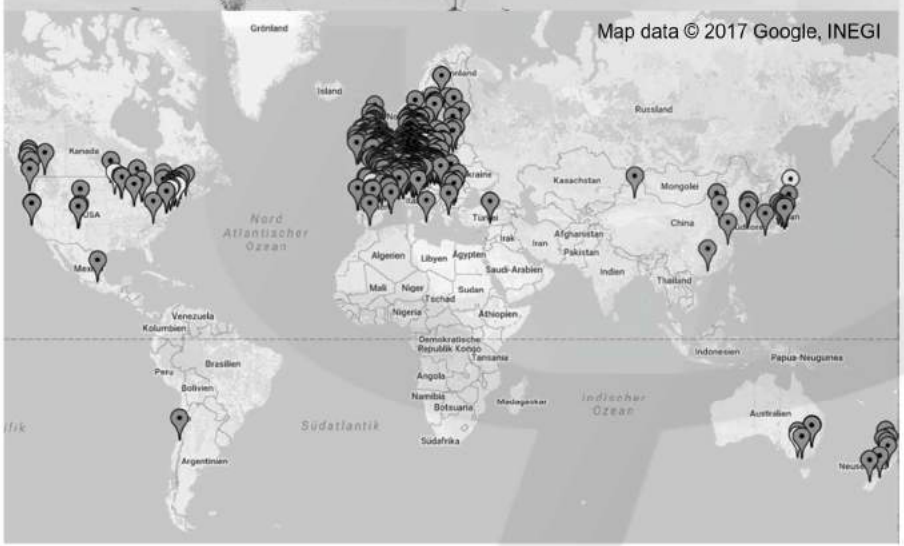


Documented detailed analysis: Ageing & performance of various building components

Photo: Peter Cook

www.stephaniebrittnacher.de

Certified Passive House buildings worldwide



www.passivehouse.com

www.stephaniebrittnacher.de

Offices

Darmstadt

Innsbruck

Research and development
Quality assurance
Building & Component certification
Training
International Passive House Conference

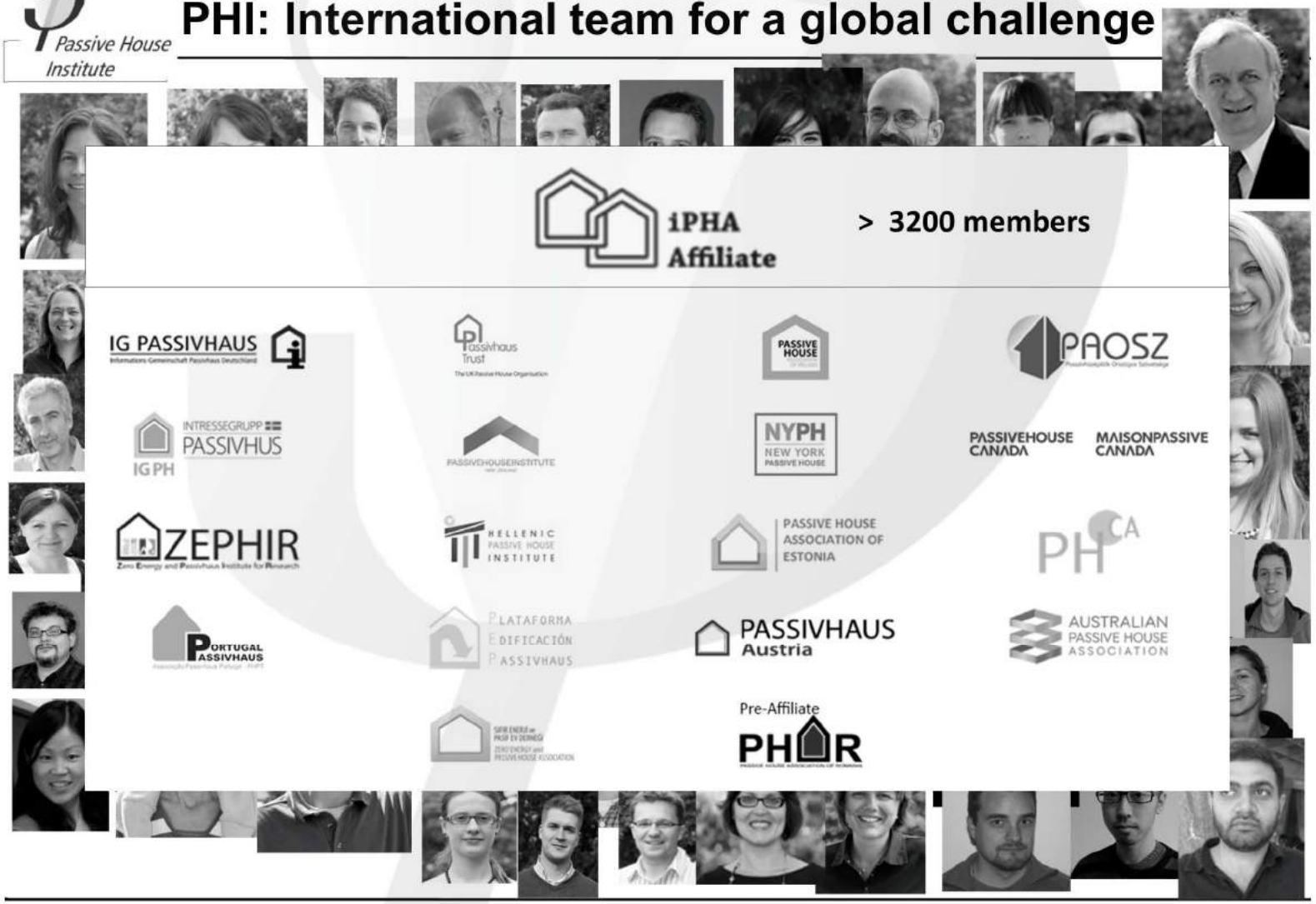
www.passivehouse.com

Network

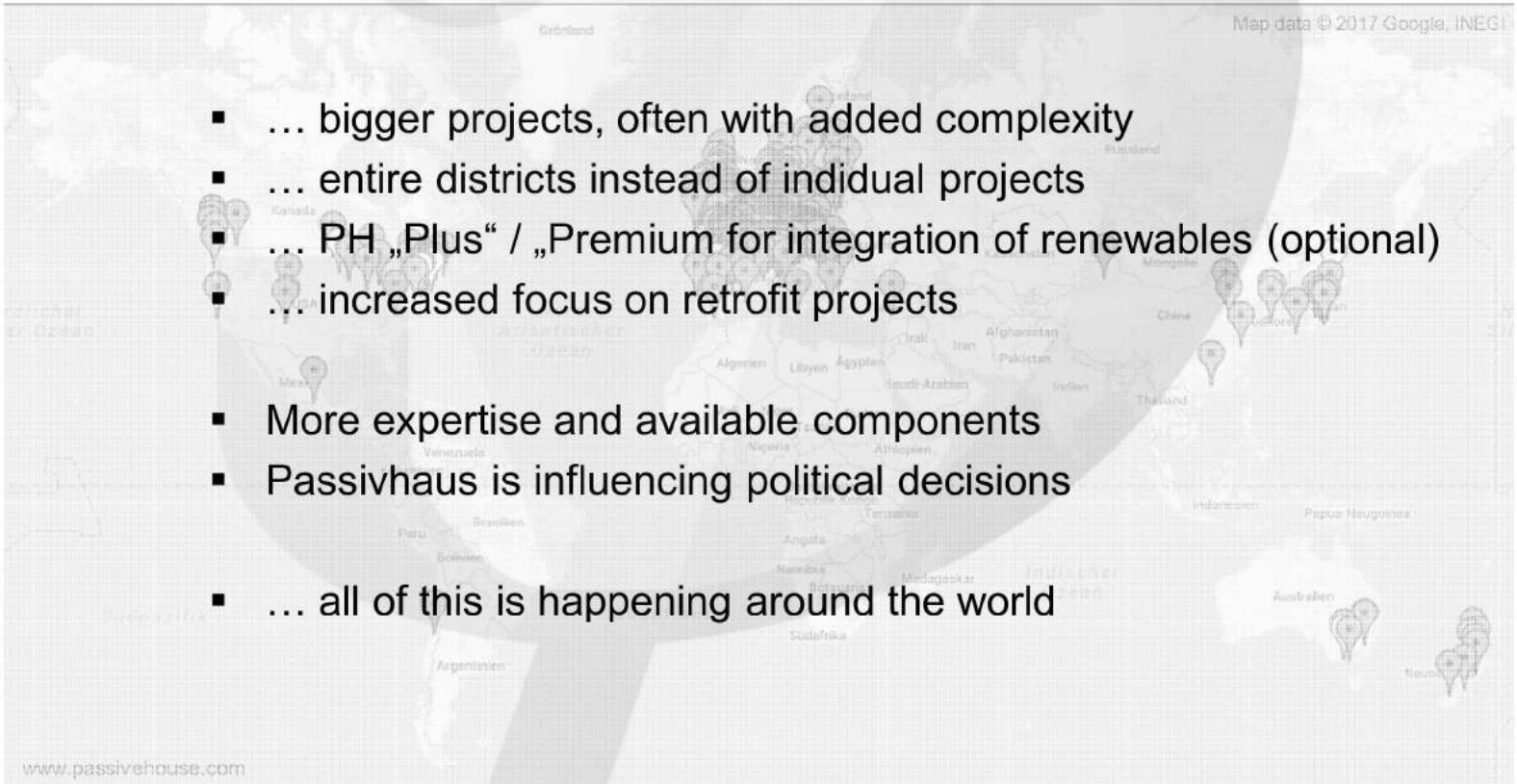
International Passive House network
Passive House promotion &
knowledge transfer e.g. International
Passive House Days, Passipedia,
Forum, Newsletter etc.

