EuroPHit

Co-funded by the Intelligent Energy Europe Programme of the European Union

EuroPHit
"Retrofitting for the energy revolution, one step at a time"

Technical ideas out of the Passive House Development

IEA Annex 61
"Development and Demonstration of Financial and Technical Concepts for Deep Energy Retrofits for Government/Public Buildings and Building Clusters"

Concepts for financing and calculation of economic key values

Speaker: Berthold Kaufmann, Passivhaus Institut, Darmstadt

Can you spot the retroffited house on this street?

Architect: Julie Torres Moskovitz the 'Tighthouse' project: 23 Park Place, Brooklyn, NYC

Thermographic image – Sam McAfee, SG.Build

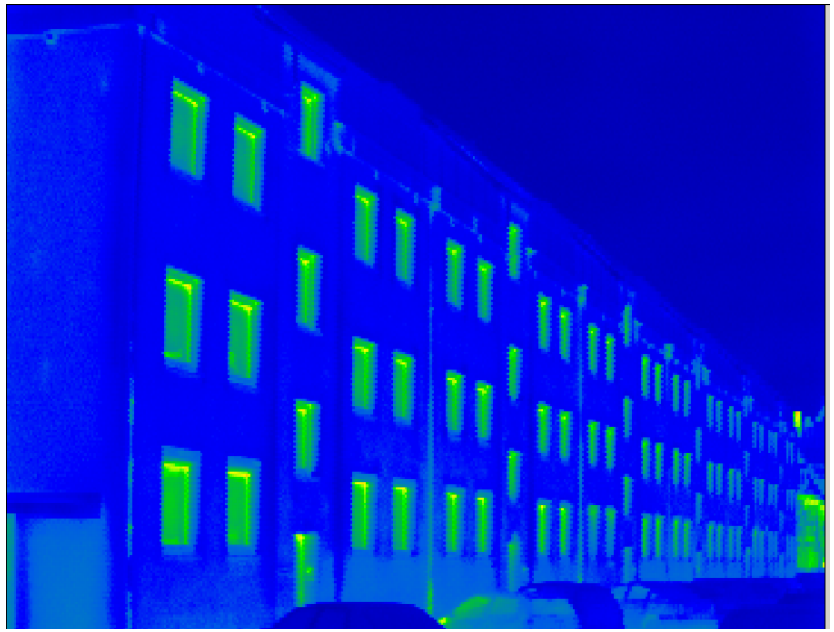
Source: Tomás O'Leary tomas@passivehouseacademy.com

Pilot project: renovation with PH components – Tevesstrasse Frankfurt

290
kWh/m²a

-95%

17
kWh/m²a



Introduction: Ideas out of the Passive House Development

recently high energy prices…

- economic numbers clearly show what to do ('deep renovation')

why do so few actors really do?

possible approaches how to solve this dilemma:

- which actions (renovation) give what savings?
  detailed energy balance calculation needed
- important question (technical): do buildings work as intended???
  Quality Control is crucial
  make good quality visible by labelling

- important question (economical): is there a budget????
  economic balance evaluation is crucial
  economic evaluation (total lifecycle) of energy efficiency actions

- what do energy efficient components really cost in detail?
  many decision makers do not know about that!

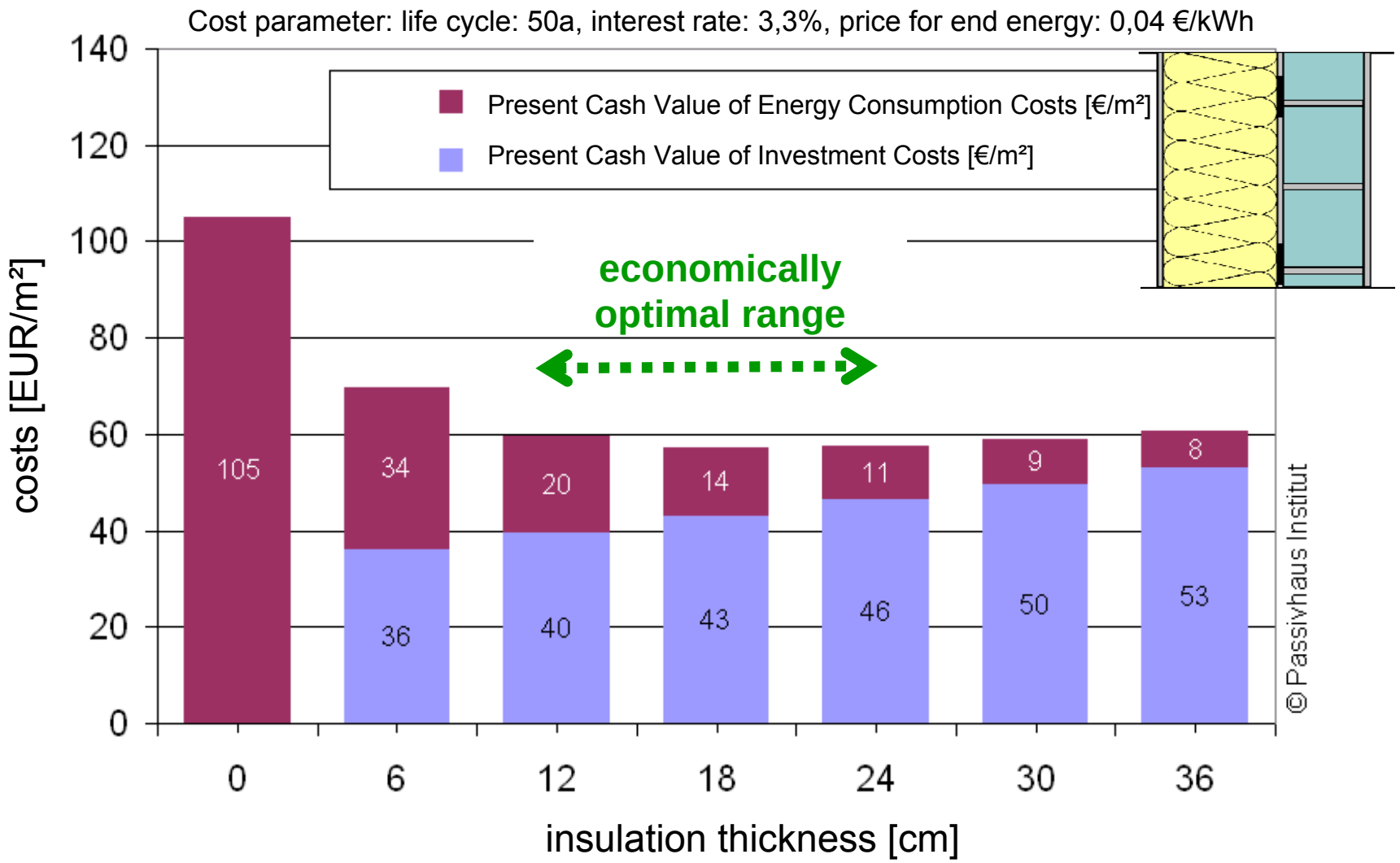
What thermal insulation layer is economically reasonable?

... What is the optimal ratio between energy savings and investment costs?

... what ist the cost of new paint for the building?

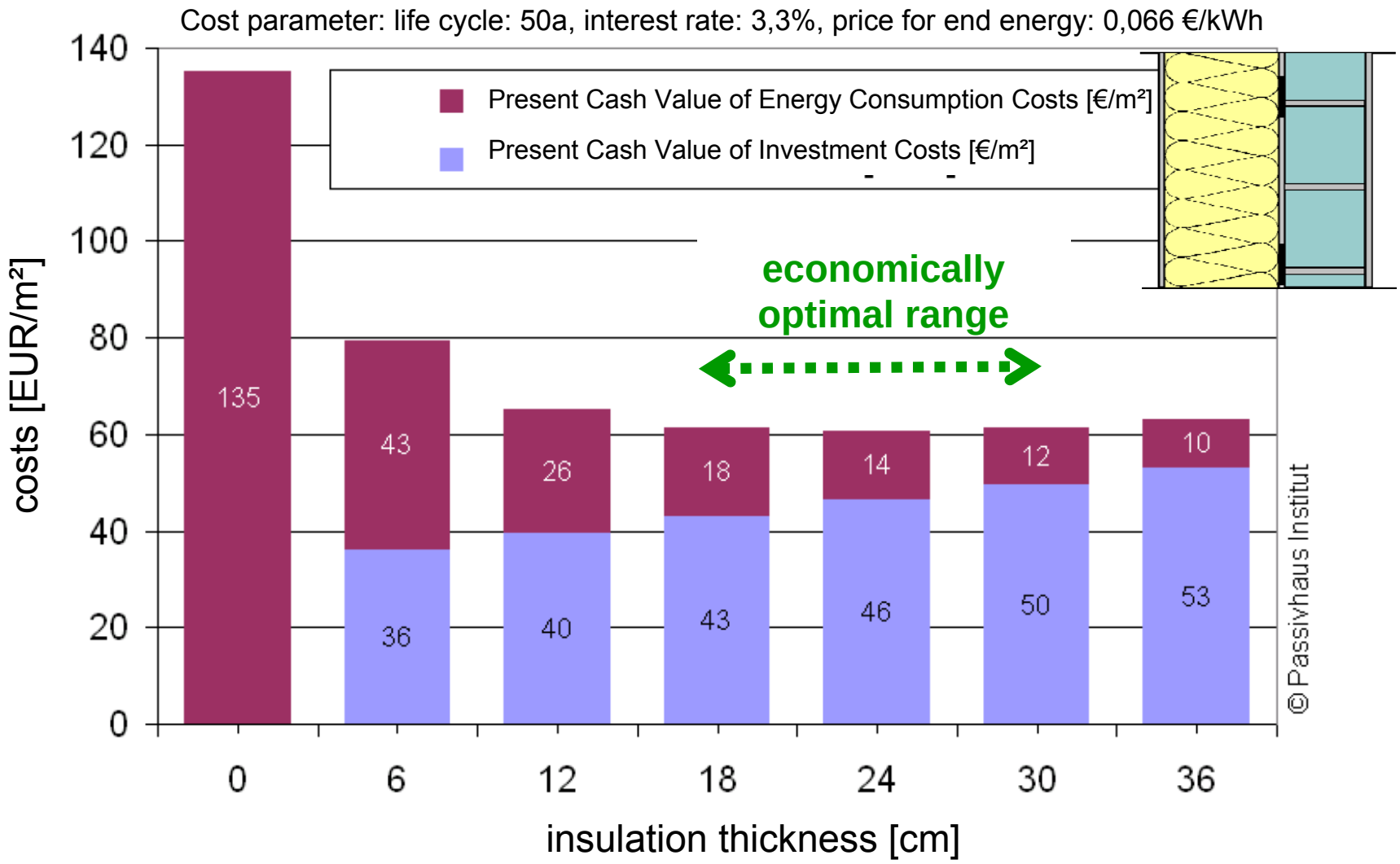
Total cost analysis of thermal insulation layer (ETHICS)

- boundary conditions as in the past (before 2004)



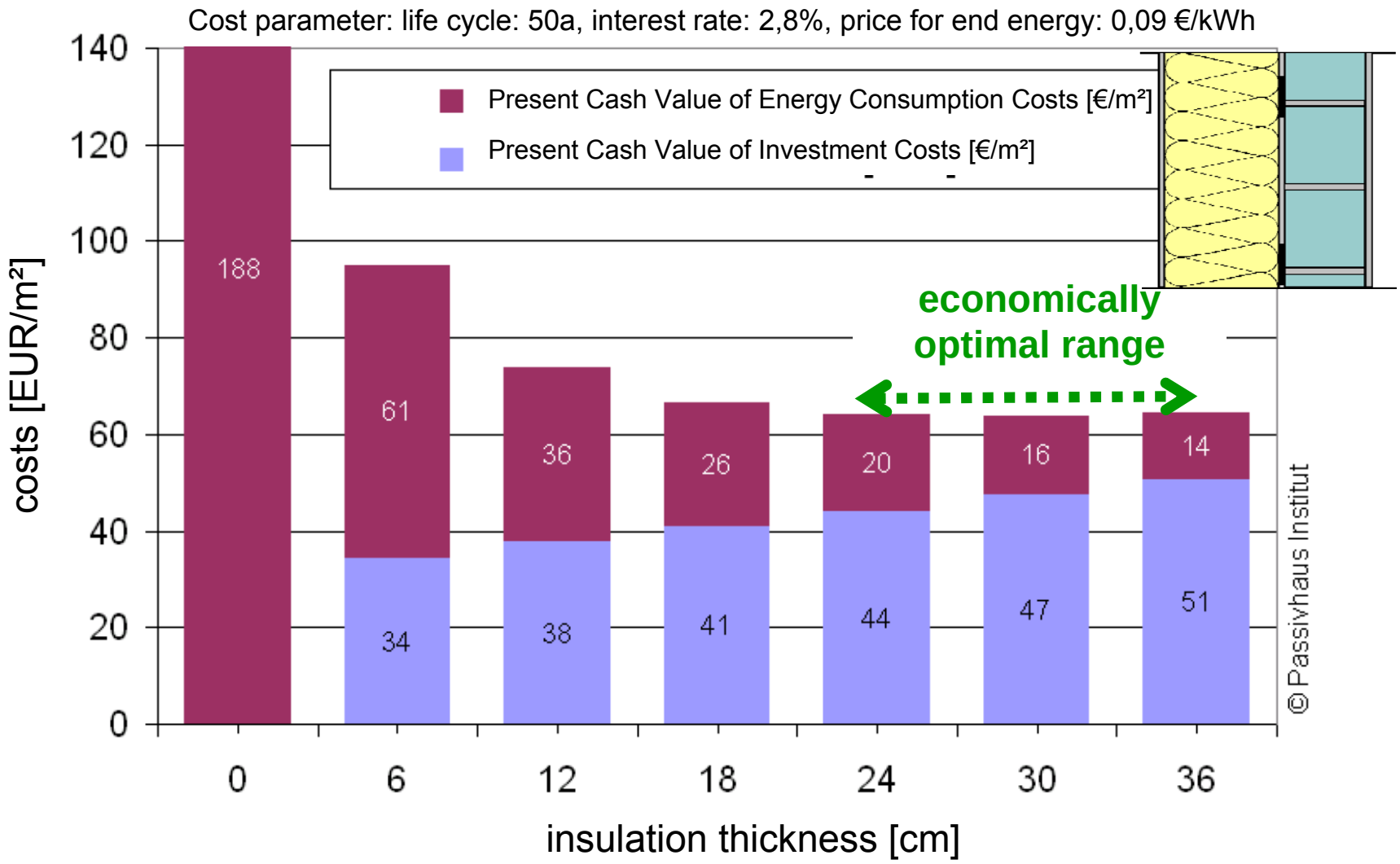
Total cost analysis of thermal insulation layer (ETHICS)

- boundary conditions as reported for german governmet (BBR 2008)



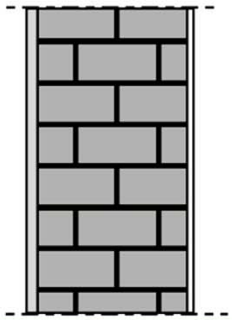
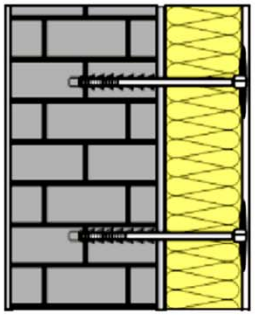
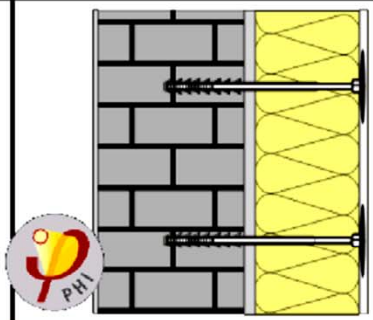
Total cost analysis of thermal insulation layer (ETHICS)

- boundary conditions as today (2012)



- detailed cost data available for Germany

Measure to be taken anyway: new rendering

Existing assembly:	anyway	economically minimal acceptable	future-proof level of protection
	measure to be taken anyway: without insulation	refurbishment including minimal required insulation	refurbishment including a sustainable level of insulation
external wall with plaster	new rendering	insulation with ETHICS	insulation with ETHICS
U-value of the existing assembly 1,41 W/(m²K)	U-value of the existing assembly 1,41 W/(m²K)	economically maximum acceptable U-value 0,16 W/(m²K)	U-value required for sustainability 0,12 W/(m²K)
		add. insulation / R-Value 22 cm 5,43 m²K/W	add. insulation / R-Value 30 cm 7,42 m²K/W
			
investments in construction:	40 €/m²	79 €/m²	86 €/m²
Investments of the energy saving measure only = costs to be allocated to the energy savings		39 €/m²	46 €/m²
Salvage value of the energy saving measure after 20 years (lifecycle is 50a):		39%	39%
Salvage value of the energy saving measure after 20 years:		15 €/m²	18 €/m²
ost of the energy saving measure after the salvage value has been subtracted:		23 €/m²	28 €/m²
Annual capital costs of the energy saving measure:		1,65 €/(m²a)	1,94 €/(m²a)
annual heating costs saved (average energy price 6,3 €Cent/kWh)::		6,81 €/(m²a)	7,03 €/(m²a)
annual profit:		5,16 €/(m²a)	5,09 €/(m²a)

[GDI 2005]
[BBR 2008]
download
www.passiv.de

full life cycle costs of renovation projects are crucial

- two identical buildings: 2 * 750 m²
- renovation according to 'EnerPHit' and 'low-energy'
- Monitoring (2 years)
- accounted costs available:

(gross)	EnerPHit	low-energy	difference
total construction:	1229 €/m² tfa.	1053 €/m² tfa.	174 €/m²
energy components:	389 €/m² tfa.	222 €/m² tfa.	166 €/m²

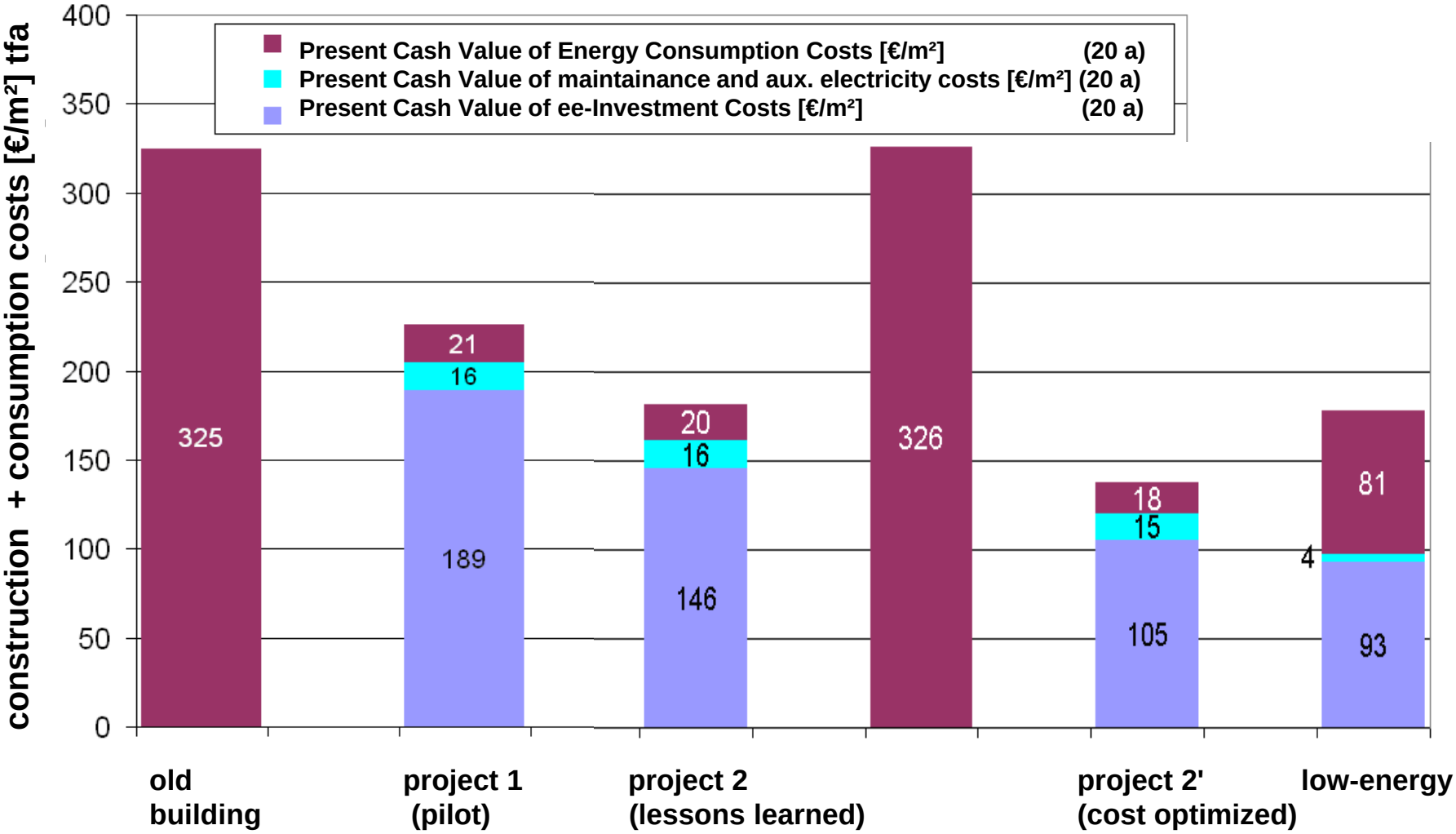
- owner: GAG housing company, Ludwigshafen

'EnerPHit' **'low-energy'**

old building: 1965

full life cycle costs of renovation projects: comparison 'EnerPHit' with 'low-energy'

- cash value of energy consumprion costs for 20 years (endenergy: 0.07 €/kWh)
- cash value of maintainance costs for 20 years
- cash value of ee-investment minus 'anyway' costs minus residual value (20 years)



source: IEA Task 37 and AKKP 42 (Ökonomie) for full reports see www.passiv.de

evident things...

you should only do build things you really need

– if you do not need a building (or have no money) don't do it.

- energy savings (EE) repay for the energy related action investment but for nothing else

look out for chances – combine the business

- if there is a building/renovation needed anyway just do the related energy saving action in that moment
- extra costs for thermal insulation etc. are quite small

recently energy prices high … interest rates low:

- investment in EE has priotity to energy consumption

economic numbers clearly show what to do ('deep renovation')

Provide good building quality

QA and QC with deep energy retrofit

Quality Assessment & Quality Control by third party
is absolutely necessary
is worth while (because not really expensive)

- thermal insulation (U-values)
- thermal leakage (thermal bridges)
- air tightness of building envelope
- heat recovery performance of ventilation system

When having checked … mark 'good quality' by labels

- labelling is helpful for visualisation
- labelling is market information
- labelling provides orientation of market players

We know about good quality and can help to get it!

but there is no guarantee… anyway – good chance to win!

Provide good quality – Certifiction by third party

Buildings
(new & renovation):

Components:

certified window frames and glazings, doors, ventilation systems compact heat pump units, construction systems without thermal bridges, low thermal bridge solutions,…

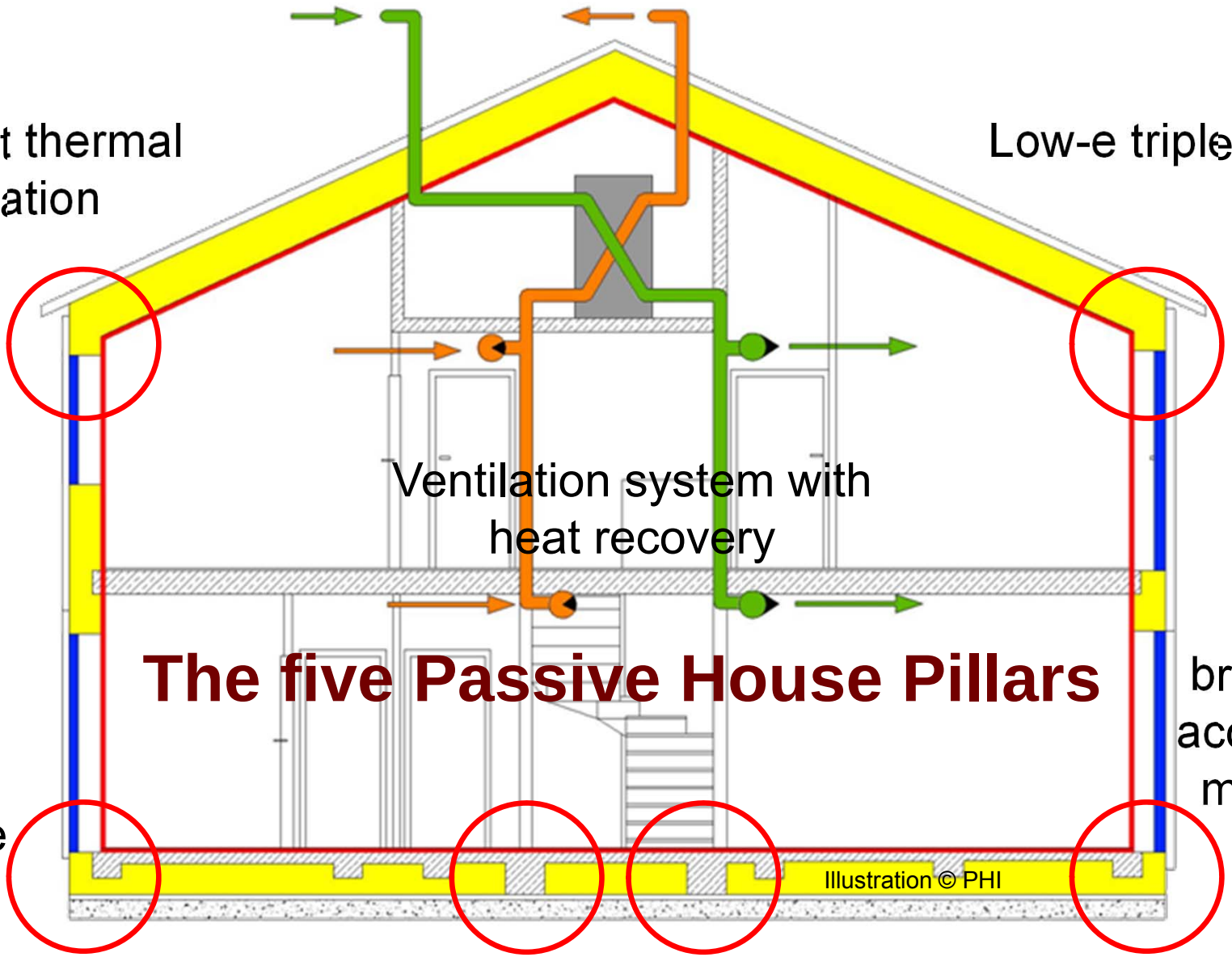
Persons:

Summary 1:

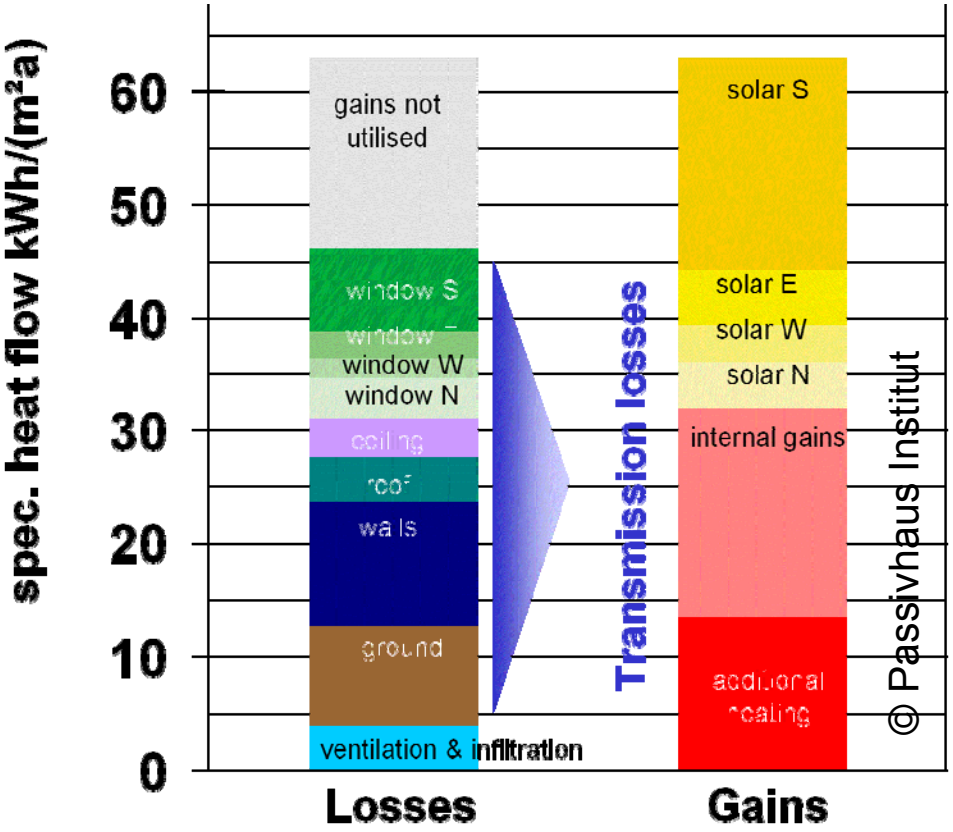
- recently high energy prices…
- for deep renovation just copy Passive House ....
- full lifecycle costs evaluation gives extra budget options:
  - extra investment on building envelope
  - significantly lower energy consumption costs
- both effects balance each other! (at present energy prices)
- ! if savings are significant ! much more than 50% possible !

- recent examples for good practice available:
  IEA Task 28 (newbuilt)
  IEA Task 37 (renovation)
  IEA Annex 61 (business models)
  EuroPHit
- the 'three risk' evaluation – what do you fear about?
  - risk of failure 1 ... nobody needs that building here
  - risk of too high construction costs / interest rates
  - risk of too low energy prices ... too low calculated cost savings
  - risk of failure 2 too bad quality, so not enough savings

It's the details that matter!

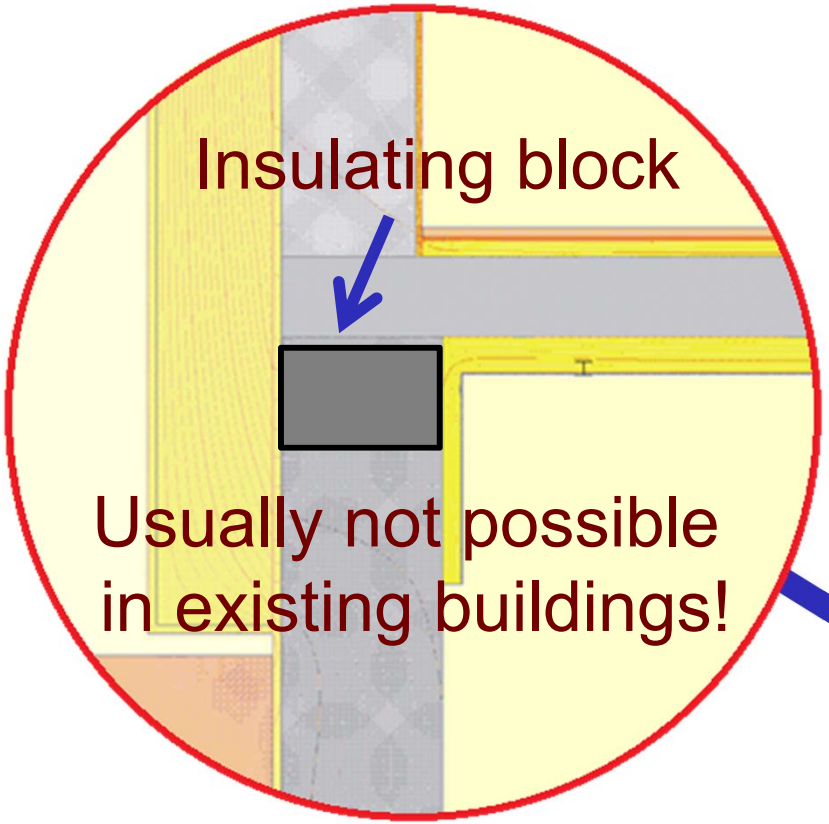


- Going to small numbers you must be exact!
- new PHPP version 8.4 (2013) available
- ... extended ventilation spreadsheet for office buildings
- ... sheets 'summer', 'cooling', 'dehumidification' revised
- ... access to further climate data sets possible