www.passivehouse-international.org

PHI: International team for a global challenge



Passive House trends 25 years on:



- … bigger projects, often with added complexity
- … entire districts instead of indidual projects
- … PH „Plus“ / „Premium for integration of renewables (optional)
- … increased focus on retrofit projects

- More expertise and available components
- Passivhaus is influencing political decisions

- … all of this is happening around the world

Reaching new heights

Office building, 2012 in Vienna. TFA ~ 21.000 m²

ARGE Atelier Hayde Architekten & Architektur Maurer

High-rises in construction

New York: Cornell Tech

26 storeys

> 350 flats (students)

Bilbao, Spain:

21 & 28 storeys

> 360 flats (social housing)

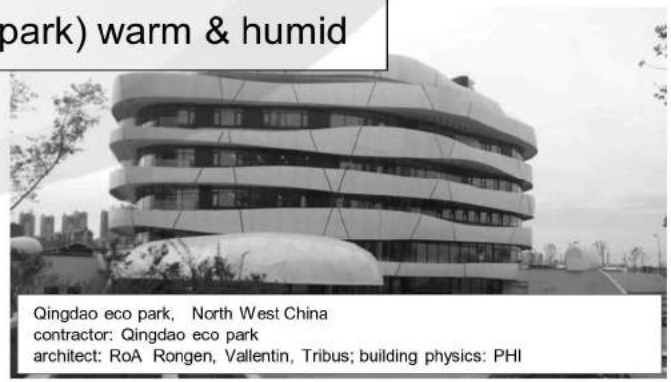
China: Challenging climate conditions

'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, (Landsea) hot & humid
- Urumqi, (Dacheng) cold & dry
- ZhuoZhou, (Hebei Xinhua) moderate
- Qingdao, (eco park) warm & humid

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

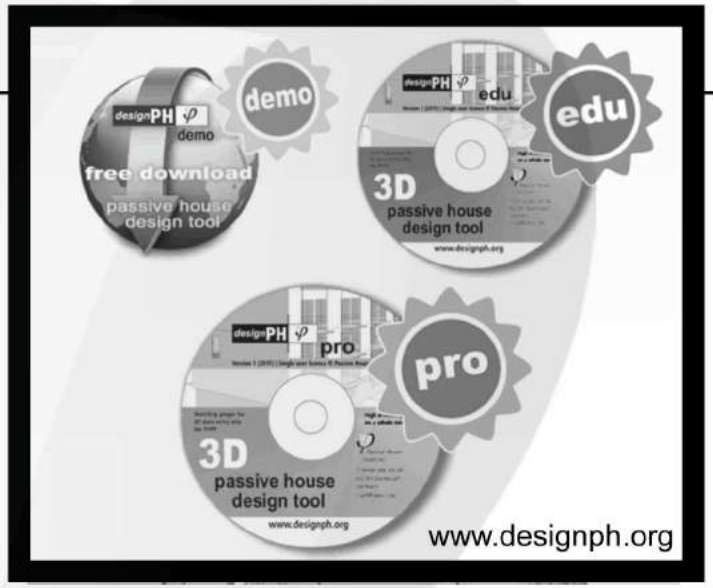


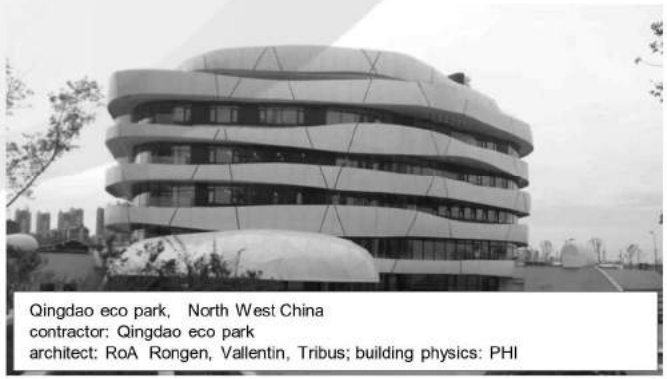
Qingdao eco park, North West China
contractor: Qingdao eco park
architect: RoA Rongen, Vallentin, Tribus; building physics: PHI

Passive House Institute

PHPP

designPH





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

PH districts & regions

www.passreg.eu

www.passreg.eu
"Bahnstadt", Heidelberg, Germany © City of Heidelberg, photo: Kay Sommer