Modernisation of existing buildings – some extra problems

Thermal bridges



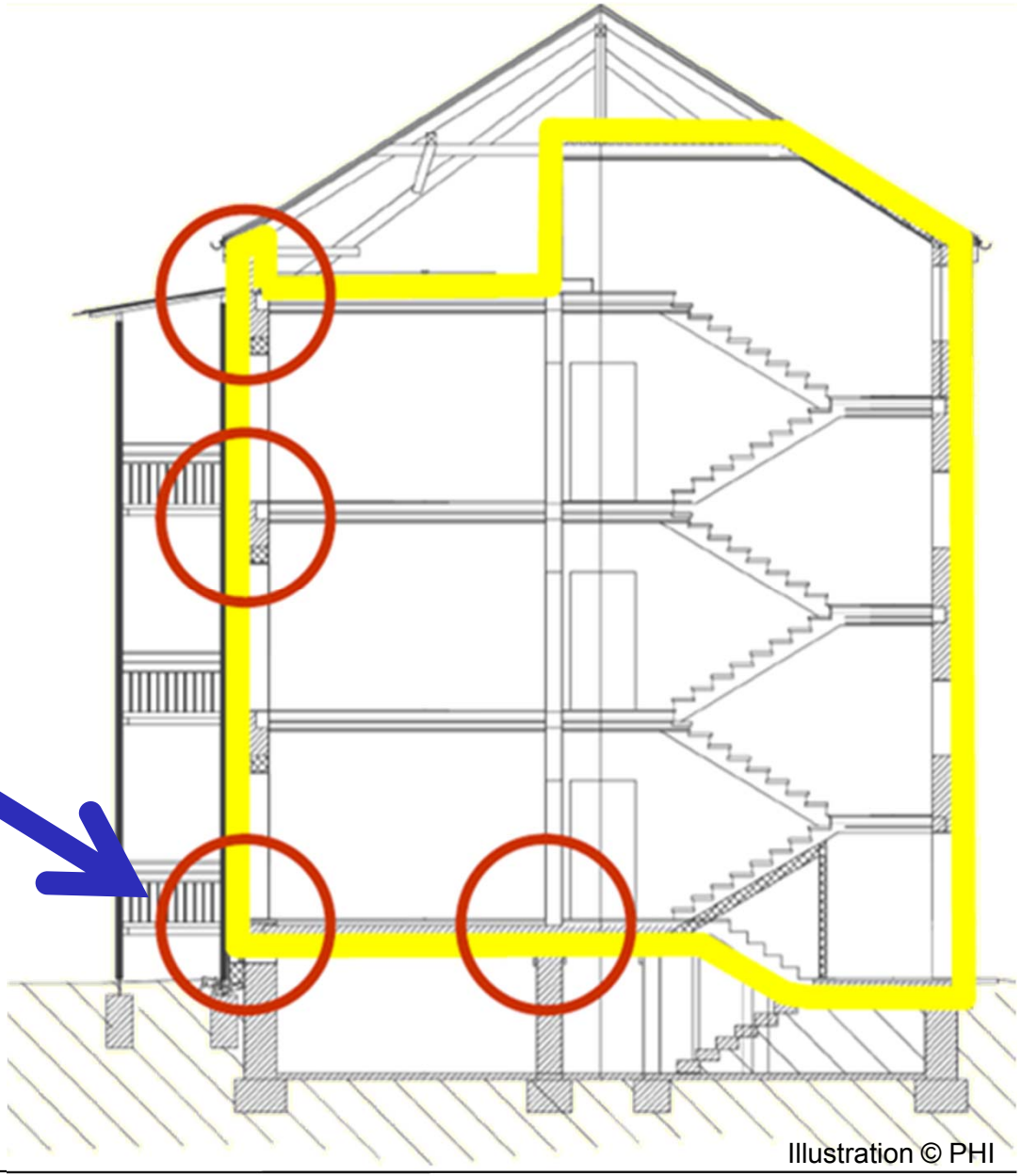
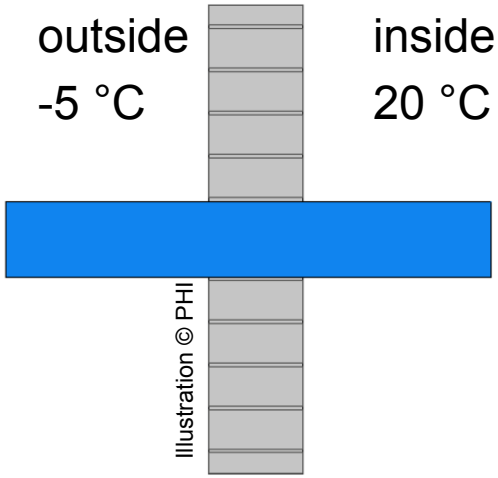
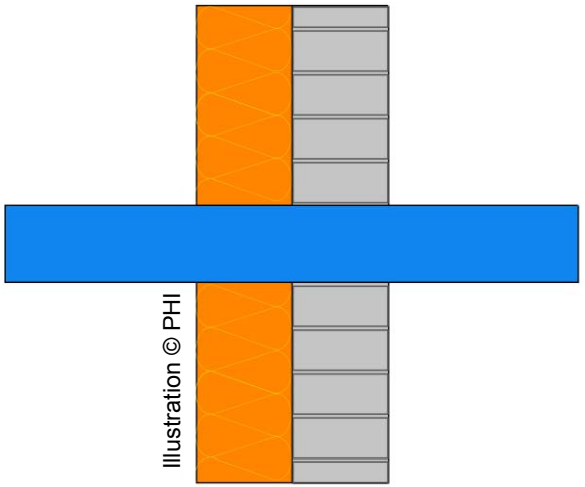


Illustration © PHI

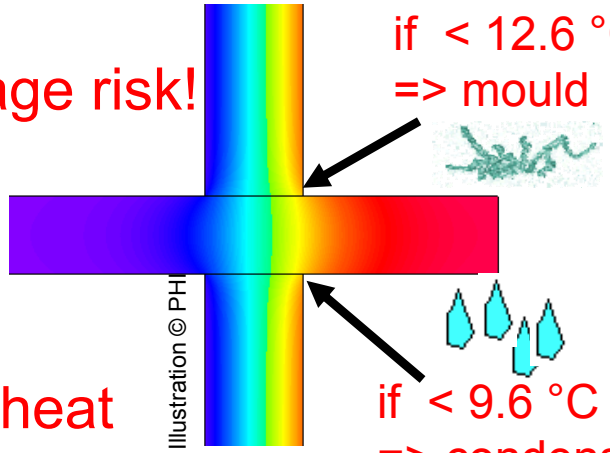
'constructive' thermal bridges as balconies sometimes cannot be removed



not insulated



Passive House insulation

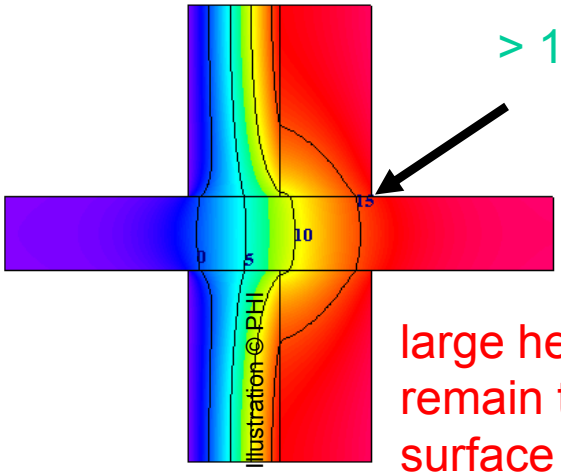


Damage risk!

if < 12.6 °C
=> mould

large heat losses!

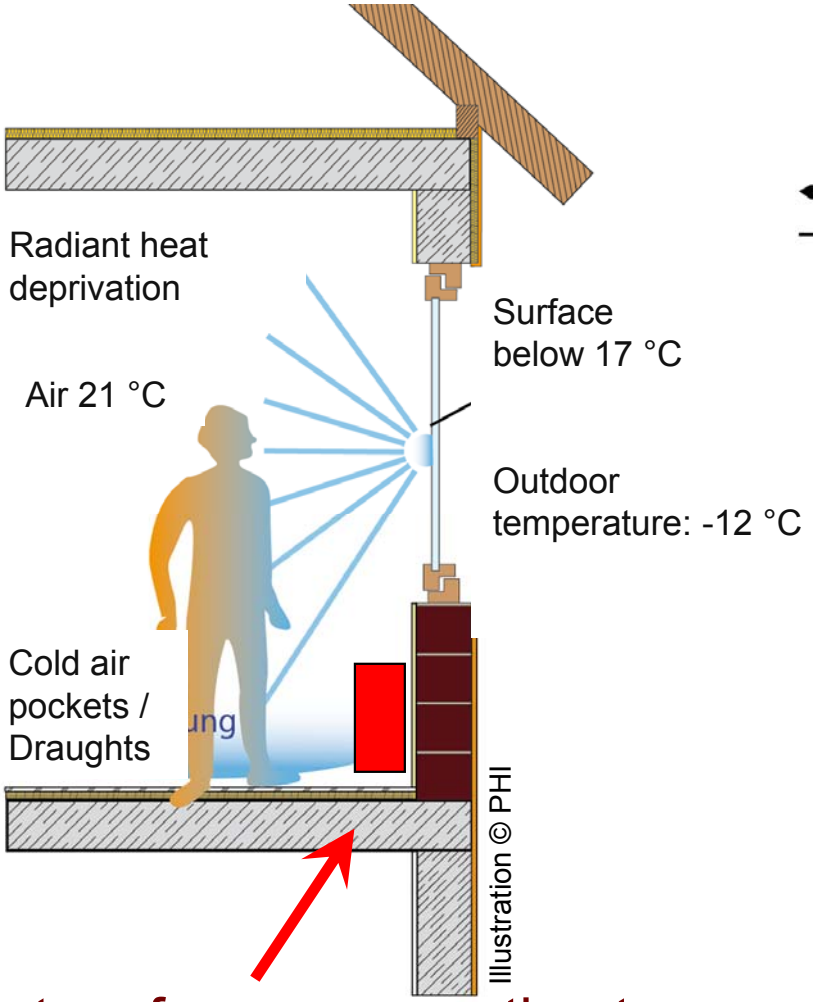
if < 9.6 °C
=> condensation



> 12.6 °C
ok!

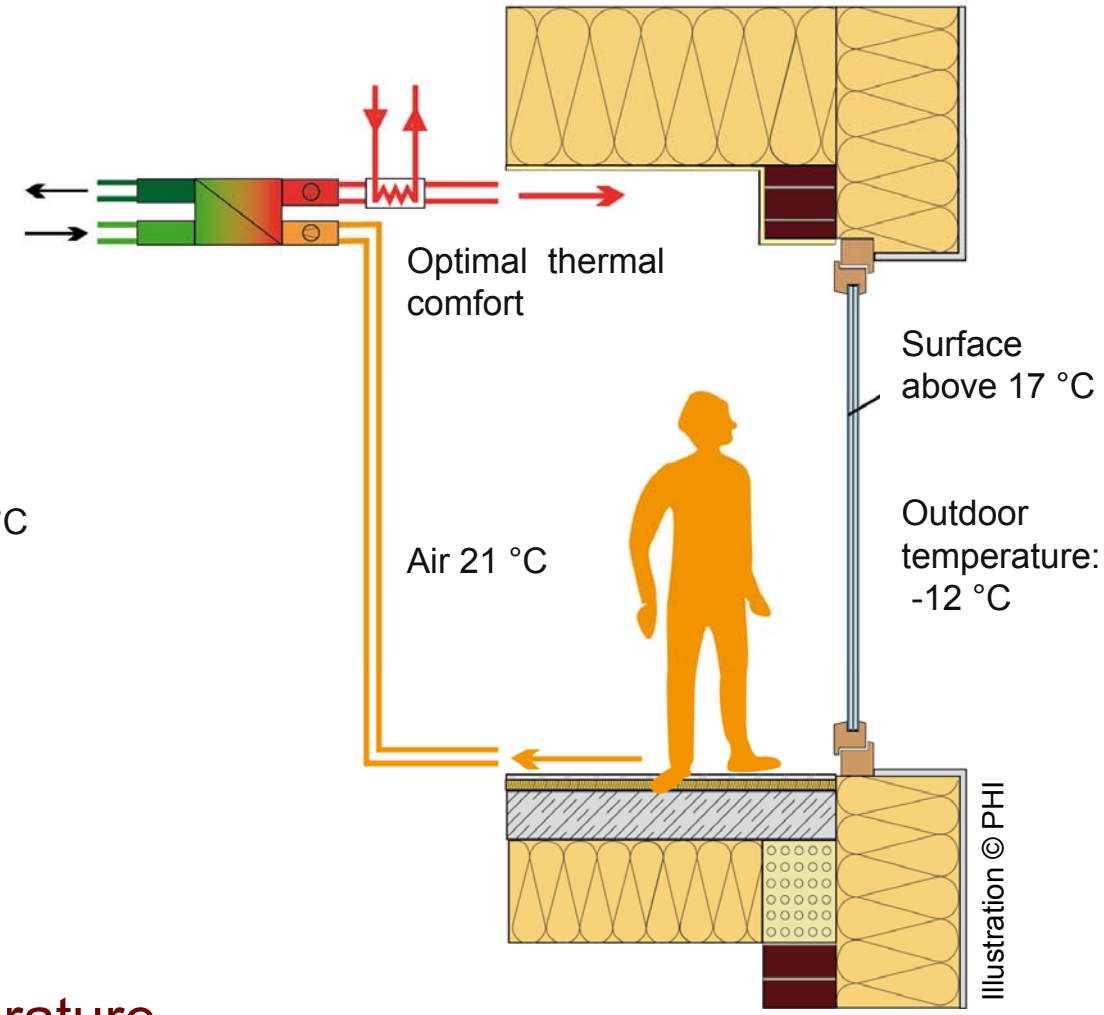
large heat losses! remain there, but surface temperatures are ok.

Existing building



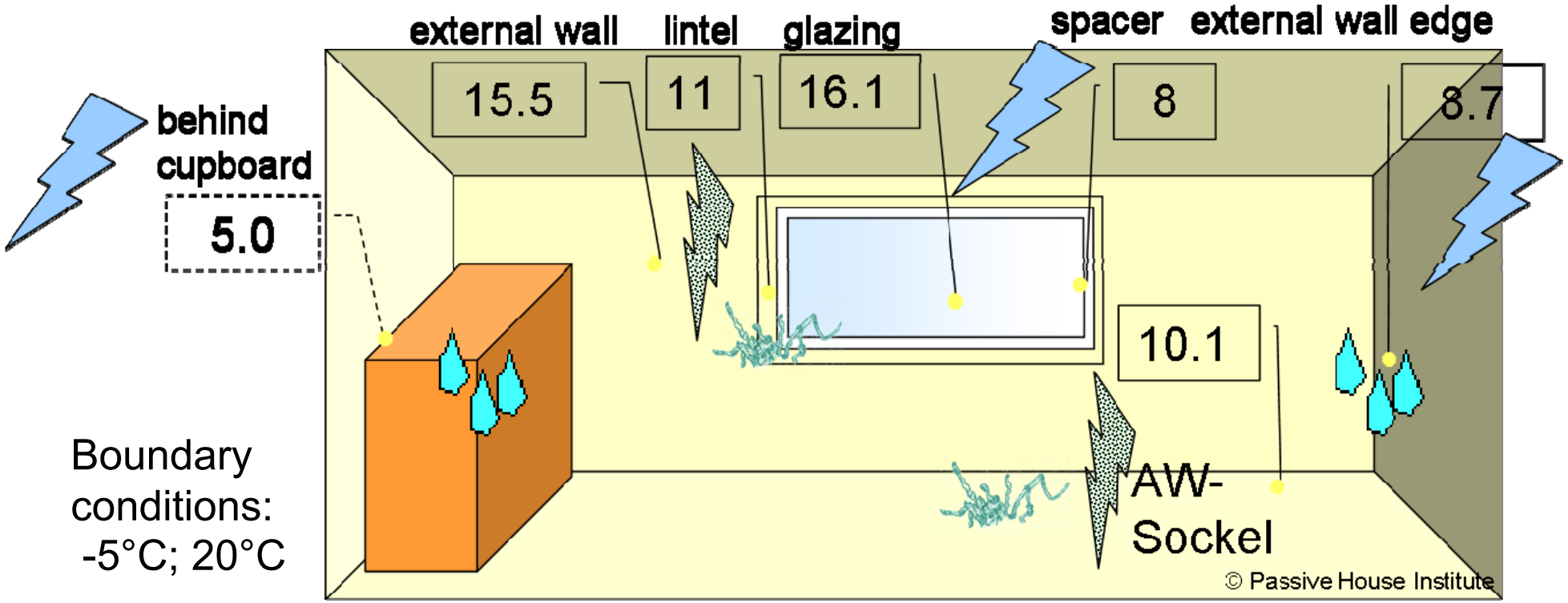
Heaters for compensating temperature and against cold air descent

Passive House



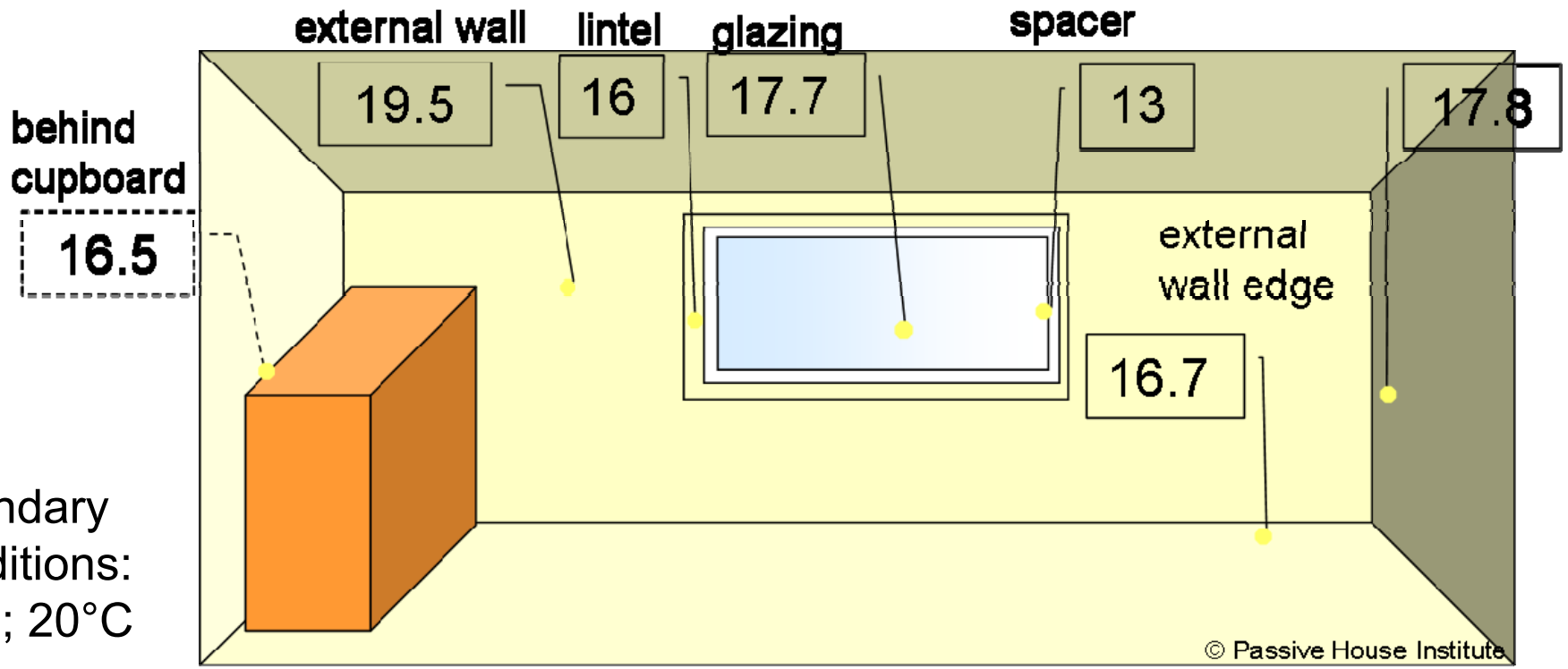
No (extra) heaters!