Monitoring PH-Settlement Bahnstadt Heidelberg

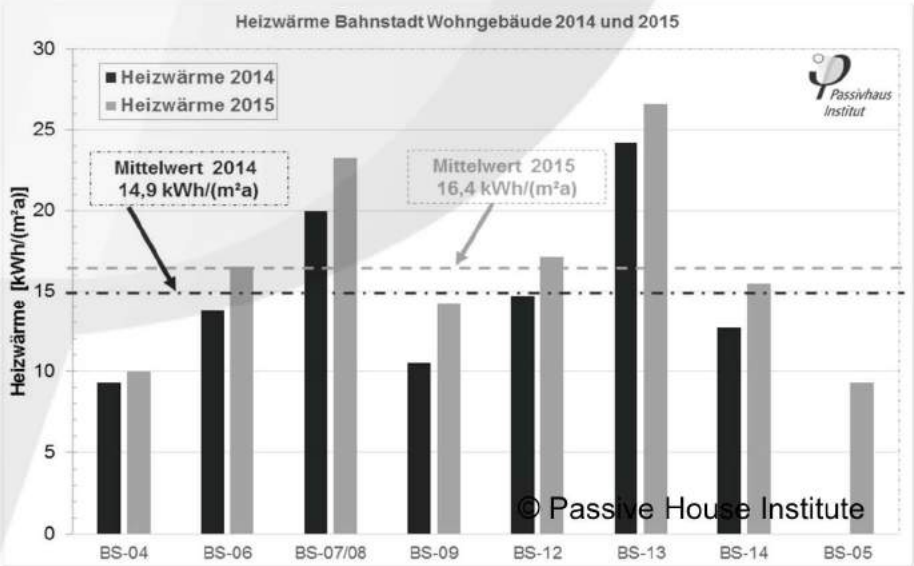
PHPP

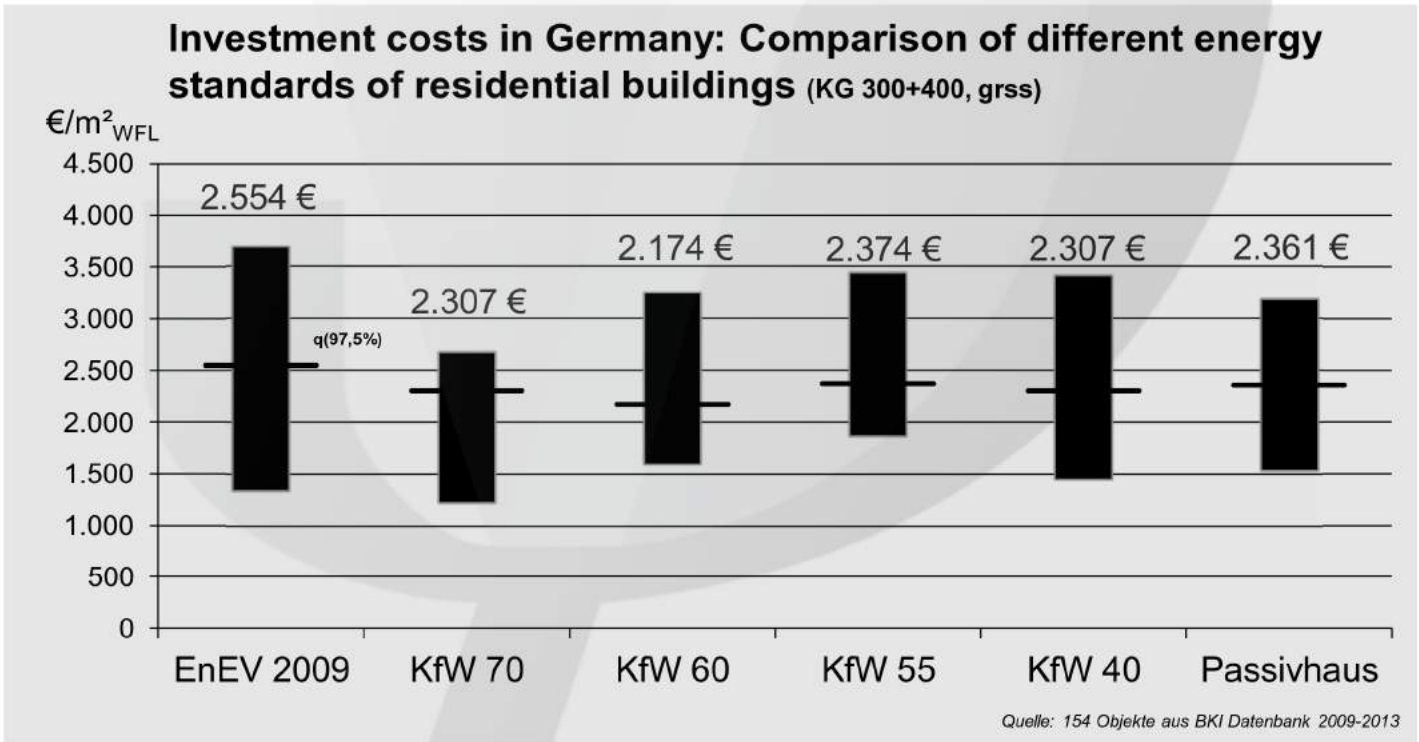
Monitoring:
~ 90 000 m²
~ 1 400 flats

Heating consumption

2014: 14.9 kWh/(m²a)
2015: 16.4 kWh/(m²a)

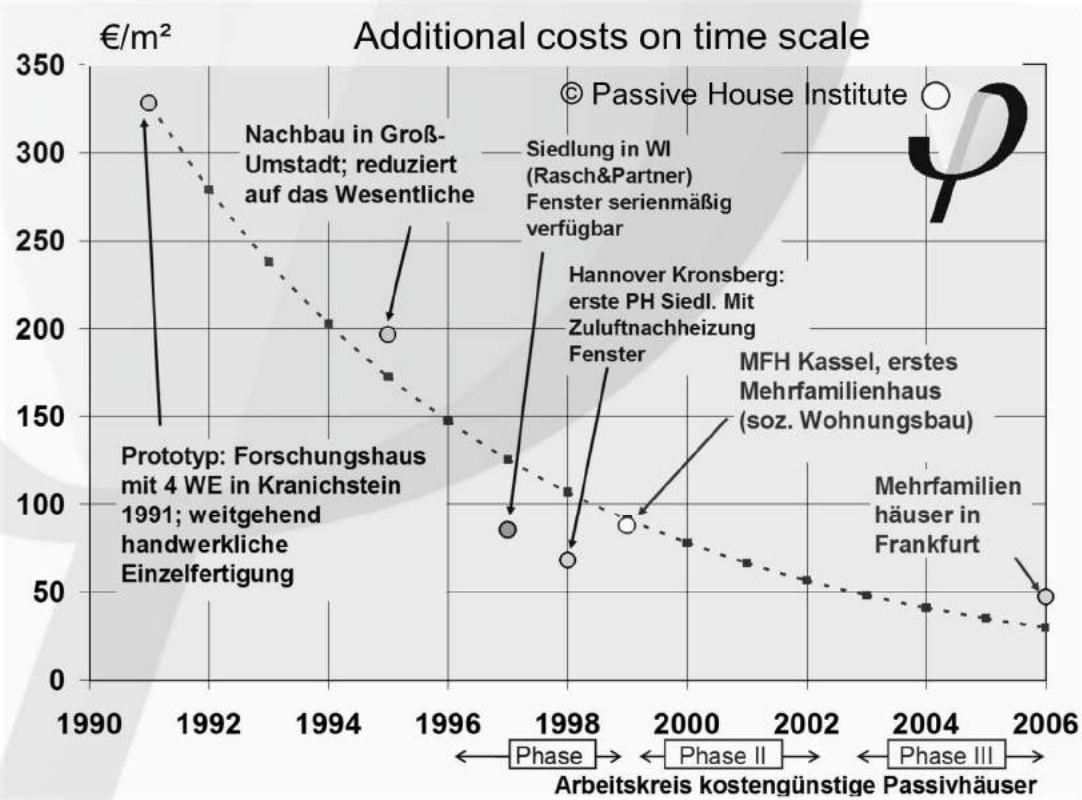
Success due to good quality assurance process





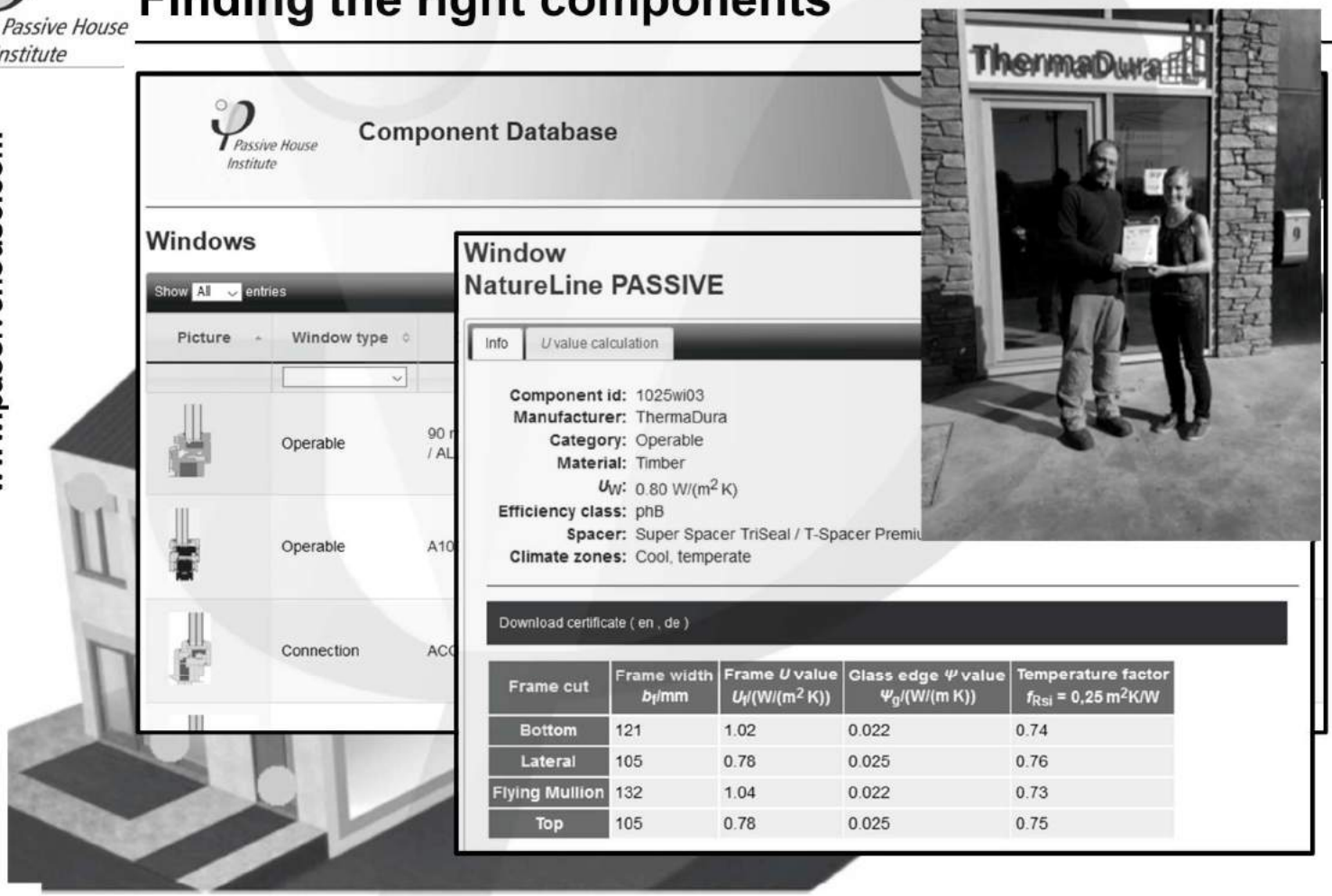
Source: Ralf Bermich, City of Heidelberg, 19th International Passive House Conference 2015