Existing situation: Uninsulated with new windows



- temperature of key surfaces = 9°C
- problem areas behind furniture, in corners and at lintel
- internal relative humidity must be less than 38% to avoid mould growth

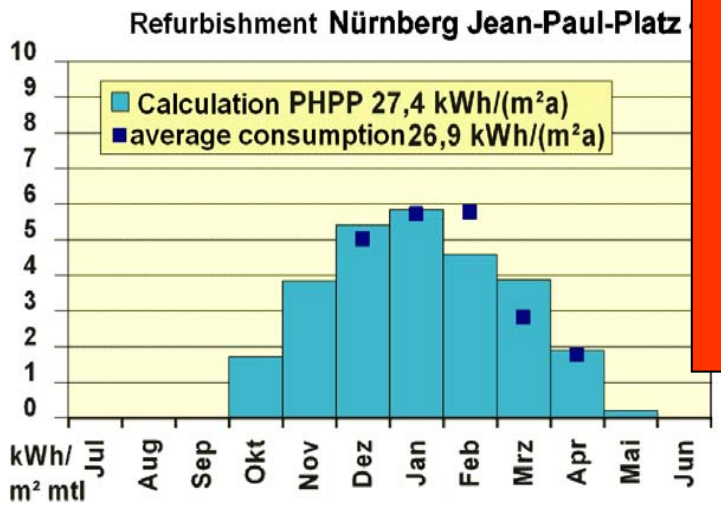
EnerPHit retrofit: 20cm insulation + PH windows



Boundary conditions:
-5°C; 20°C

- temperature of key surfaces greater than 16°C
- no mould problems, even behind furniture!
- internal relative humidity can reach 62% without fear of mould growth

status quo



200 kWh/m²a

85% reduction

after refurbishment

- basement thermally insulated
- thermally insulated walls
- Passive House windows
- ventilation with high efficient heat recovery

26 kWh/m²a

Building refurbishement Nürnberg, Jean-Paul-Platz
Architect: Burkhard Schulze-Darup

SFH Groove Cottage, Hereford (UK)

Before

After refurbishment 25 kWh/(m²a)

Client: Andrew Simmonds and Lorna Pearcey, GB
Architect: Simmonds.Mills Architects, GB
Completion: 2009

Listed office building, Rimbach (DE)

Before

After refurbishment: 20 kWh/(m²a)

Client: Grundstücksgesellschaft Schlossstr. 9 Becker u. Martin GbR, DE
Architect: Peter Hinz, Planungsgruppe 7, DE
Completion: 2011

Governmental offices - Expost in Bozen (IT)

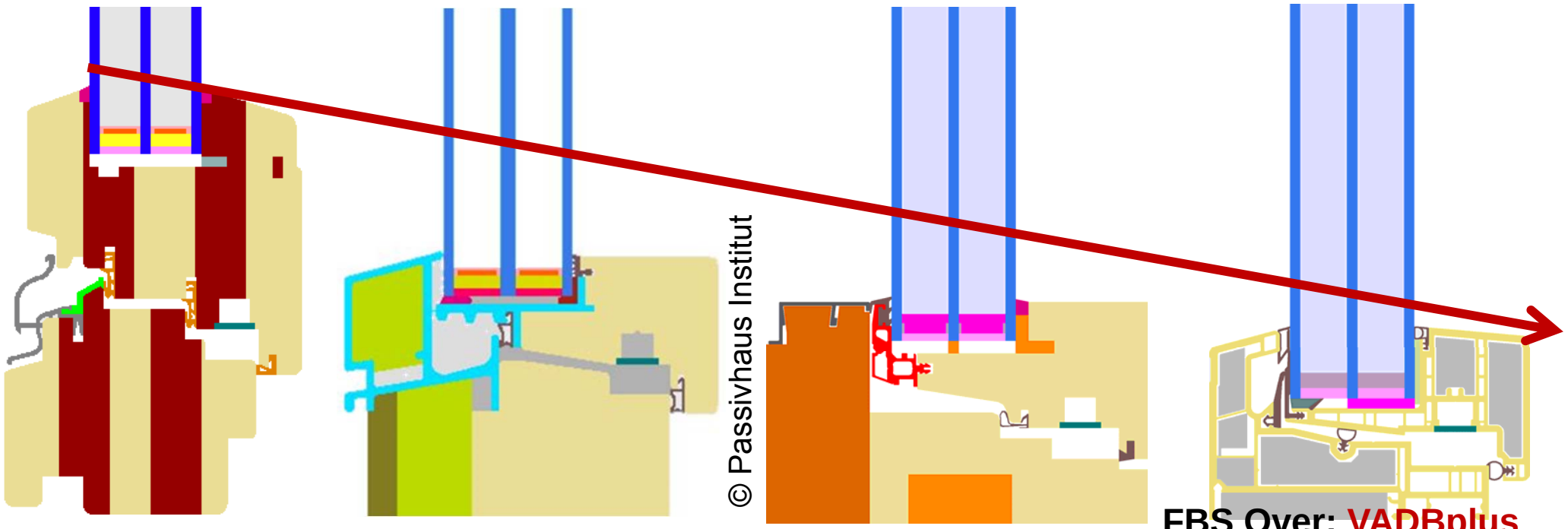
Before

After refurbishment 12 kWh/(m²a)

Client: Provincia Autonoma di Bolzano-Alto Adige, IT
Architect: Michael Tribus Architecture, IT
Completion: 2006

components available: windows and window frames for Passive Houses

- the recommended trend: slim frames to get maximum input
- low U-values to further reduce thermal losses
- low costs...



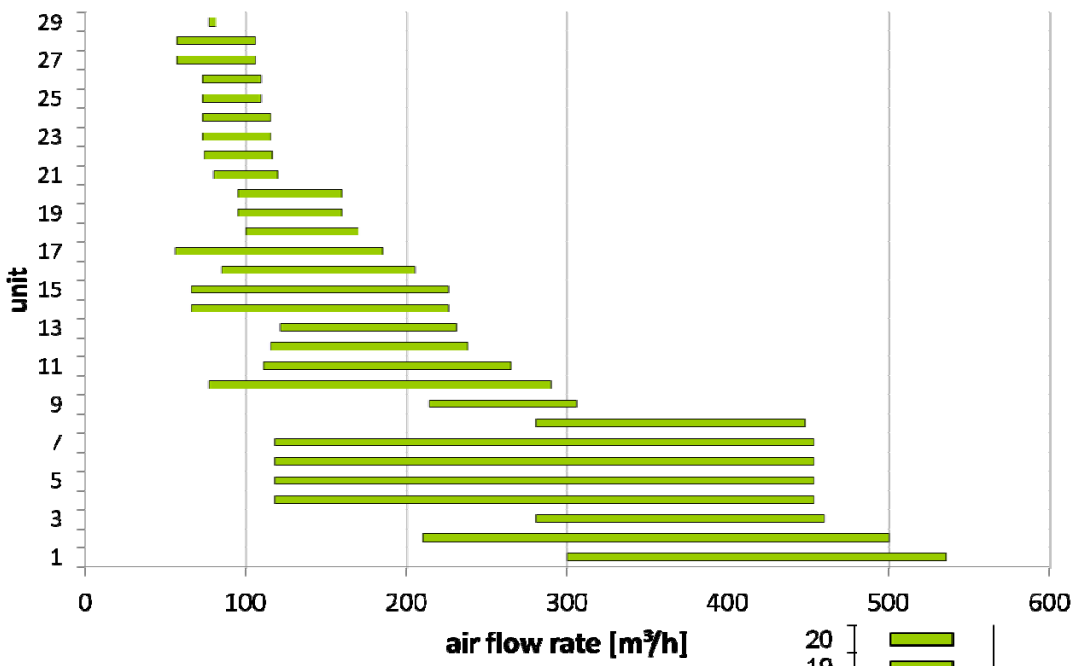
Winter ewitherm
bf: 154/169 mm
$U_{W,}$: 0,77 W/(m²K)
Ψ_{opak}: 0,170 W/(mK)
Efficiency class: $_{ph}$**C**

Pazen *ENERsign*
bf: 100 mm
$U_{w,}$: 0,68 W/(m²K)
Ψ_{opak}: 0,106 W/(mK)
Efficiency class : $_{ph}$**A**

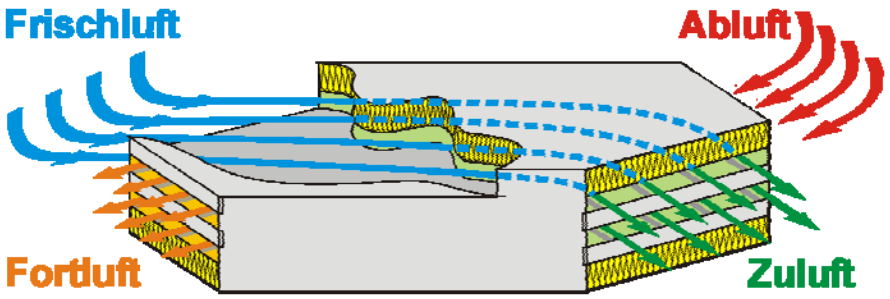
ProPh-F. SmartWin
bf: 87 mm
$U_{W,}$: 0,79 W/(m²K)
Ψ_{opak}: 0,098 W/(mK)
Efficiency class : $_{ph}$**A**

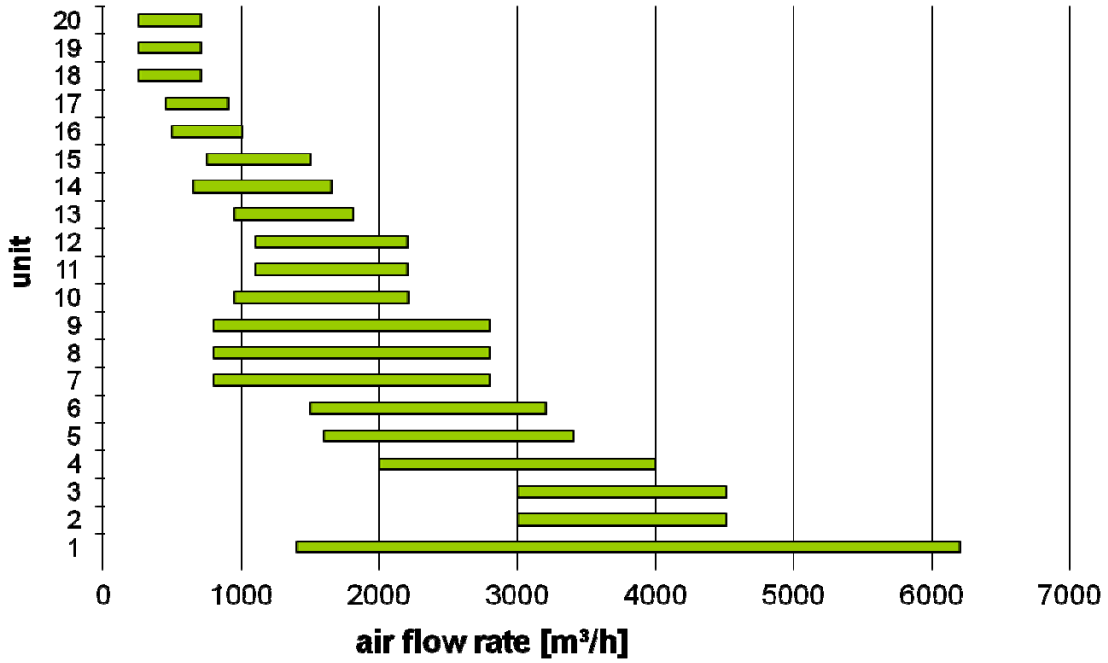
FBS Over: VADBplus
bf: 75/100 mm
$U_{W,}$: 0,74 W/(m²K)
Ψ_{opak}: 0,076 W/(mK)
Efficiency class : $_{ph}$**A**

Ventilation system with heat recovery is applicable to any building!

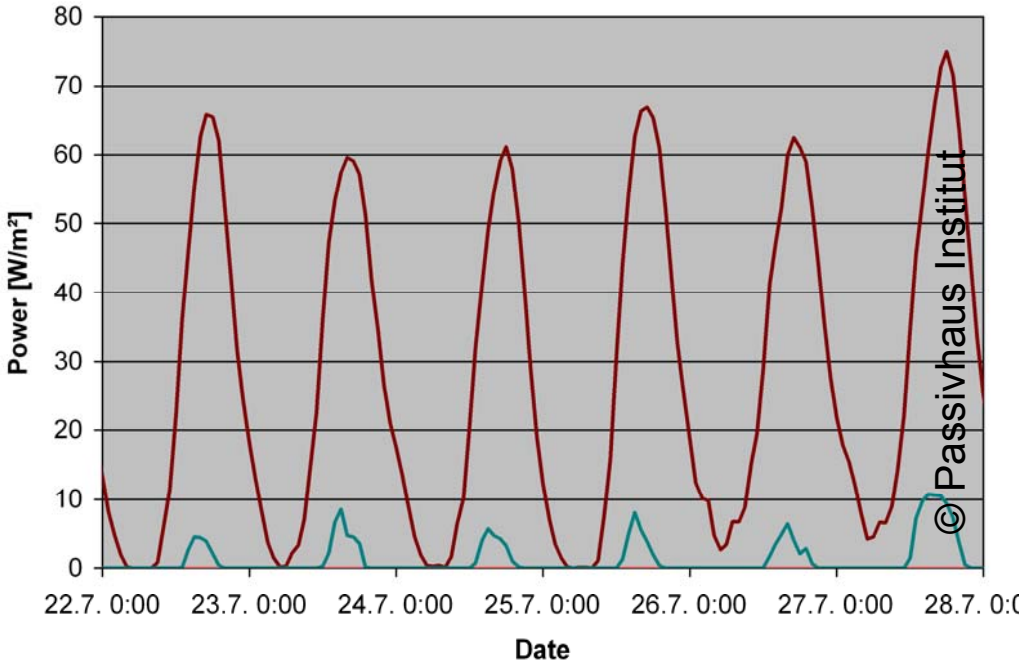


- about 50 ventilation units certified up to now (100...7000 m³/h)
- see components database at www.passiv.de

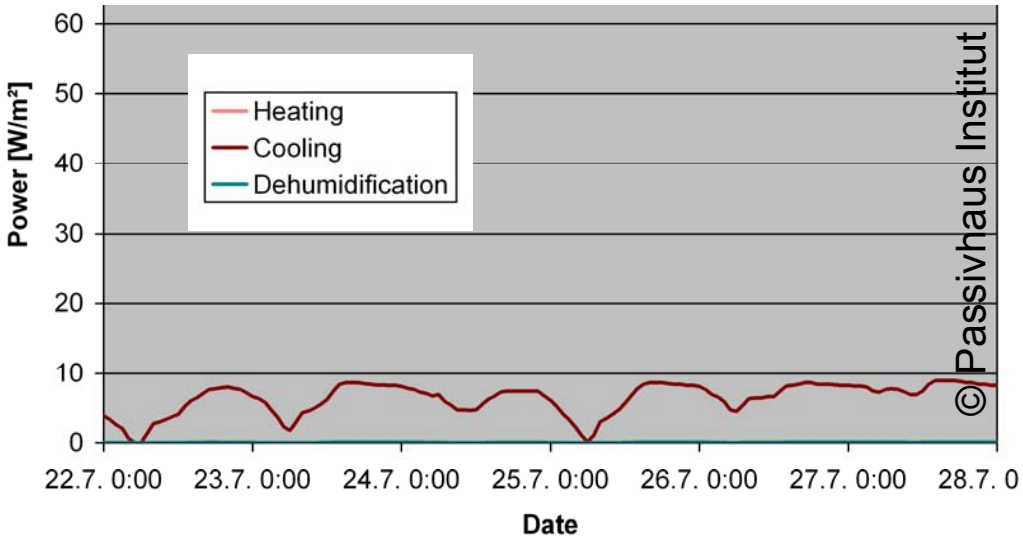




if active cooling needed − no more cooling peak power problem



Existing old standard building:
needs very high cooling power



Passive House:
only low cooling power needed
no electric peak power problem


Office A.S.S.A. Santa Croce, Italy
Arch: Silvia Mazzetti, Building Physics: Günther Gantioler

for more information see www.passipedia.org

The policy background

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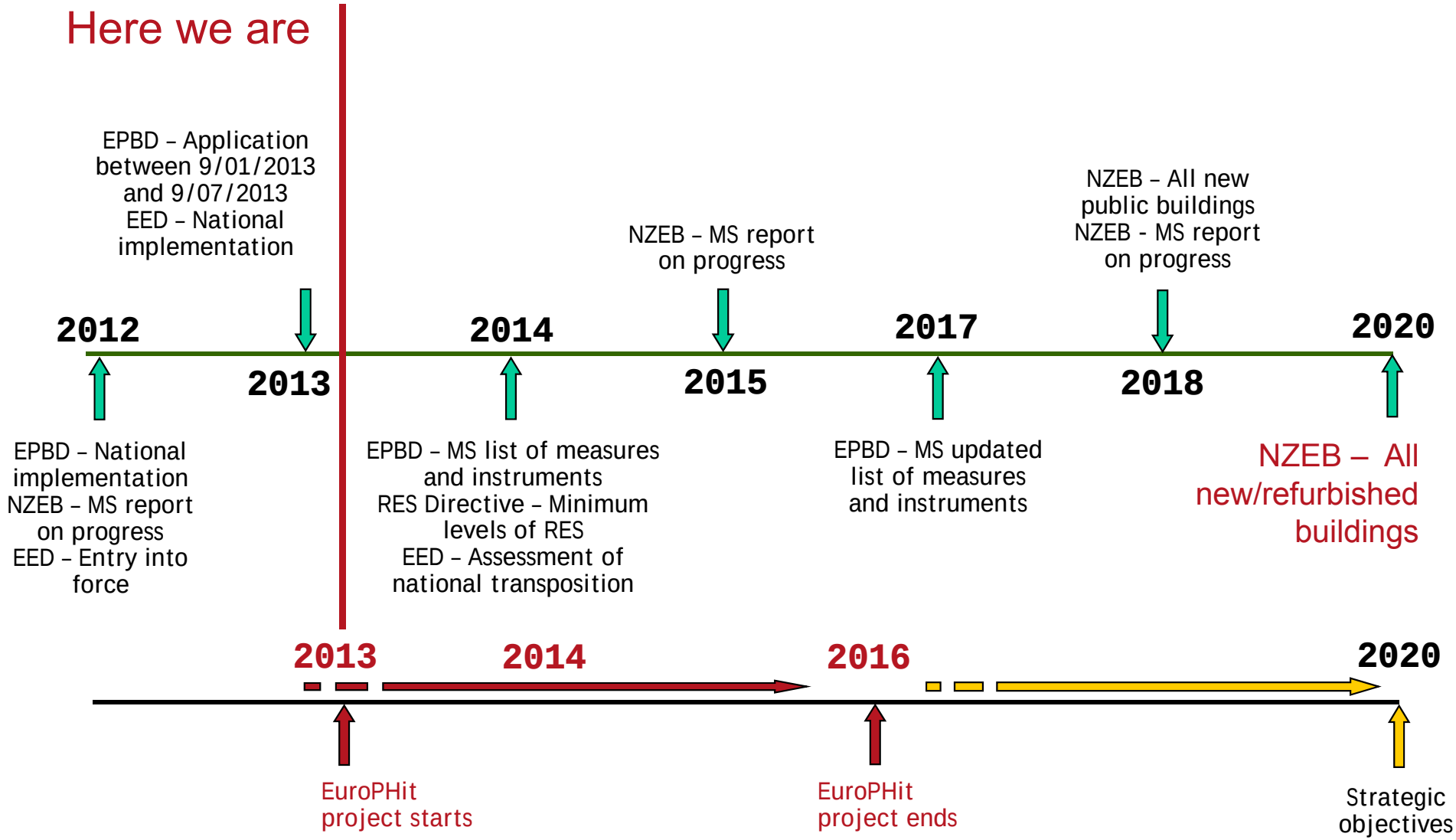