Effects of the learning curve & component availability



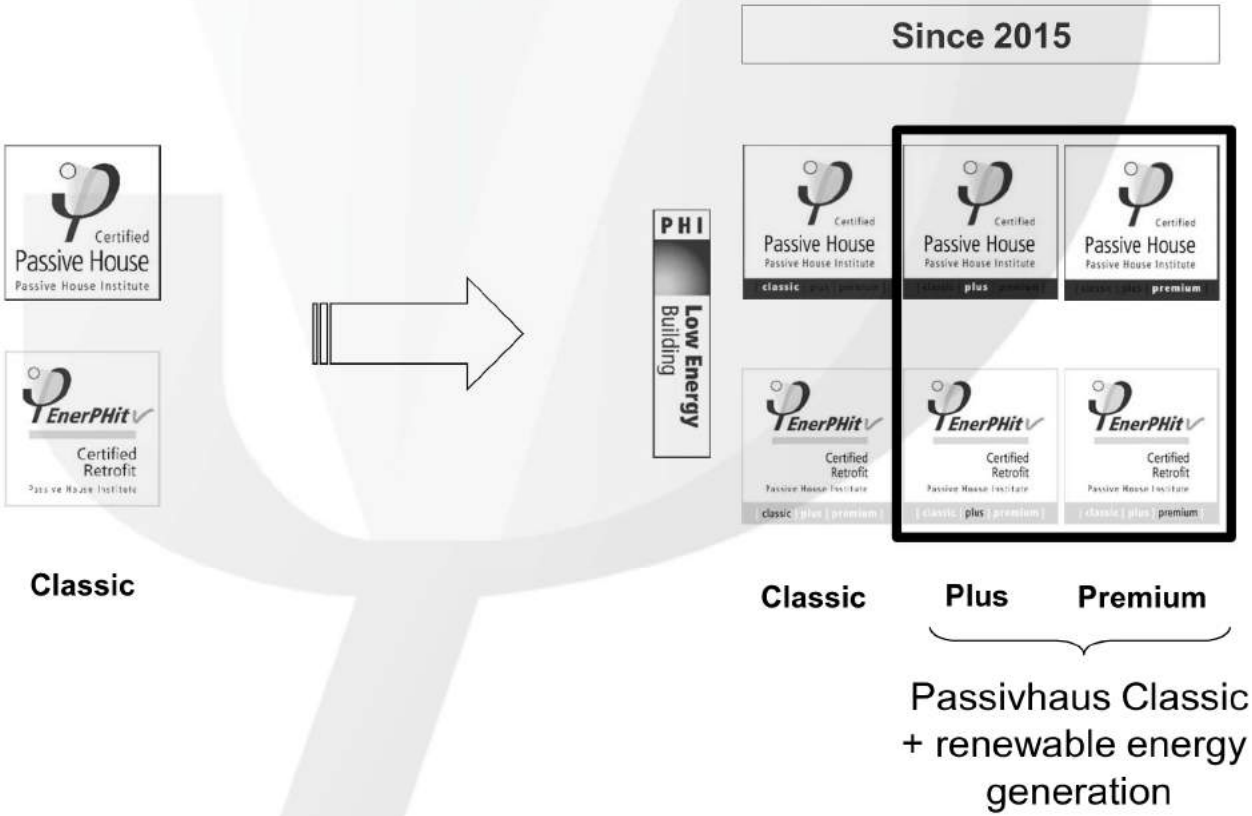
Finding the right components

www.passivehouse.com



Frame cut	Frame width b_f/mm	Frame U value U_f/(W/(m² K))	Class edge Ψ value Ψ_g/(W/(m K))	Temperature factor f_{Rsi} = 0,25 m²K/W
Bottom	121	1.02	0.022	0.74
Lateral	105	0.78	0.025	0.76
Flying Mullion	132	1.04	0.022	0.73
Top	105	0.78	0.025	0.75

Two years since introduction of the PH classes



Target buildings:

- small houses in shaded or cold locations
- near misses (e.g. airtightness target missed, wrong windows installed)
- countries with limited availability of Passive House components

Requirements:

- heating demand: PH requirements + **15 kWh/(m²a)**
- cooling demand: PH requirements + **15 kWh/(m²a)**
- PER demand: PH requirements + **15 kWh/(m²a)**
- airtightness: $n_{50} \leq 1.0$ ACH
- Renewable energy generation: no requirements

Verification and certification similar to Passive House using PHPP

Passive House & Renewables

The goal:

- Efficiency + renewables to reduce carbon footprint of buildings.

Keep in mind:

- RE use is limited – it *matters* how much is needed.
- Time profiles supply / demand don't match up, storage losses need to be taken into account.

PER approach (Passivhaus Classic, Plus & Premium)

- Optimise system as a whole i.e. buildings in the context of RES.
  → Sustainable use of regional RE resources
  independent of supply structure or political decisions

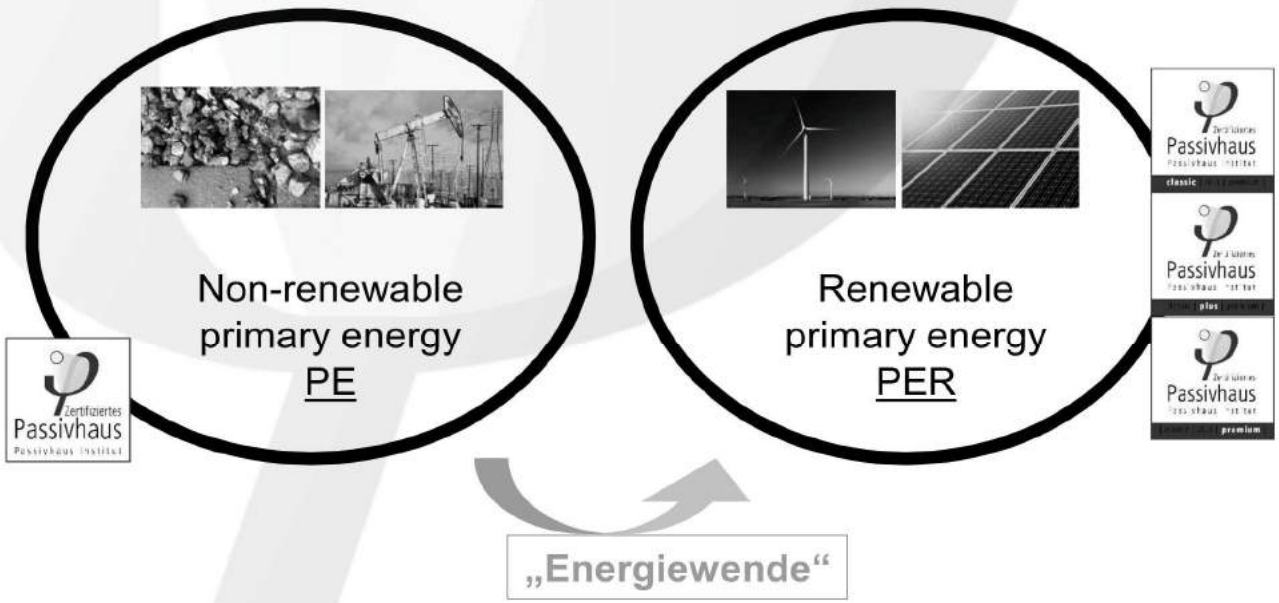
Passive House Classes

(1) Functional definition, performance based*

→ Limited useful energy demand
heating, cooling ≤ 15 kWh/m²$_{TFA}$ a)