Passive House Institute

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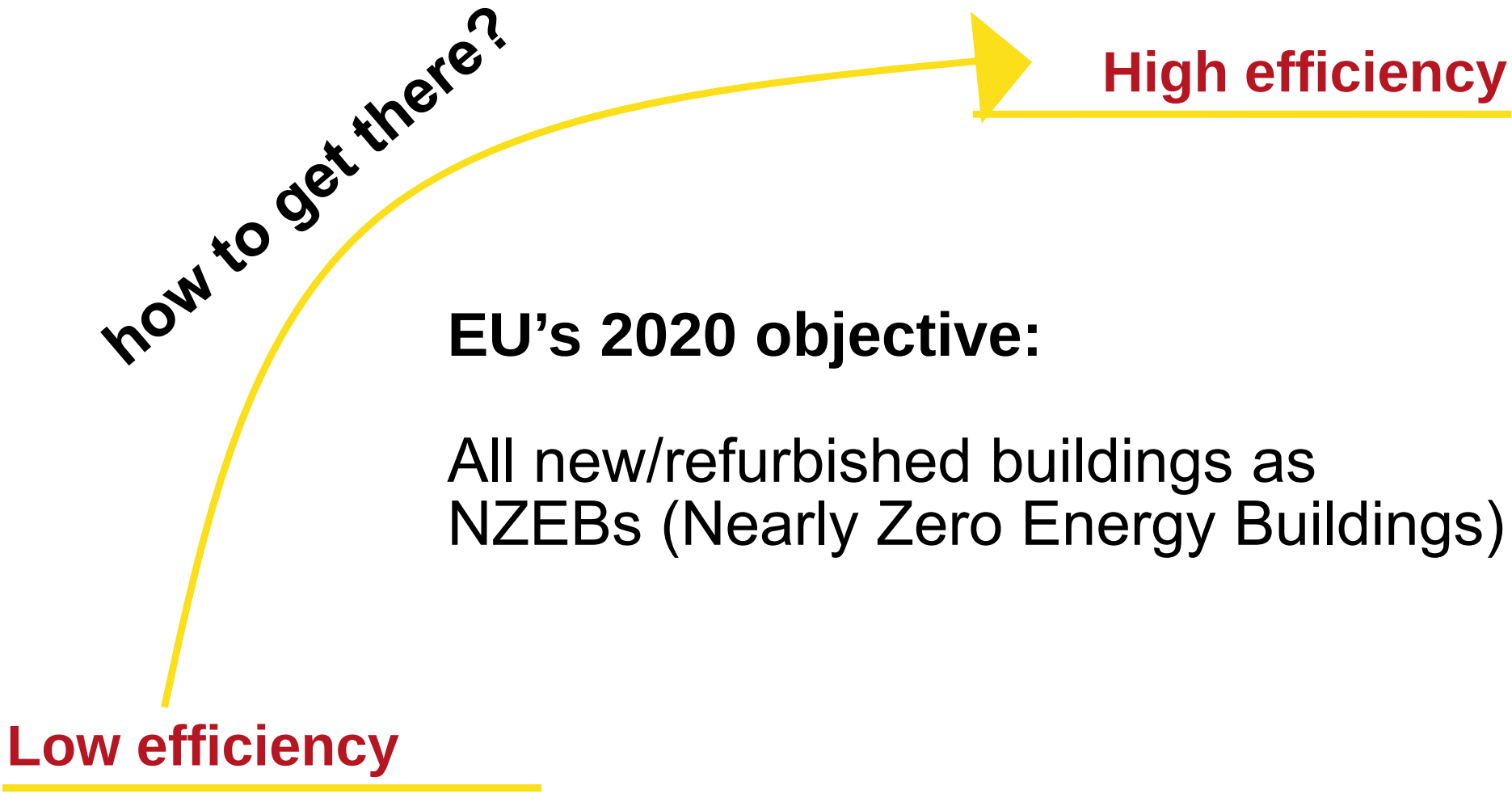

EU's 2020 objective:

All new/refurbished buildings as NZEBs (Nearly Zero Energy Buildings)

All at once

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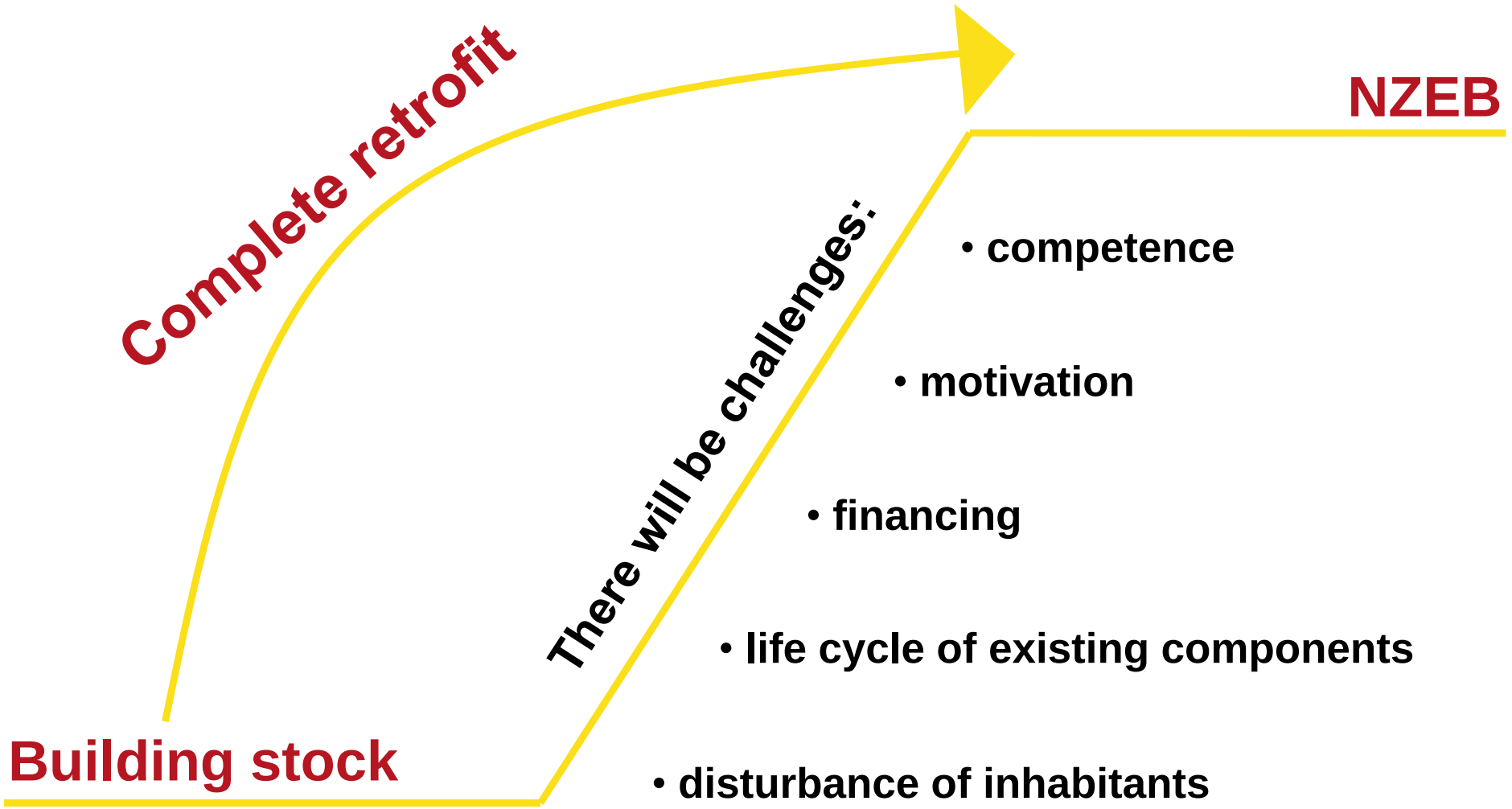

...Or step by step

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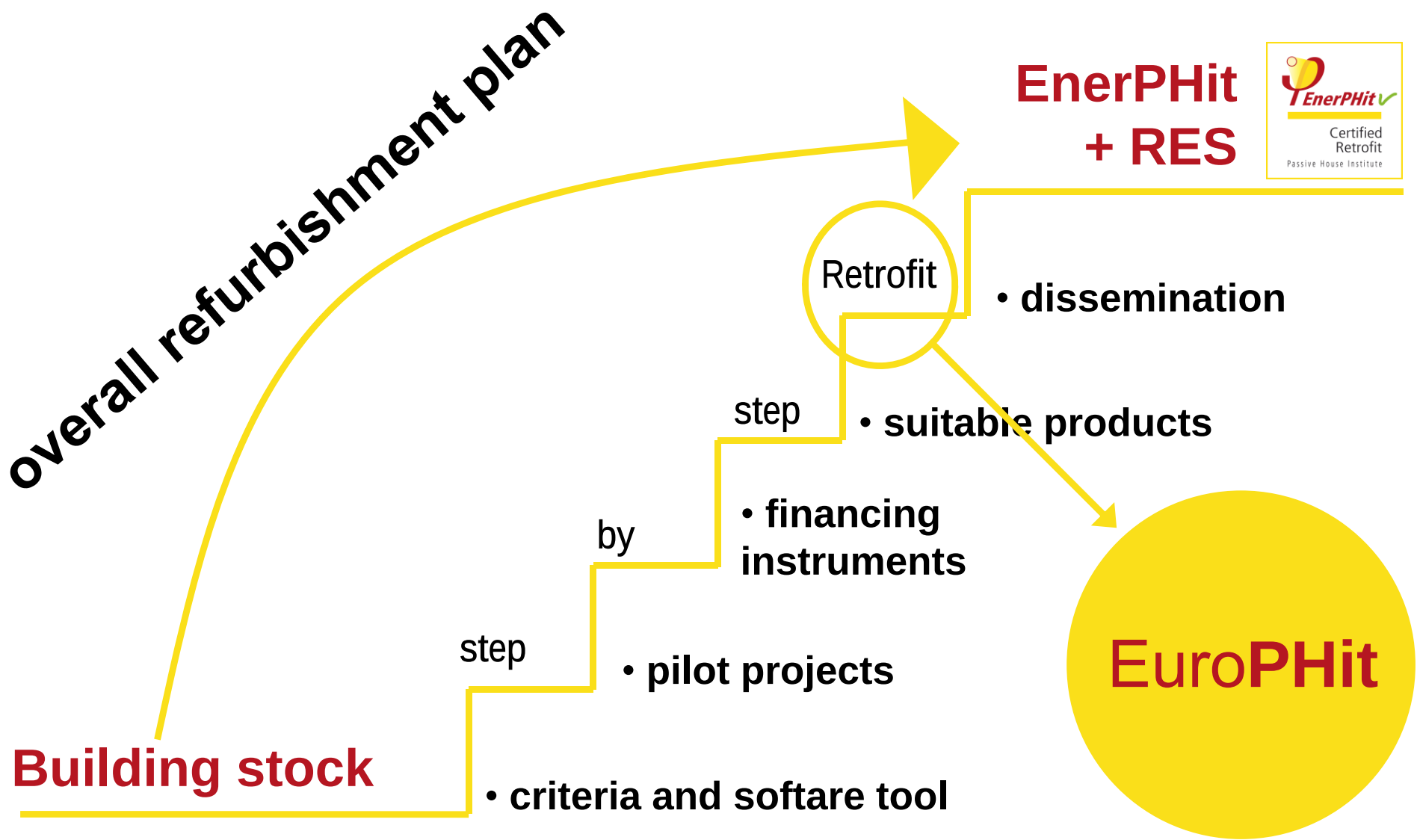

- EnerPHit = cost optimal renovation with PH-components
- ≤ 25 kWh/m²a heating energy demand
- Alternatively component evaluation
- EnerPHit^{+i} for mostly interior thermal insulation
- applicable for residental & nonresidental

EnerPHit

Certified Retrofit

Passive House Institute

Zertifikat

Passivhaus Institut
Dr. Wolfgang Feist
Rheinstraße 44/46
D-64283 Darmstadt

Das Passivhaus Institut verleiht dem Gebäude

Passivhaus, Passivstr. 100, D-12345 Passivstadt

das Zertifikat

EnerPHit
Qualitätsgeprüfte Modernisierung mit Passivhaus-Komponenten
Passivhaus Institut

Bauherrschaft:	Paula Passiv Passivstr. 100, D-12345 Passivstadt
Architektur:	Architekturbüro Passiv Passivstr. 100, D-12345 Passivstadt
Haustechnik:	HLS-Büro Passiv Passivstr. 100, D-12345 Passivstadt

Die Planung des Gebäudes erfüllt die vom Passivhaus Institut vorgegebenen Kriterien für die Modernisierung mit Passivhaus-Komponenten.

Bei sachgemäßer Bauausführung hat das Gebäude die folgenden Eigenschaften:

Gebäudekennwerte:	Kennwert	Grenzwert	
Jährlicher spezifischer Heizwärmebedarf	99 kWh/(m²a)	≤ 25 kWh/(m²a)	[1]
Jährlicher spezifischer Primärenergiebedarf für Heizung, Warmwasser, Lüftung und Haushaltsstrom bei Standardnutzung	999 kWh/(m²a)	≤ 129 kWh/(m²a)	✔
Luftdichtheit der Gebäudehülle (n50-Wert bei Drucktestergebnis)	0,99 h⁻¹	≤ 1,00 h⁻¹	✔
Mittlerer Wärmeschutzstandard der Einzelbauteile:			
Außenwand Wärmedurchgangskoeffizient	0,99 W/(m²K)	≤ 0,15 W/(m²K)	✔
Kellerdecke / Bodenplatte Wärmedurchgangskoeffizient	0,99 W/(m²K)	≤ 0,19 W/(m²K)	[2]
Dach / Oberste Geschossdecke Wärmedurchgangskoeffizient	0,99 W/(m²K)	≤ 0,12 W/(m²K)	✔
Wärmebrücken Ψe Gebäudehülle (ohne Fenstereinbau-Wärmebrücke)	0,99 W/(m²K)	kein Grenzwert	
Fenster Wärmedurchgangskoeffizient $U_{w,eingebaut}$	0,99 W/(m²K)	≤ 0,85 W/(m²K)	✔
Lüftungsanlage effektiver Wärmebereitstellungsgrad	99 %	≥ 75 %	✔

[1] Grenzwert hier nicht relevant [2] Grenzwert gebäudeabhängig unterschiedlich hoch [3] Grenzwert nicht erreichbar (Ausnahmeregelung)

Zertifizierungskriterien erfüllt? Auswahl des Bewertungsverfahrens		
	nach Heizwärmebedarf	
	nach Bauteilqualität	✔

MUSTER

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Secondary school retrofit in Baesweiler, Germany
© Rongen Architects

Quality renovation

...achieved with the Passive House principles

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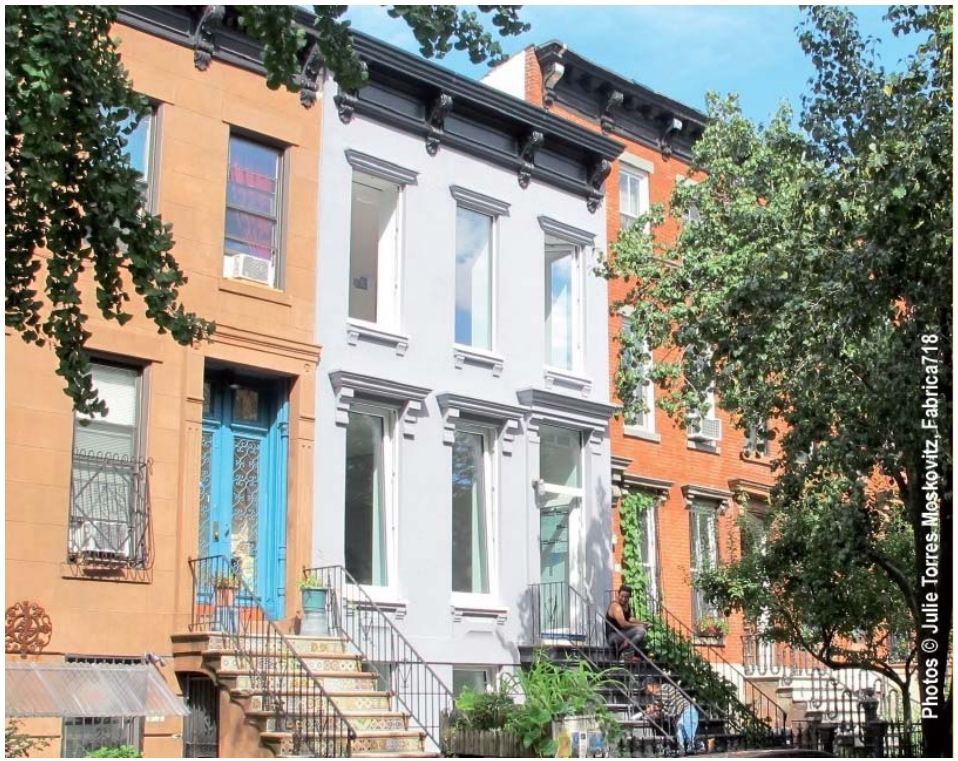
- With EnerPHit Standard as the goal and Passive House principles as the basis, EuroPHit applies knowledge on deep energy retrofits to the yet critical area of step-by-step refurbishments



Architect: Julie Torres Moskovitz
'Tighthouse' project: 23 Park Place, Brooklyn, NYC

EuroPHit

- Criteria and certification scheme for retrofits aiming for the EnerPHit Standard of the course of years
- Financing models and market incentive programmes tailored to step-by-step retrofits
- Design concepts and sound guidelines for the development of suitable, high performance building components
- Specific energy balance tools for gradual energy retrofits
- Training materials and workshops focusing on the specific needs of step-by-step refurbishment
- Building case studies showing the way towards an increasingly high quality, energy efficient building stock.