→ Comfort & building physics
ventilation, airtightness, temperature & humidity conditions…

(2) Total efficiency / climate impact



*Further information: Passive House criteria on www.passivehouse.com

PER encourages future-ready energy concepts

Reducing the *renewable* source energy demand

- Efficiency measures for **space heating** have the biggest impact (low RE availability during winter!)
- **Electrical heating** becomes more favourable, especially in combination with heat pump systems.
- **Biomass** only encouraged to a limited extent. (extremely valuable, competitive & limited resource !)
- Moderate use of gas and other **fossil fuels** important

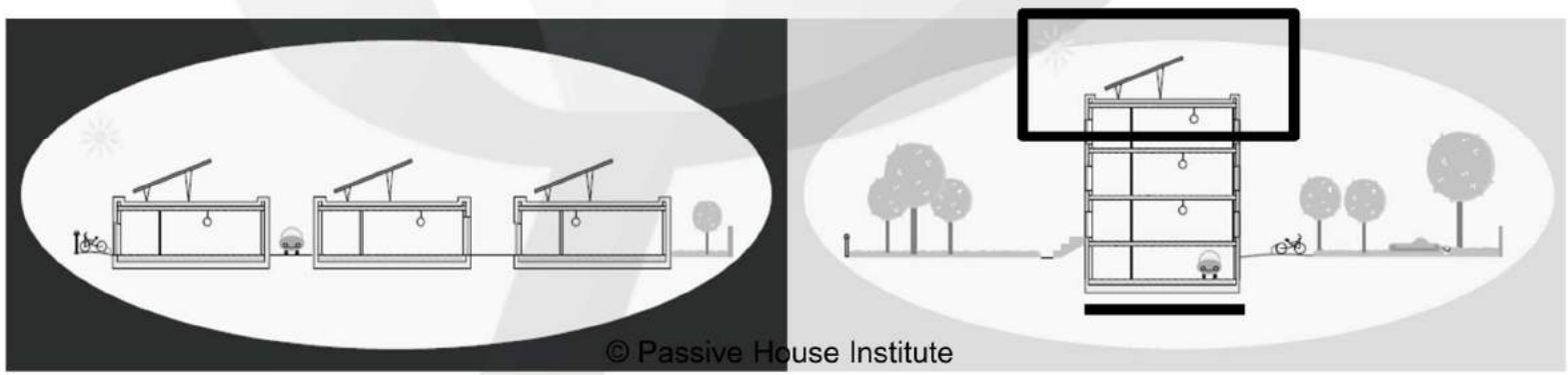
Passive House and Renewables

- Net-zero / plus energy often misleading !!
  - *Multistory buildings are discriminated despite their advantages*
  - *Efficiency must come first*

- Passive House approach:

  Take the building's footprint area as a reference for energy production.

  Take off-site production into account.



Passive House Classes

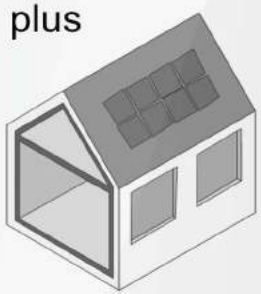
Requirement: Low useful energy demand → heating ≤ 15 kWh/(m²a)

classic

Certified Passive House – Passive House Institute – classic | plus | premium

EnerPHit Certified Retrofit – Passive House Institute – classic | plus | premium

plus



Certified Passive House – Passive House Institute – classic | plus | premium

EnerPHit Certified Retrofit – Passive House Institute – classic | plus | premium

premium

Certified Passive House – Passive House Institute – classic | plus | premium

EnerPHit Certified Retrofit – Passive House Institute – classic | plus | premium

+ higher overall efficiency (PER)
+ renewable energy production

Passive House Institute

premium

120

Energy generation
[$kWh_{PER}/(m^2_{projected}*a)$]

Zertifiziertes Passivhaus
Passivhaus Institut
premium

Zertifiziertes Passivhaus
Passivhaus Institut
plus

Energy demand
[$kWh_{PER}/(m^2_{TFA}*a)$]

Zertifiziertes Passivhaus
Passivhaus Institut
classic

PHINZ @PHI_NZ · 3. März

This could soon be New Zealand's first #PassiveHouse Plus #SPPHC17

4 5

Source: https://twitter.com/PHI_NZ/status/837528196266385410

What about the building stock?

Photo: Passive House Institute

EnerPHit = Retrofit with Passive House components

- Energy savings
- Economics
- Health & comfort
- Building physics
- "Beauty"

EnerPHit Certified Retrofit Passive House Institute

EnerPHit = Retrofit with Passive House components

Path 1) Components must fulfill minimum quality requirements

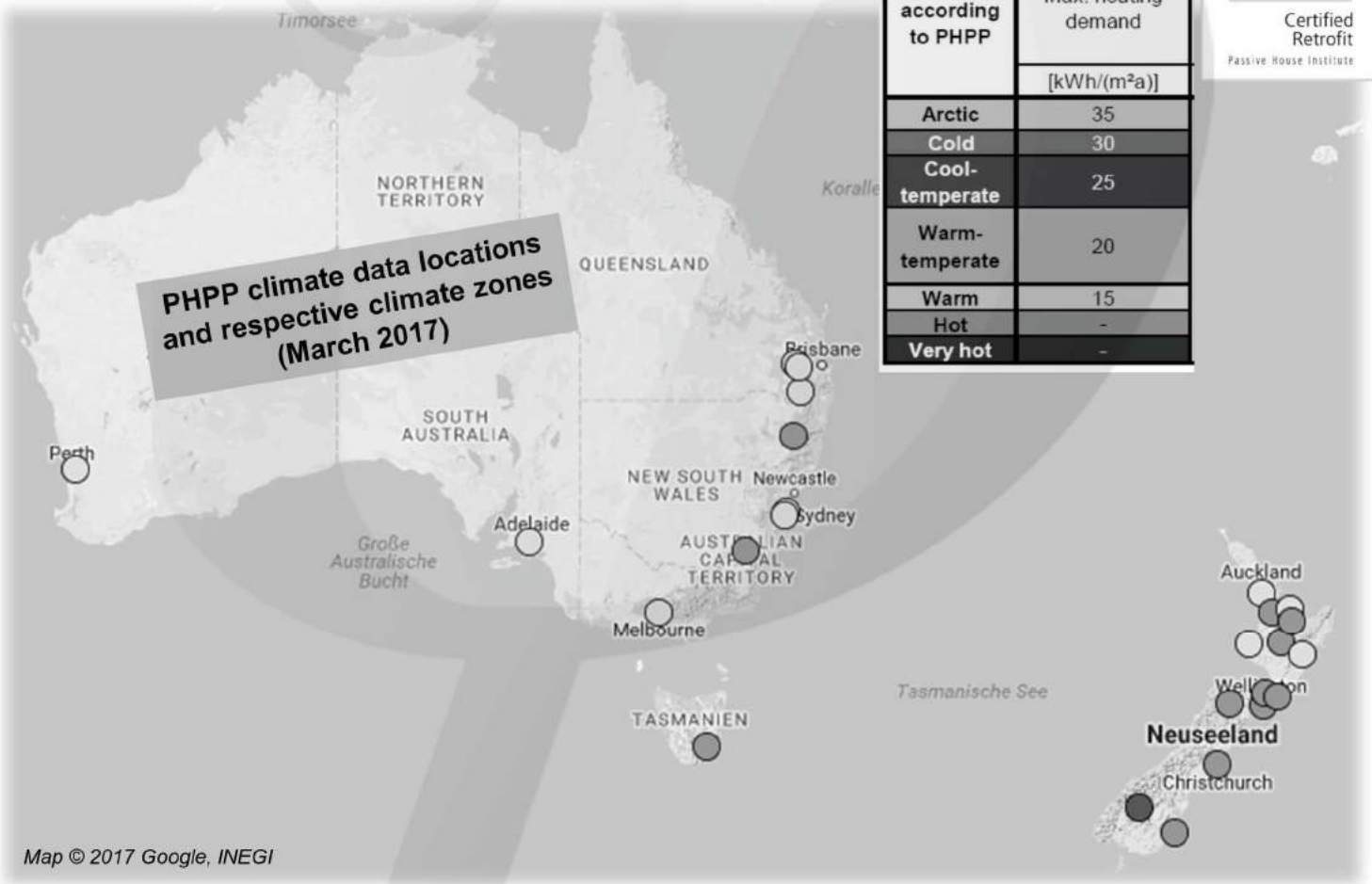
Path 2) Energy demand below threshold (heating + cooling)