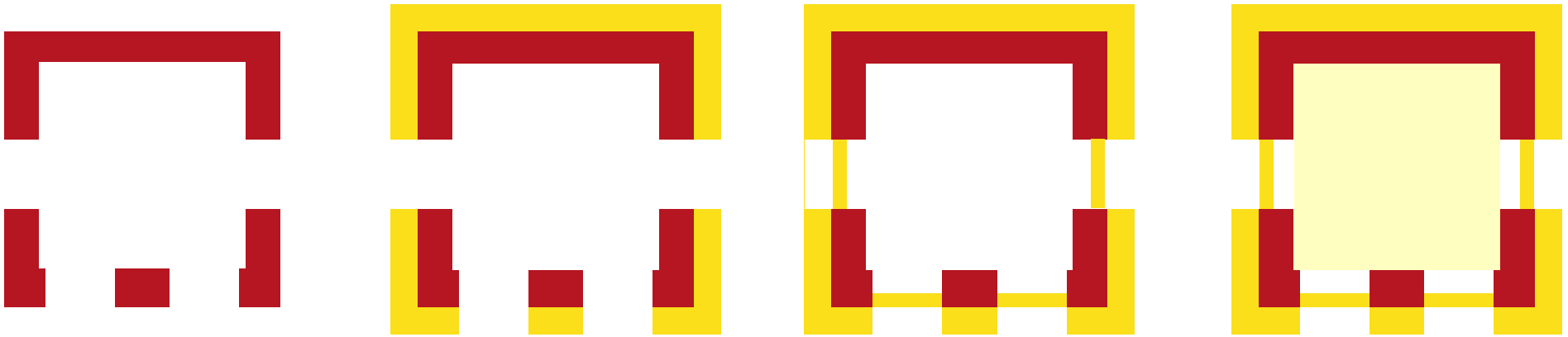
EuroPHit

- Develop retrofit energy modelling **software** (PHPP)
- Library of **step-by-step** retrofit **construction details**
- Actual retrofit of **12 buildings** across Europe
- Specialist **training** for Designers and Contractors
- Identify **products** required for deep retrofit
- Develop **financial models** to stimulate demand
- **Disseminate** the results

What is step-by-step retrofit?

EuroPHit

1. Components step-by-step



Building stock

Insulation

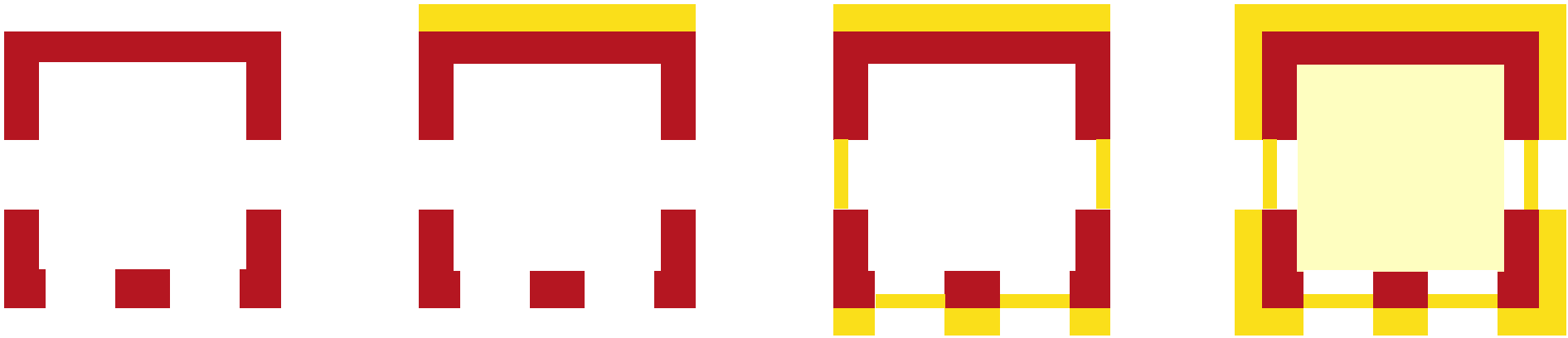
Windows, airthightness & ventilation

RES & heating system

What is step-by-step retrofit?

EuroPHit

2. Facades / Sides / parts step-by-step



Building stock

North side

South side + windows, airtightness & ventilation

Rest + RES & heating system

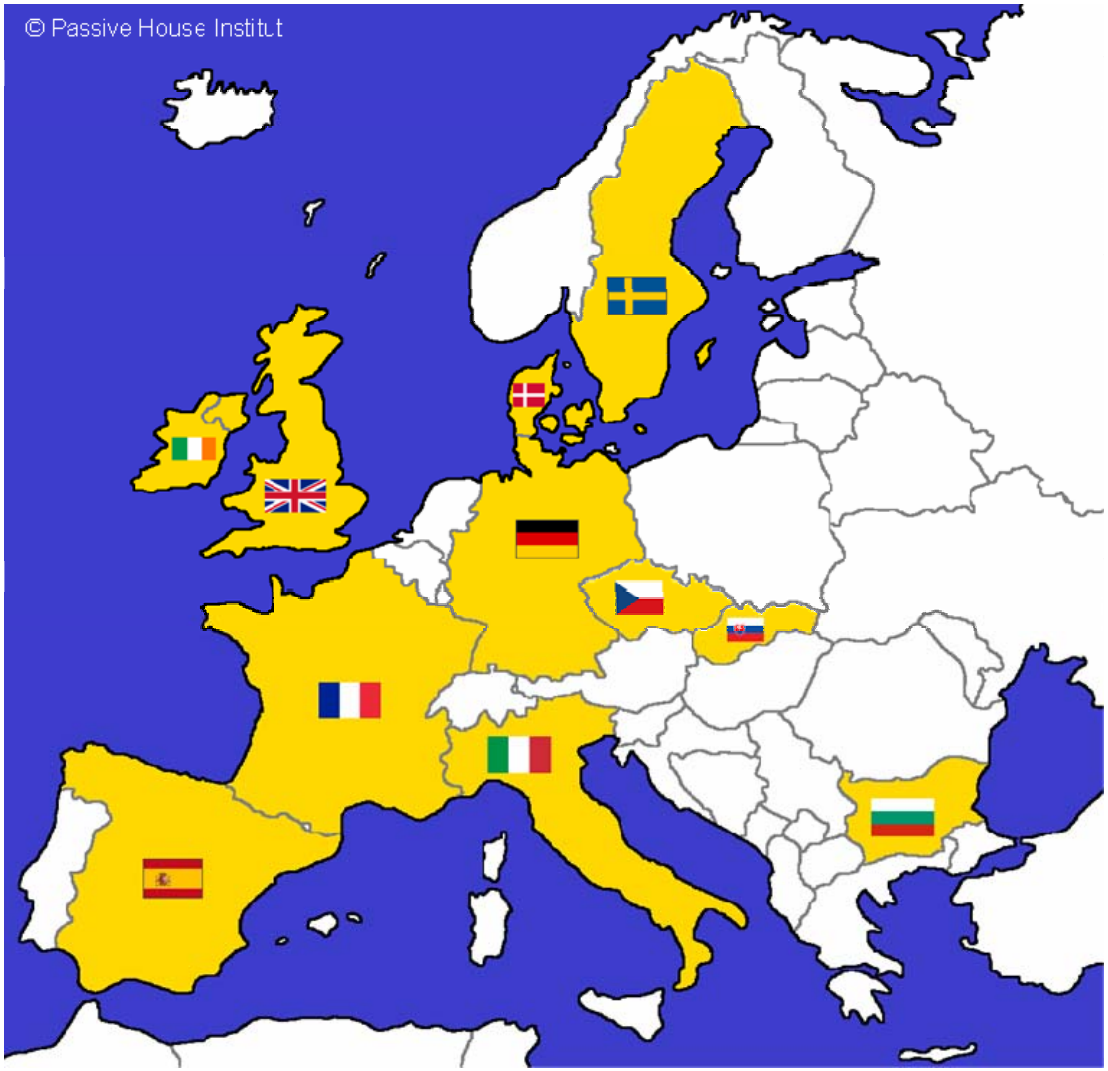
EuroPHit

'deep renovation'

- is much more than 50% reduction with respect to 'old' buildings
- is not that costly as sometimes told
- best practice experience is yet available

- is a business with many options

let us just start – there are enough examples ready to learn



EuroPHit

is located

Here:


EXPOST
before renovation
CE 273FB
MICHAEL TRIBUS ARCHITECTURE

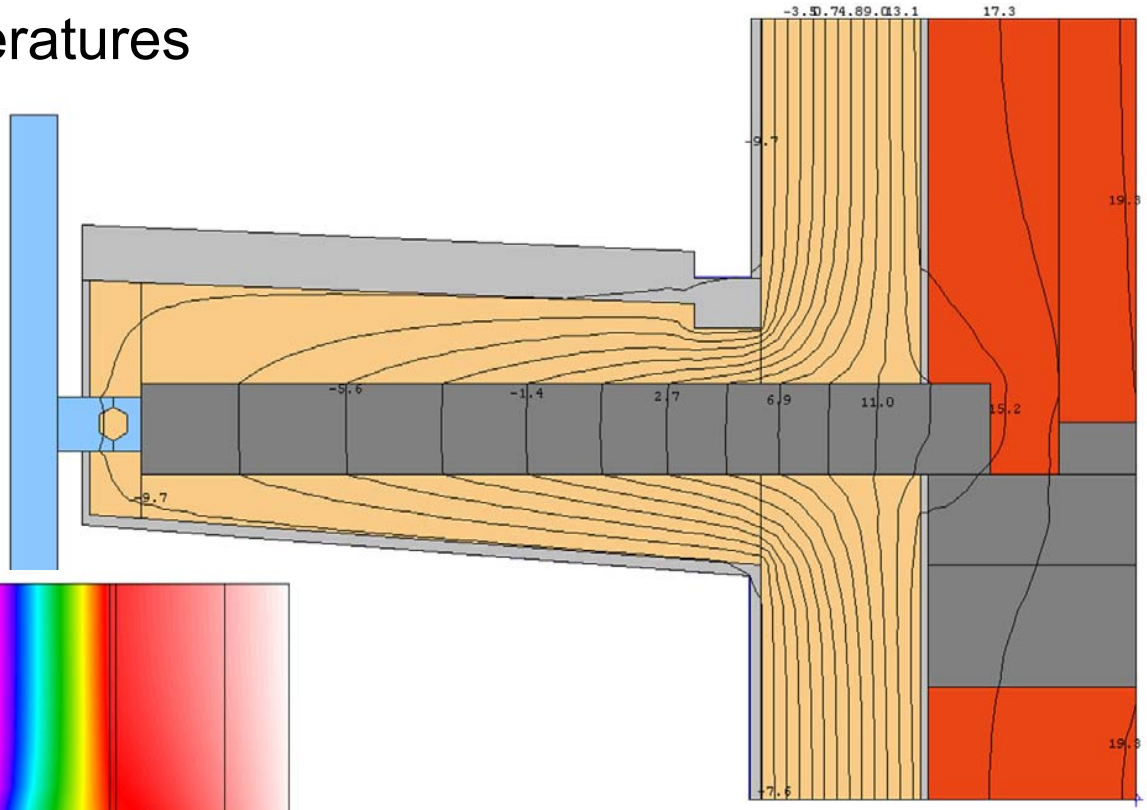
MICHAEL TRIBUS ARCHITECTURE

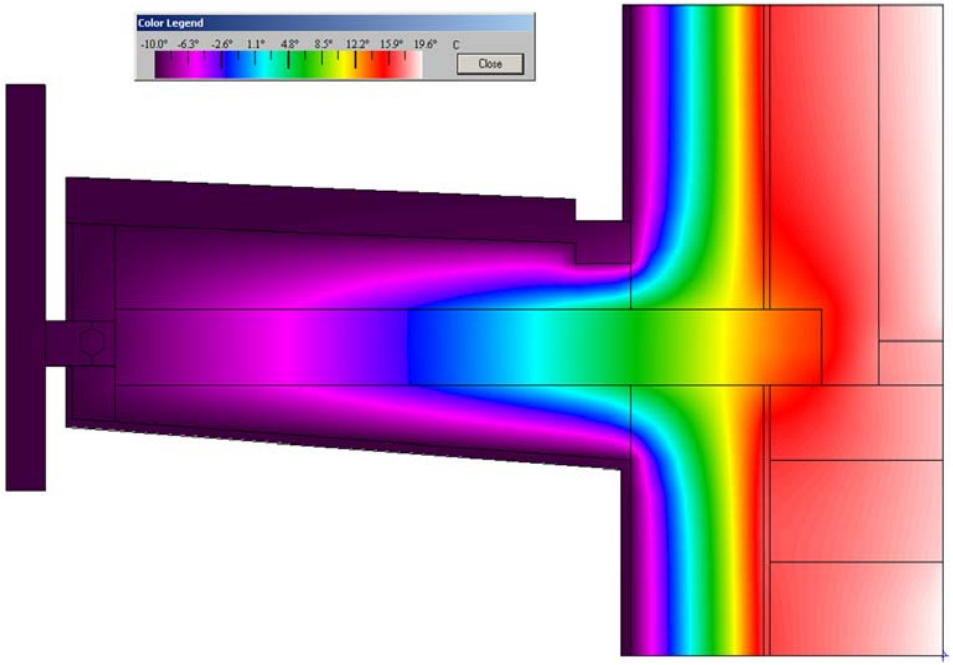
Passive House Institute

EXPOST
before

MICHAEL TRIBUS ARCHITECTURE

- you must check design for thermal performance!
- inside surface temperatures
- thermal flux (psi-value)





MICHAEL TRIBUS ARCHITECTURE

EXPOST
afterwards

MICHAEL TRIBUS ARCHITECTURE

newest development: sustainable PH buildings – all (renewables) are possible

due to very low energy demand,

the choice of source for energy is quite free

AND: net zero energy buildings are realistic

- heating & cooling with heatpump & ground coupled probes
  might be supported by ever cheaper PV-panels

- co-generation / combined heat & power (CHP)
  reduces primary energy use: waste heat of engine is used for heating

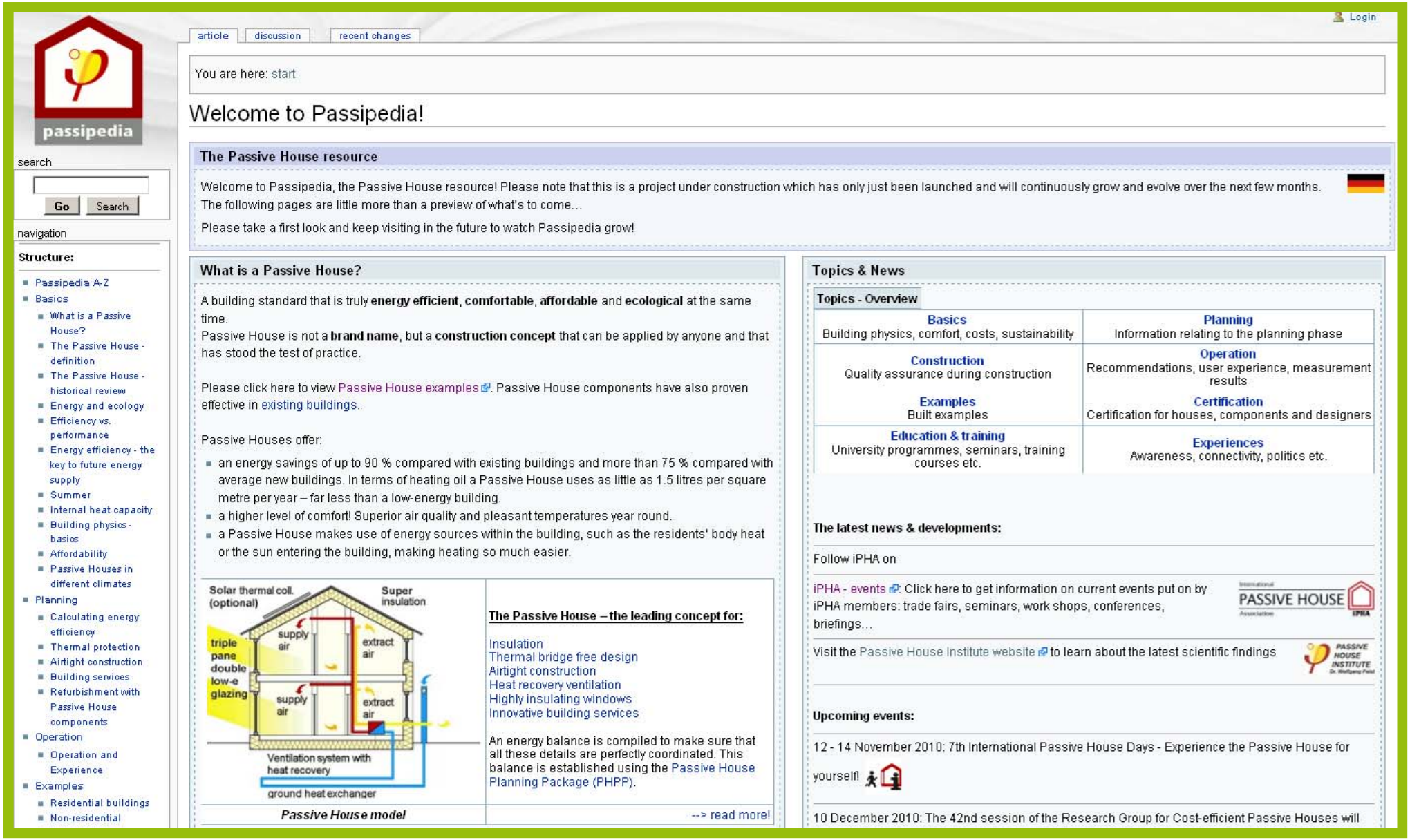
- just keep in mind that PE-factor for electricity is about 3
- reduce internal loads, that pays twice!