International criteria:
Targets suitable for the local climate conditions
Full criteria: www.passivehouse.com

Passive House Institute

EnerPHit Certified Retrofit Passive House Institute

Climate zone according to PHPP	Heating: Max. heating demand [kWh/(m²a)]
Arctic	35
Cold	30
Cool-temperate	25
Warm-temperate	20
Warm	15
Hot	-
Very hot	-



Passive House Institute

Building:	EnerPHit pilot project
Street:	
Postcode/City:	Wellington
Province/Country:	NZ-New Zealand
Building type:	
Climate data set:	NZ0002a-Wellington
Climate zone:	4: Warm-temperate — Altitude of location: 79 m

Verification of EnerPHit criteria for building components is based on climate zone requirements

EnerPHit (retrofit): Component characteristics

Building envelope to exterior air[1] (U-value)	W/(m²K)	0.29	≤	0.3
Building envelope to ground[1] (U-value)	W/(m²K)	0.38	≤	0.49
Wall w/int. insulation in contact w/exterior air (U-value)	W/(m²K)	-	≤	0.5
Wall w/interior insulation in contact w/ground (U-value)	W/(m²K)	-	≤	0.92
Flat roof (SRI)	-	-	≥	-
Inclined and vertical external surface (SRI)	-	33	≥	-
Windows/Entrance doors ($U_{W/D,installed}$)	W/(m²K)	0.78	≤	1.05
Windows ($U_{W,installed}$)	W/(m²K)	-	≤	1.10
Windows ($U_{W,installed}$)	W/(m²K)	-	≤	1.20
Glazing (g-value)	-	0.50	≥	-
Glazing/sun protection (max. solar load)	kWh/(m²a)	100	≤	-
Ventilation (effective heat recovery efficiency)	%	82	≥	75
Ventilation (humidity recovery efficiency)	%		≥	-

Climate zone according to PHPP	Opaque envelope[1] against... ...ground: Insulation	...ambient air: Exterior insulation	...ambient air: Interior insulation[2]	...ambient air: Exterior paint[3]	Windows (Overall[4]: Max. heat transfer coefficient ($U_{D/W,installed}$)
	Max. heat transfer coefficient (U-value)			Cool colours	Max. heat transfer coefficient ($U_{D/W,installed}$)
	[W/(m²K)]			-	[W/(m²K)]
Arctic	Determined in PHPP from project specific heating	0.09	0.25	-	0.45 0.50 0.60
Cold		0.12	0.30	-	0.65 0.70 0.80
Cool-temperate		0.15	0.35	-	0.85 1.00 1.10
Warm-temperate		0.30	0.50	-	1.05 1.10 1.20
Warm		0.50	0.75	-	1.25 1.30 1.40

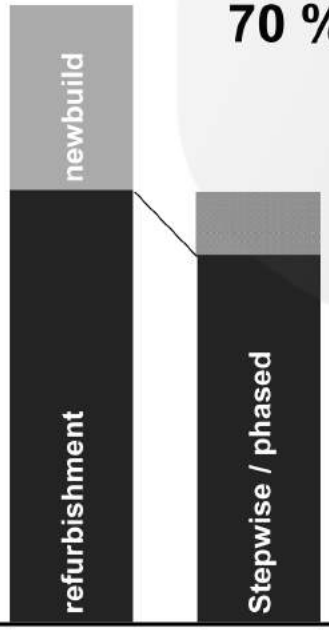
Passive House Institute

In one go …?
OR in phases ?

EnerPHit
Certified Retrofit
Passive House Institute

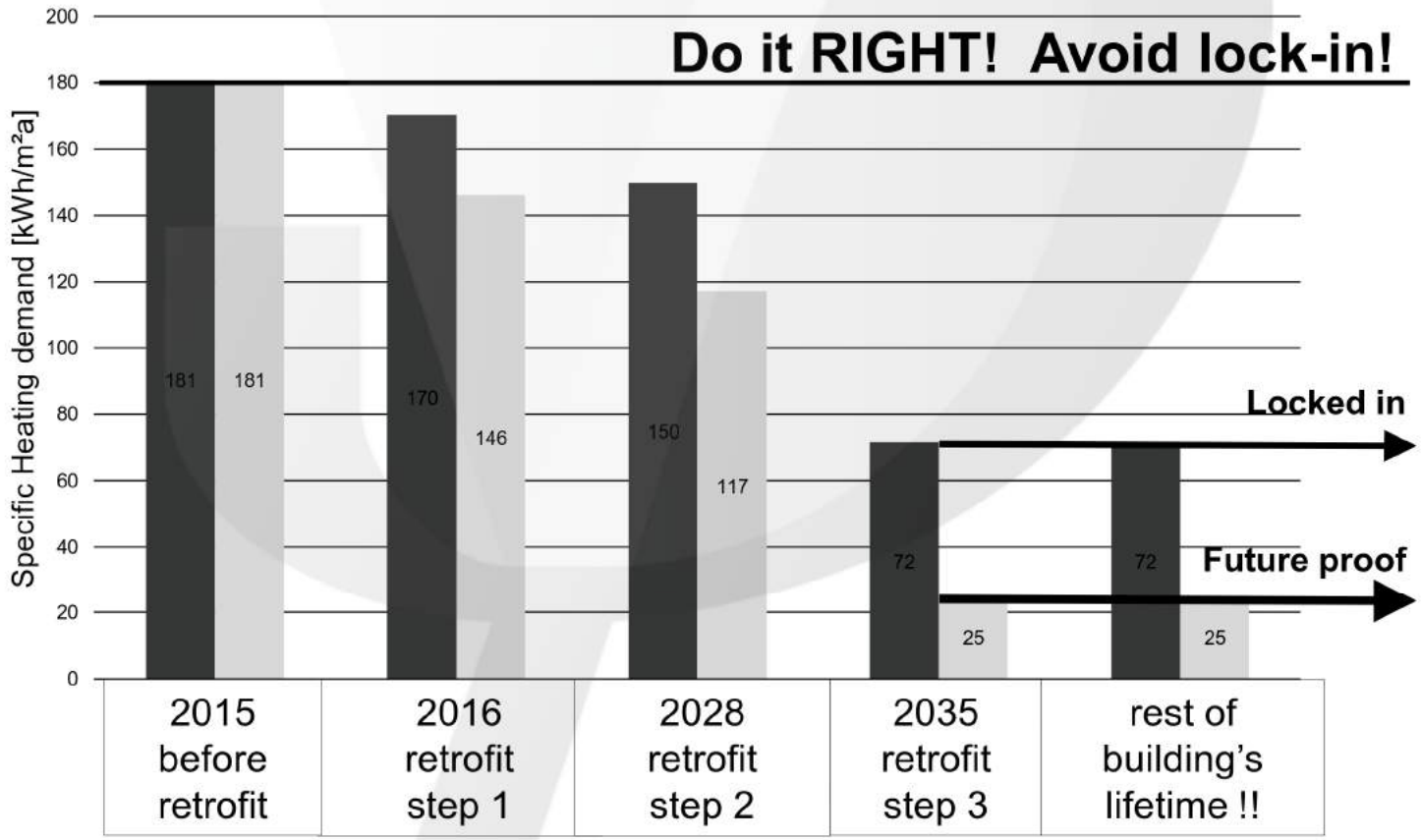
2014, German Federal Institute for Research of Building, Urban Affairs and Spatial Development

- **Out of all construction sector investments 70 % go into refurbishments / 30% newbuild**



- **Of these 85% were phased retrofit measures**

Plan your retrofit strategy !!



20 projects – 11 completed

Total of TFA to be retrofitted : 40 000 m²

Component development for retrofit solutions

EuroPHit

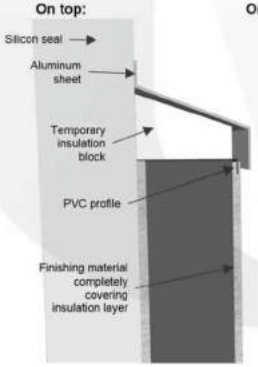
www.europhit.eu

Window installation

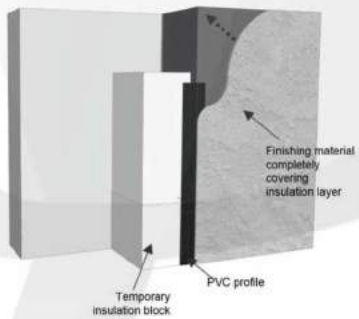
Current situation:

Possible solution:

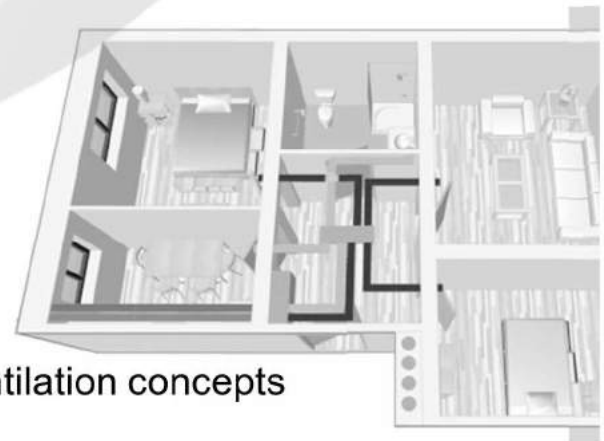
On top:



On the side:

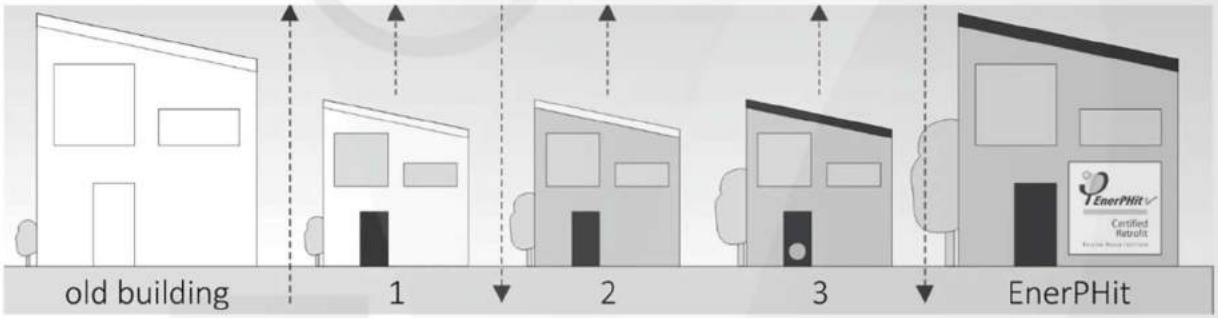


EIFS detailing



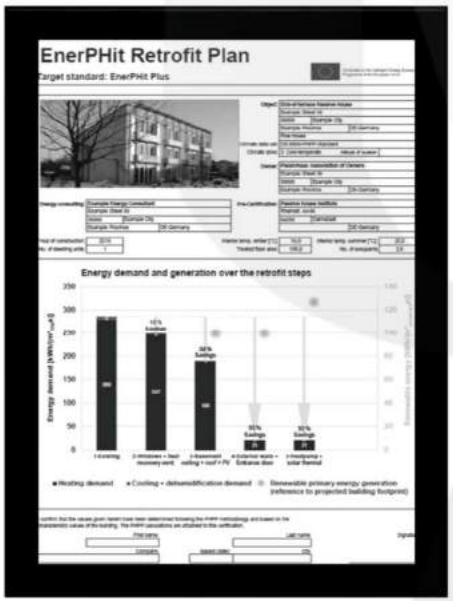
Ventilation concepts

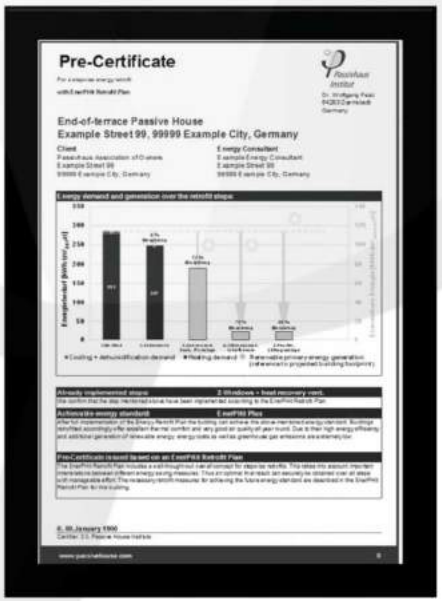
Certification scheme for stepwise retrofit



PHPP

version 9.6





- Clearly defined retrofit steps (order & energy savings)
- Interdependencies between measures considered

→ **No lock-in !!**

1) Assess building & plan your retrofit strategy

Scheduler

Source file: 'EuroPHit_SBS_Windows_2_EnerPHit_PHPP.xlsm' (PHPP version: 9.3)

EnerPHit Retrofit Plan: End-of-terrace Passive House, Example City, DE-Germany

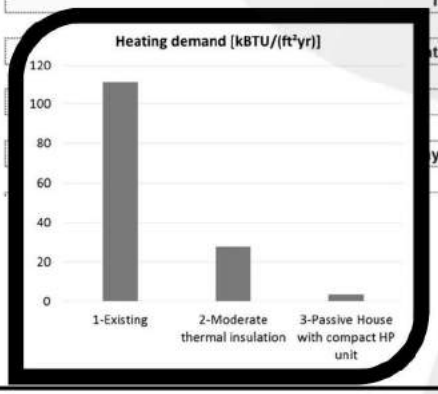
Retrofit steps:														1	2		3			4		5			
Assemblies	Last renewal	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2016	2017	2020	2022	2025	2030	2032	2035	2037	2040	2045	2050
Render facade	1966																			X					
Facade decoration	1966																			X					
Balconies/Loggias	1966																			X					
Exterior door	1987																			X					
Pitched roof covering	1966																X								
Flat roof																									
Roof weatherings	1987																X								
Windows	1966														X										
Blinds / sun screens	1966														X										
Basement ceiling	2022																X								
Boiler	2015																					X			
Ventilation	2017														X										
Solar thermal system	2035																					X			

- Good condition
- Slightly worn out, small repairs necessary
- Quite worn out, larger repairs necessary
- End of service life
- Time of refurbishment (actual/recommended)

*based on: “Aging characteristics of building components and maintenance costs”, Professor P. Meyer

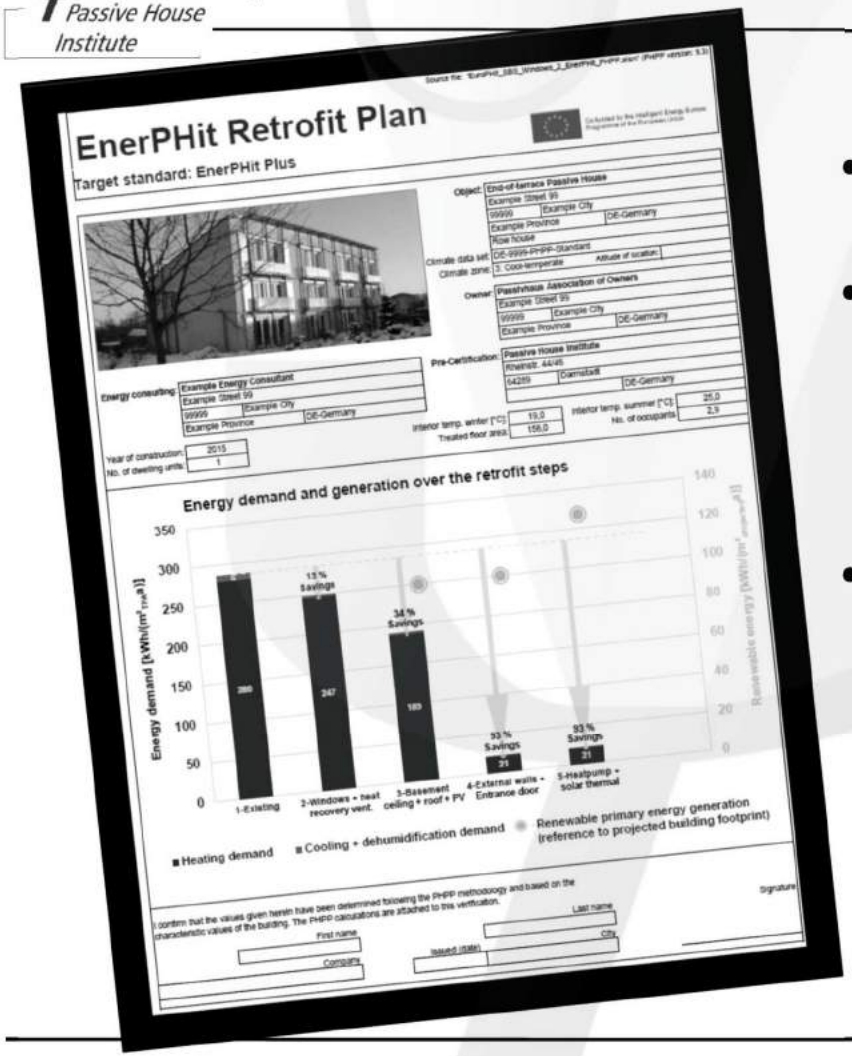
2) Model retrofit steps as PHPP variants