- PHPP (Passive House Planning Package)
  gives advice for the most preferable choice

- further information
- www.passiv.de
- www.passipedia.org
- www.passivehouse-international.org

-

where to get more information? – passipedia, the passive house resource

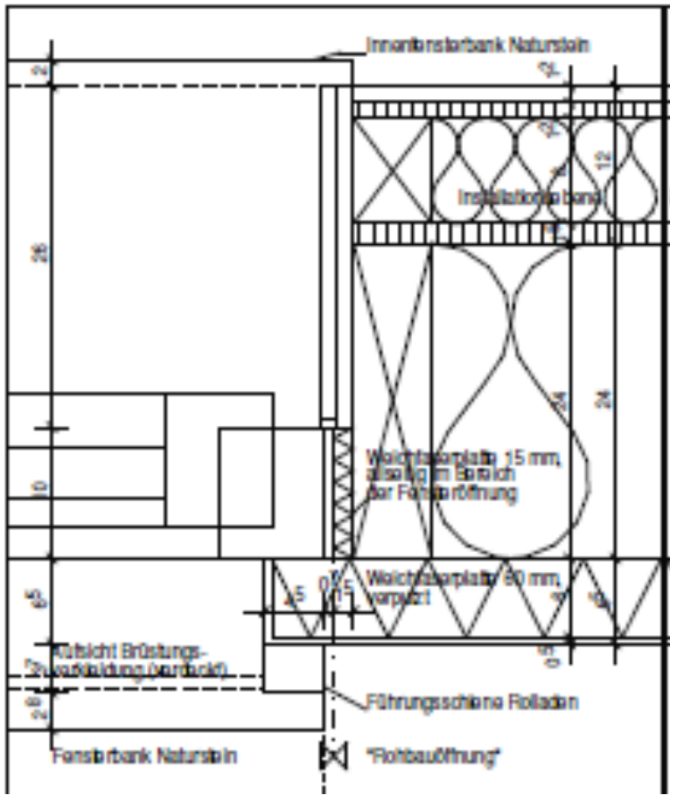


www.passipedia.org

Passive House Institute

example: cost comparison new built row house

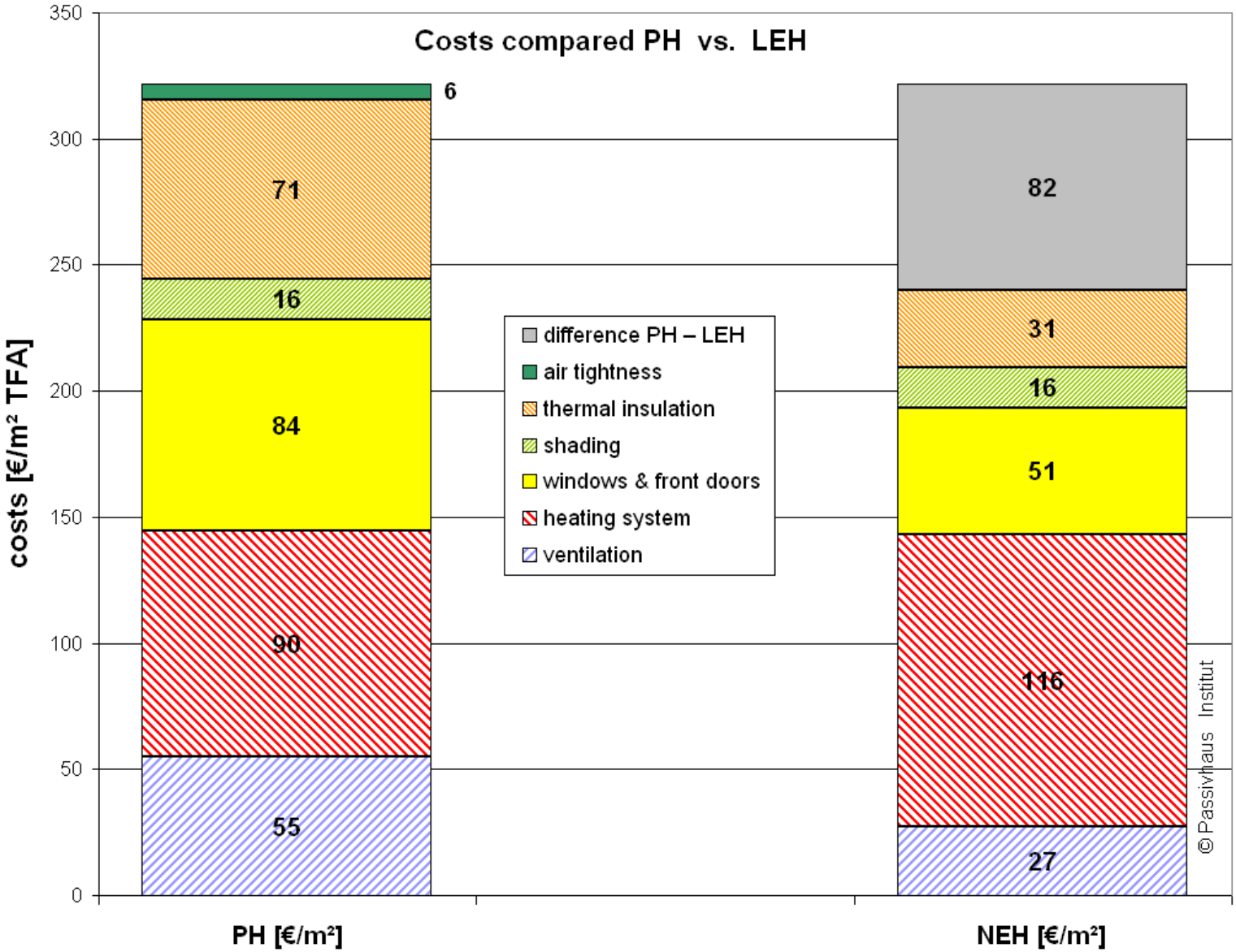
- row house: wooden construction 184 m² (treated floor area)
- rendering outside on wood fiber board
- Windows: 30 m² (plastic) shading of south windows
- district heating
- construction costs (KG 300+400) 1200 €/m²



Architect: Zielke, Darmstadt

Costs compared: new built row house

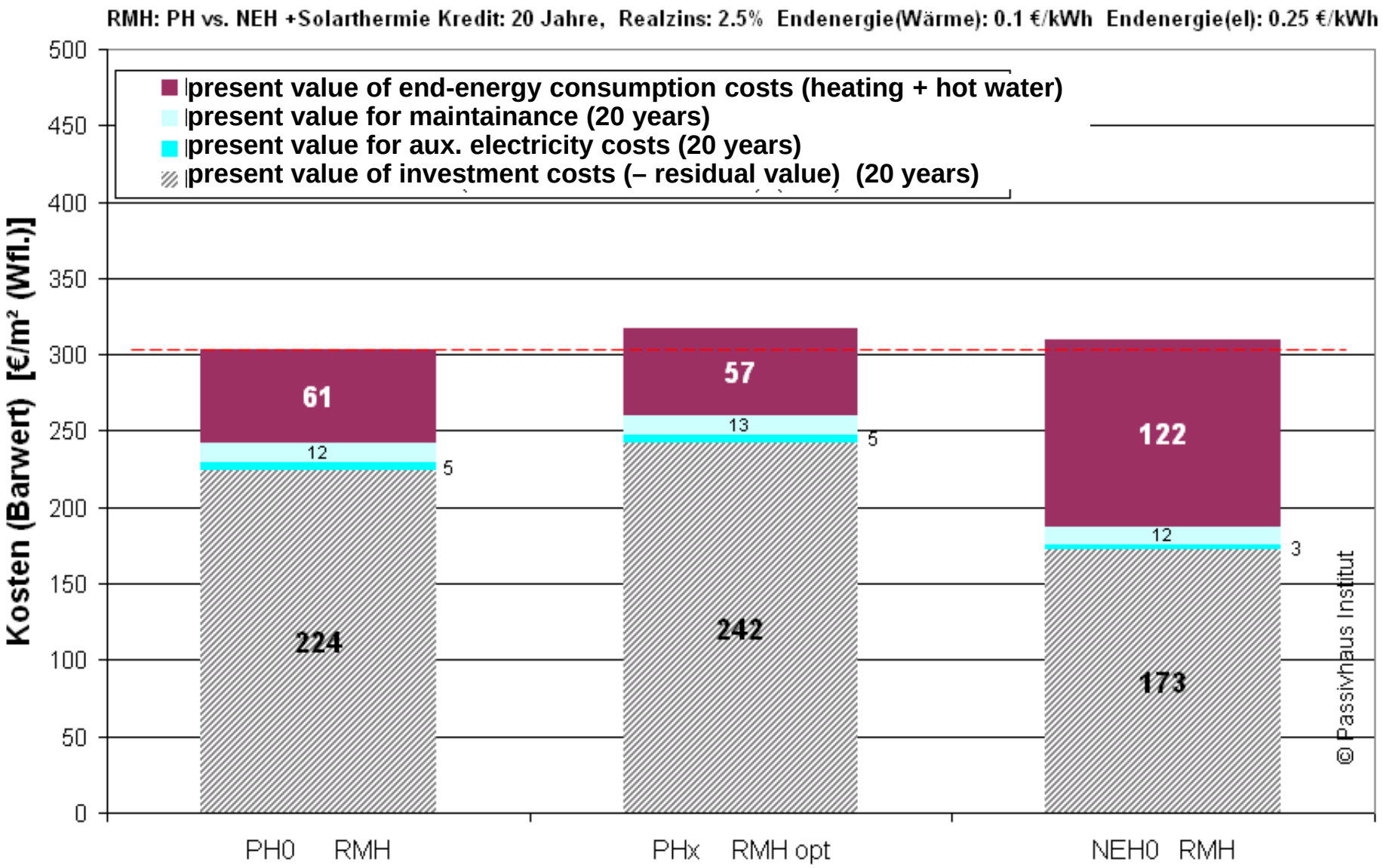
- moderate extra costs for Passive House compared to LEH(NEH)



Quelle: AKKP 42 Ökonomie

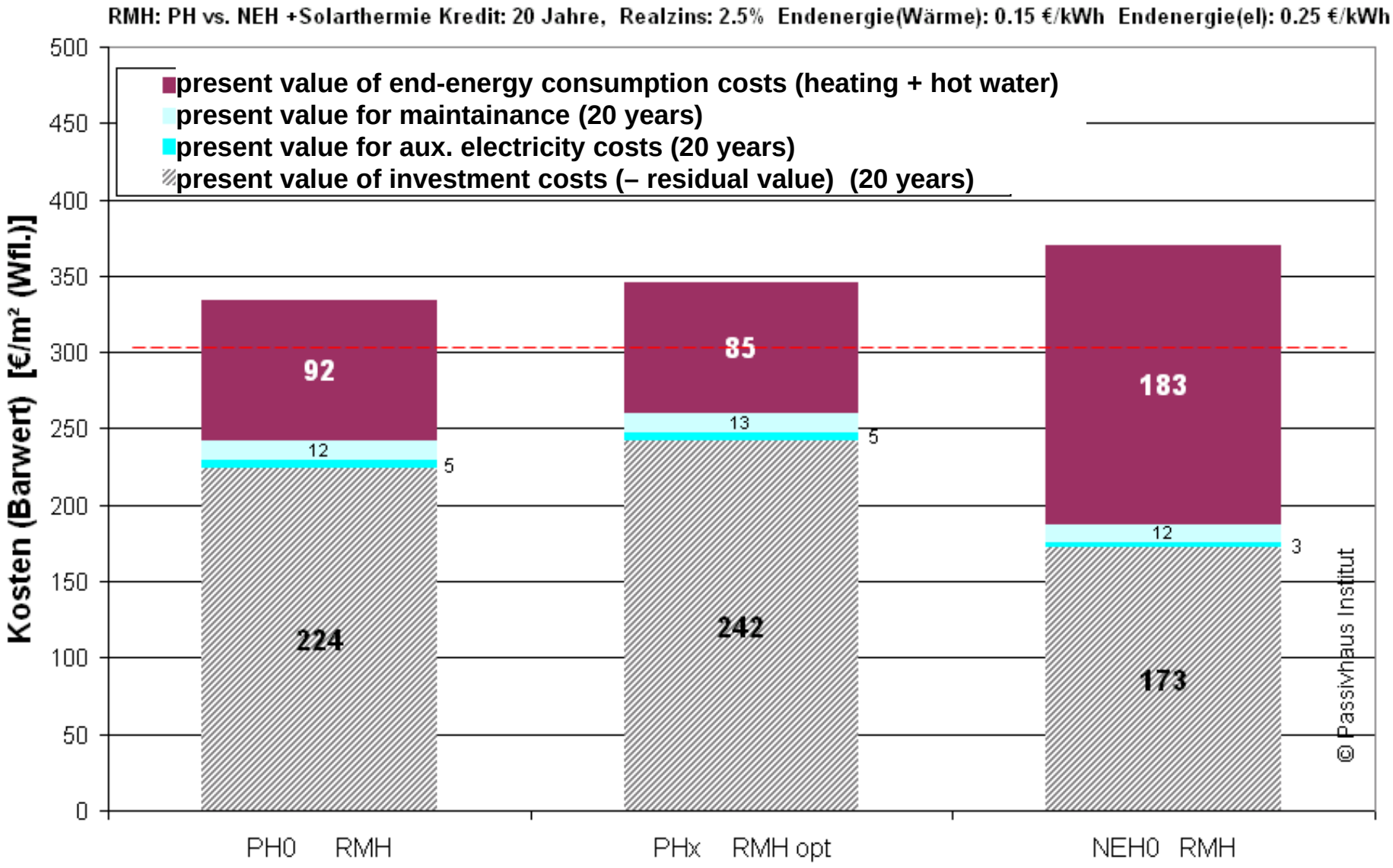
Passive House compared to low energy building (RMH)