		Active					
	Select the active variant here >>>>>>>	4-Passive house natural gas	Existing	Moderate thermal insulation	Passive House with compact HP unit	Passive house natural gas	Passive House
Results	**Units**	4	1	2	3	4	
Heating demand	kBTU/(ft²yr)	**3.75**	111.8	27.8	3.7	3.7	
Heating load	BTU/(hr.ft²)	**3.03**	48.0	14.5	3.0	3.0	
Cooling & dehum. demand	kBTU/(ft²yr)						
Cooling load	BTU/(hr.ft²)						
Frequency of overheating (> 77 °F)	%	**0.6**	1.5	1.1	0.8	0.6	
PER demand	kBTU/(ft²yr)	**19.65**	292.9	61.6	9.9	19.7	
Passive House Premium?	yes / no	**no**	no	no	yes	no	
Final energy		-	-	-	-	-	
User determined results		-	-	-	-	-	
Input variables	**Units**	**Value**	**1**	**2**	**3**	**4**	
Building assembly layers	R-Value						
a Interior insulation layer	R per inch	5.15		3.61	5.15	5.15	
	in	3.149606299		1.77	3.15	3.15	
b tion layer external wall	R per inch	3.61		3.61	3.61	3.61	
	in	10.8		3.94	10.83	10.83	
c Insulation layer roof	R per inch	3.61	1.44	3.61	3.61	3.61	
	in	15.7	7.87	3.94	15.75	15.75	
d yer of basement ceiling	R per inch	3.61	1.44	3.61	3.61	3.61	
	in	9.8	1.97	1.97	9.84	9.84	



Parallel calculation of up to 100 variants

3) Link PHPP results to ERP



- Order & timing of retrofit steps
- Guidelines and clear documentation of interdependencies & intermediary stages
- Optional: Investment costs and cost effectiveness

4) Obtain EnerPHit Pre-Certification ☺

Pre-Certificate

For a stepwise energy retrofit
with EnerPHit Retrofit Plan

Passivhaus Institut
Dr. Wolfgang Feist
64283 Darmstadt
Germany

End-of-terrace Passive House
Example Street 99, 99999 Example City, Germany

Client
Passivhaus Association of Owners
Example Street 99
99999 Example City, Germany

Energy Consultant
Example Energy Consultant
Example Street 99
99999 Example City, Germany

Energy demand and generation over the retrofit steps:

Already implemented steps:	2-Windows + heat recovery vent.
Achievable energy standard:	EnerPHit Plus

We confirm that the step mentioned above have been implemented according to the EnerPHit Retrofit Plan.

After full implementation of the Energy Retrofit Plan the building can achieve the above-mentioned energy standard. Buildings retrofitted accordingly offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency and additional generation of renewable energy, energy costs as well as greenhouse gas emissions are extremely low.

Pre-Certificate is issued based on an EnerPHit Retrofit Plan

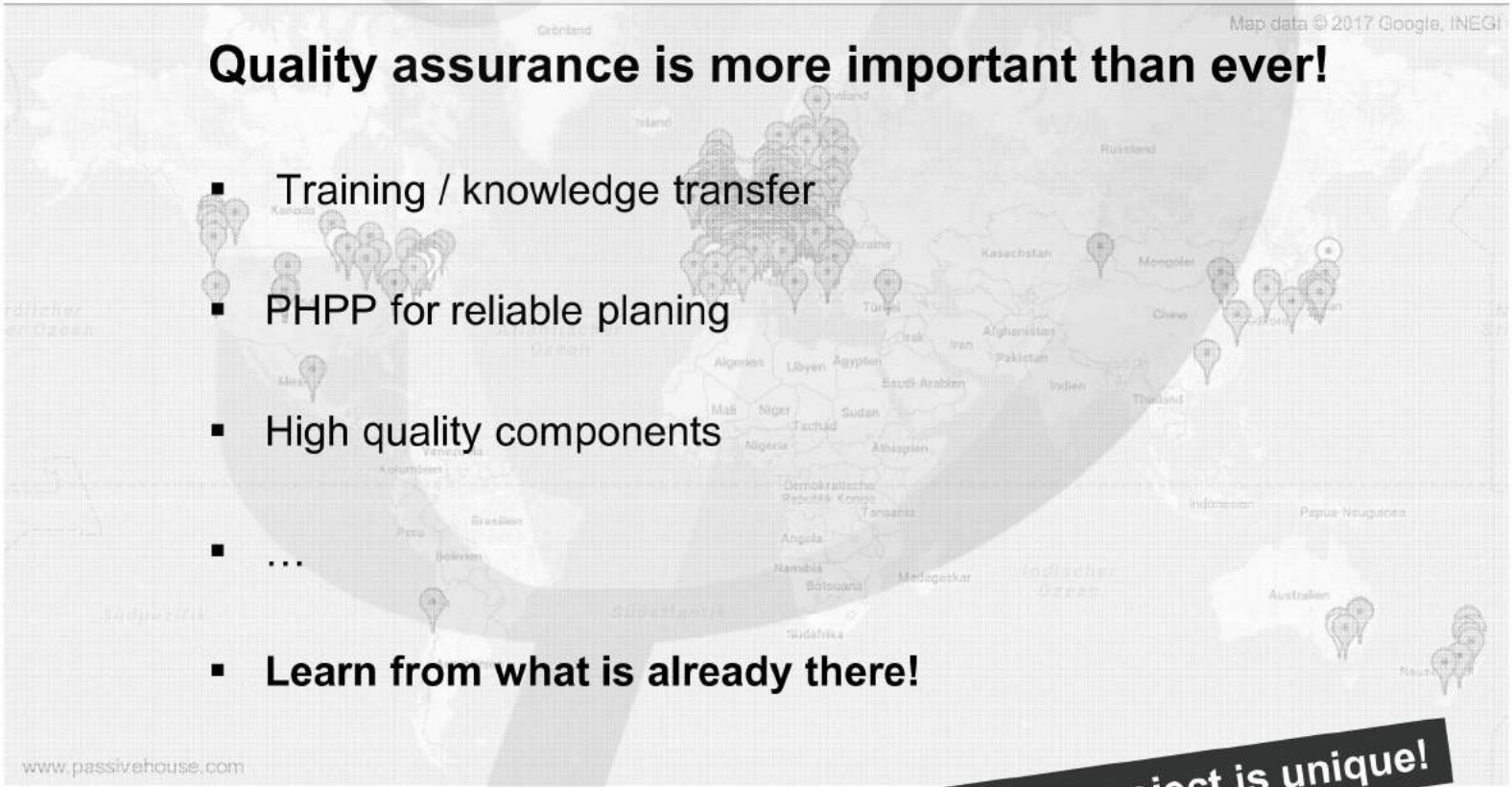
The EnerPHit Retrofit Plan includes a well-thought-out overall concept for stepwise retrofits. This takes into account important interrelations between different energy saving measures. Thus an optimal final result can securely be obtained over all steps with manageable effort. The necessary retrofit measures for achieving the future energy standard are described in the EnerPHit Retrofit Plan for this building.

0, 00.January 1900
Certifier: 0 0, Passive House Institute

www.passivehouse.com

EnerPHit
Certified Retrofit
Passive House Institute

Passive House 25 years on…



Quality assurance is more important than ever!

- Training / knowledge transfer
- PHPP for reliable planing
- High quality components
- …
- **Learn from what is already there!**

Every project is unique!

Passivhaus: 25 years on & step-by-step EnerPHit

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SPPHC17, Christchurch, 5th February 2017

www.passivehouseconference.org

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The present collection of slides was assembled for the following event:

South Pacific Passive Hous Conference, #SPPHC17
Christchurch, 3-5 February 2017