- Energy costs as today (2012):
  PH and LEH (NEH) almost equal



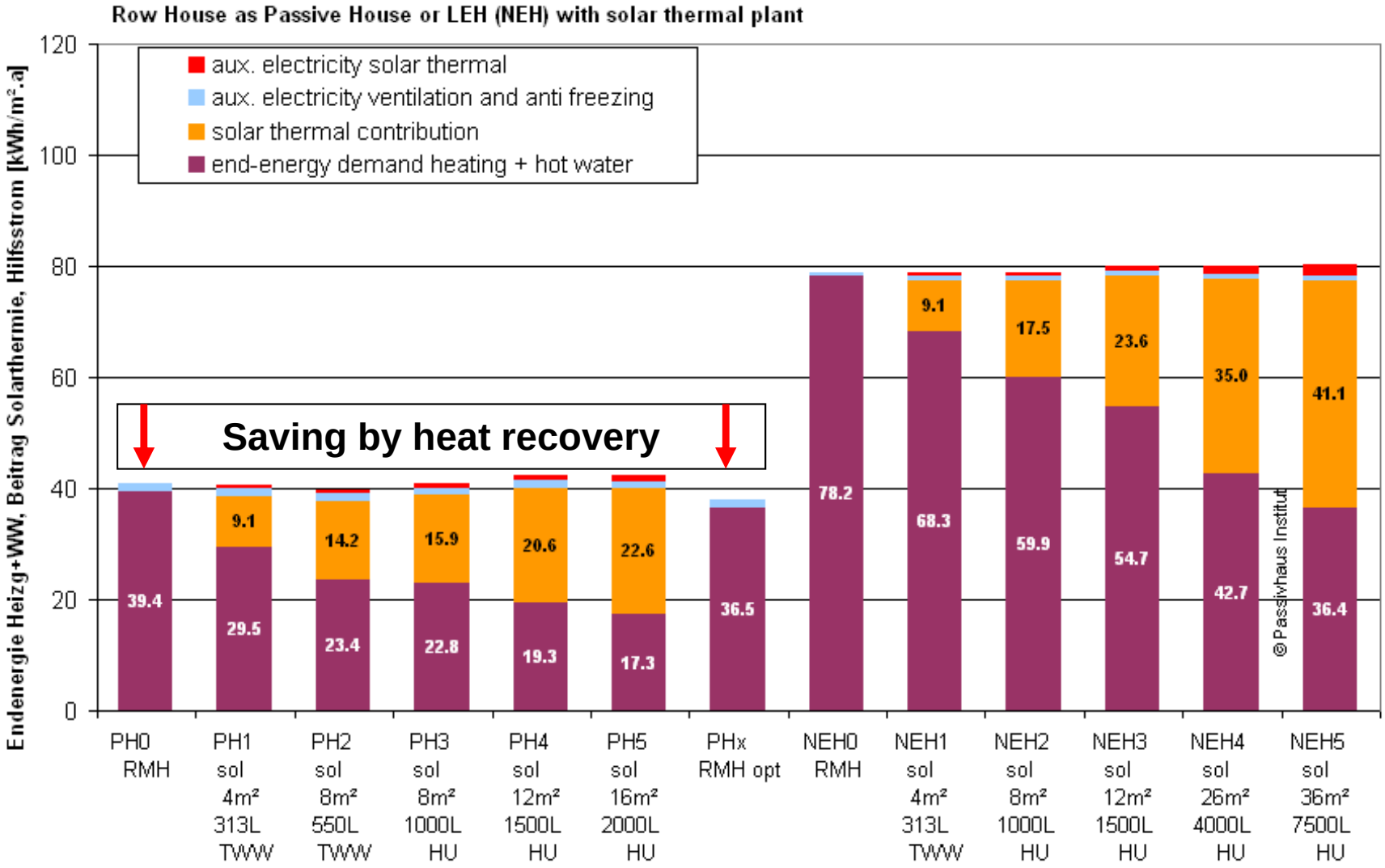
Passive House compared to low energy building (Szenario '15cent')

- higher energy prices: significant advantage for PH



Passive House compared to low energy building

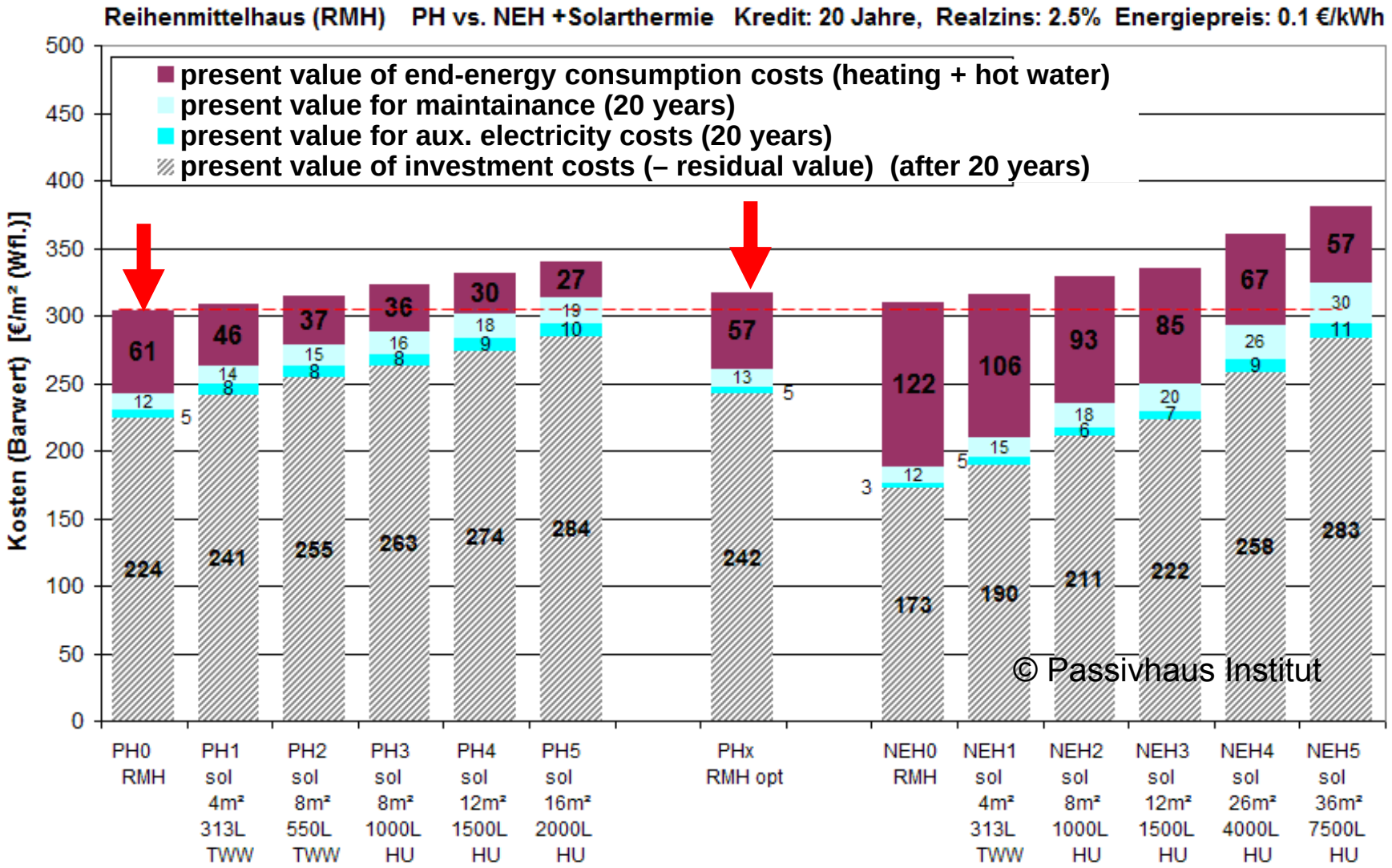
- PH compared to 'low-e'
- ventilation with heat recovery gives significant contribution



Quelle: Protokollband 42 (Ökonomie) Arbeitskreis Kostengünstige PH

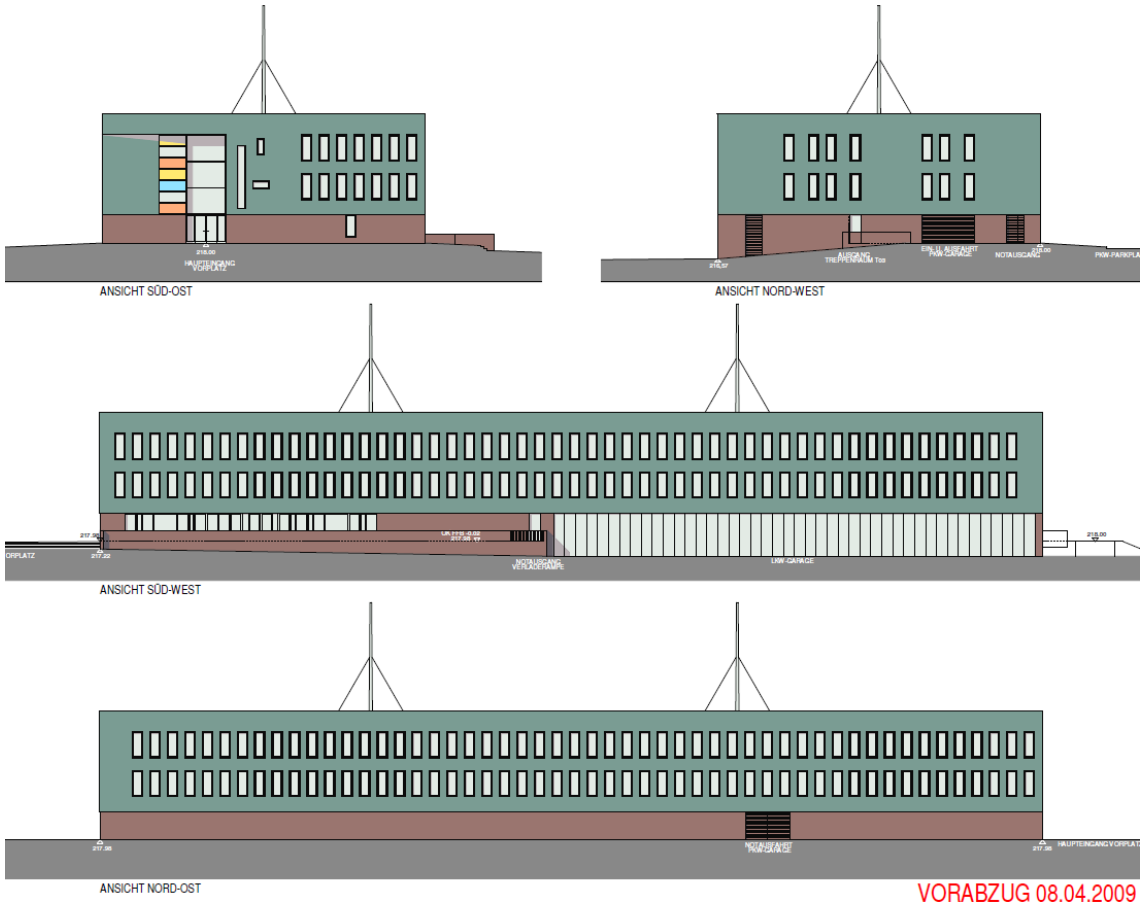
PH compared to 'low-e' building

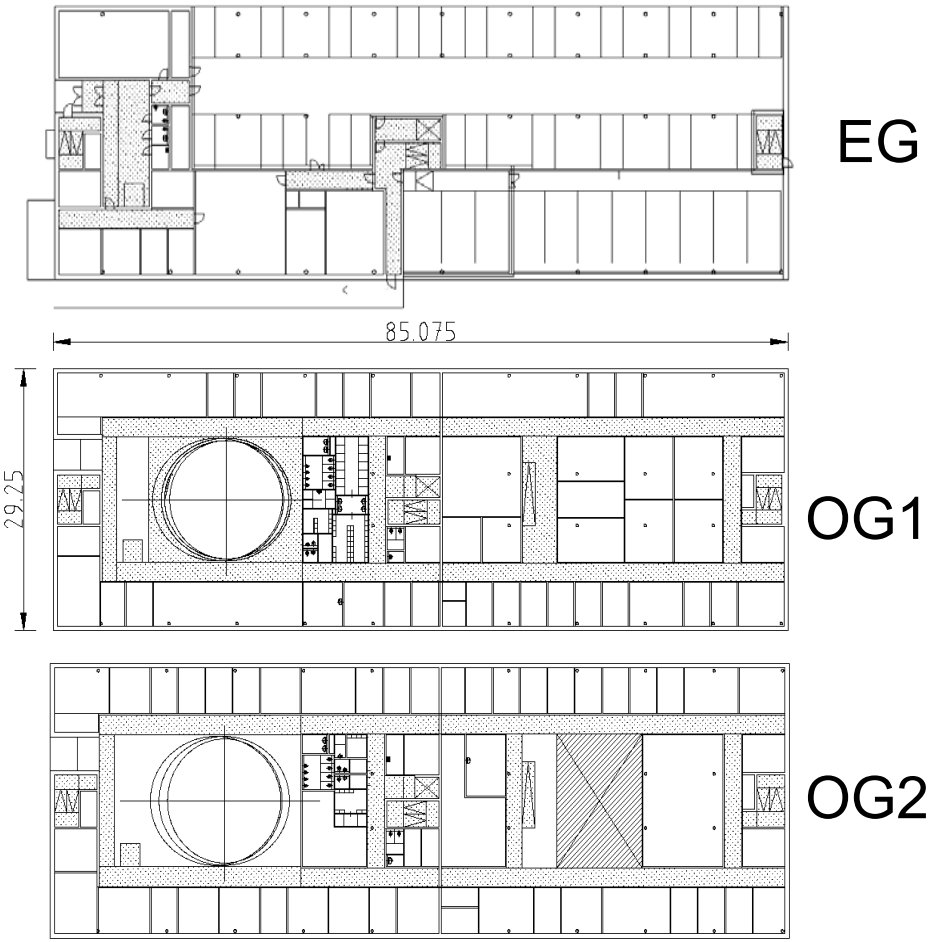
- A ventilation system is not that 'expensive'!



Quelle: Protokollband 42 (Ökonomie) Arbeitskreis Kostengünstige PH

economic evaluation of governmental office building: low energy 2007 − 2009 and PH

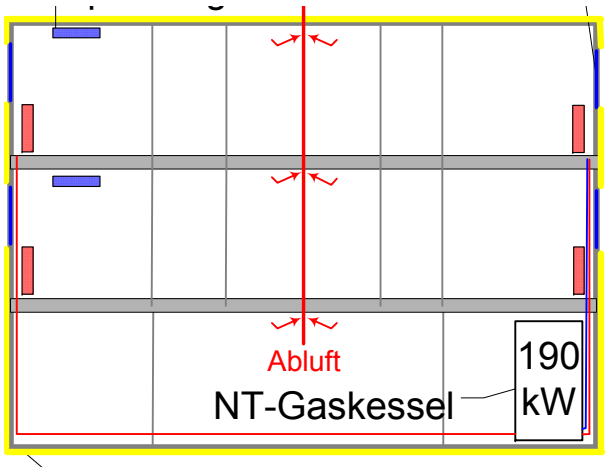


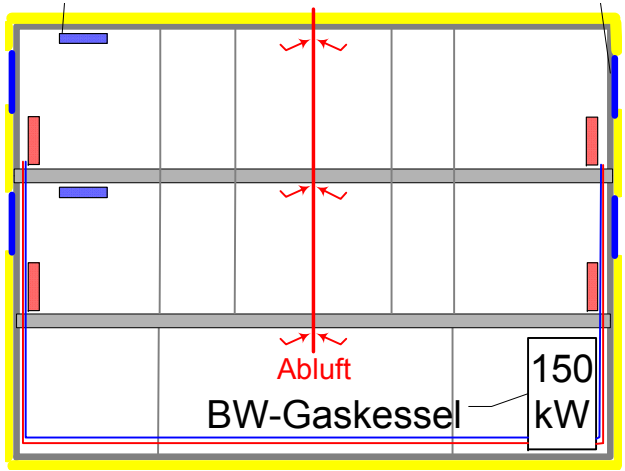


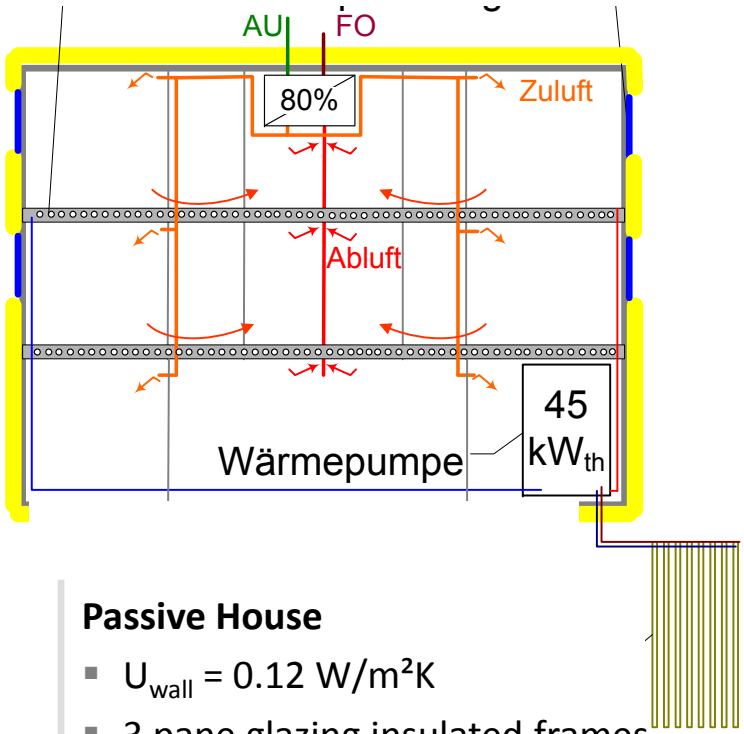
NGF: 4684 m² NF: 3053 m² EBF: 3870 m²

source: Passivhaus Institut, Diploma Theses Anne Huse "Ökonomische Evaluierung…" available for download **at** www.passiv.de

economical comparison for office building







Low energy 2007

- U_{wall} = 0.46 W/m²K
- 2pane glazing, standard frames U_w = 1.48 W/m²K
- Split cooling devices
- Standard gas boiler
- Internal gains: 5,71 W/m²
- Air tightness: 1,5 /h
- Lighting: 4 W/(100lx*m²) installed;
- Fluorescent lamps with **VVG**;
- **Without special light design**

Low energy 2009

- U_{wall} = 0.26 W/m²K
- 3 pane glazing, standard frames U_w = 1.11 W/m²K
- Split cooling devices
- Condensing gas boiler
- Internal gains: 5.71 W/m²
- Air tightness: 1,5 /h
- Lighting: 4 W/(100lx*m²) installed;
- Fluorescent lamps with **VVG**;
- **Without special light design**

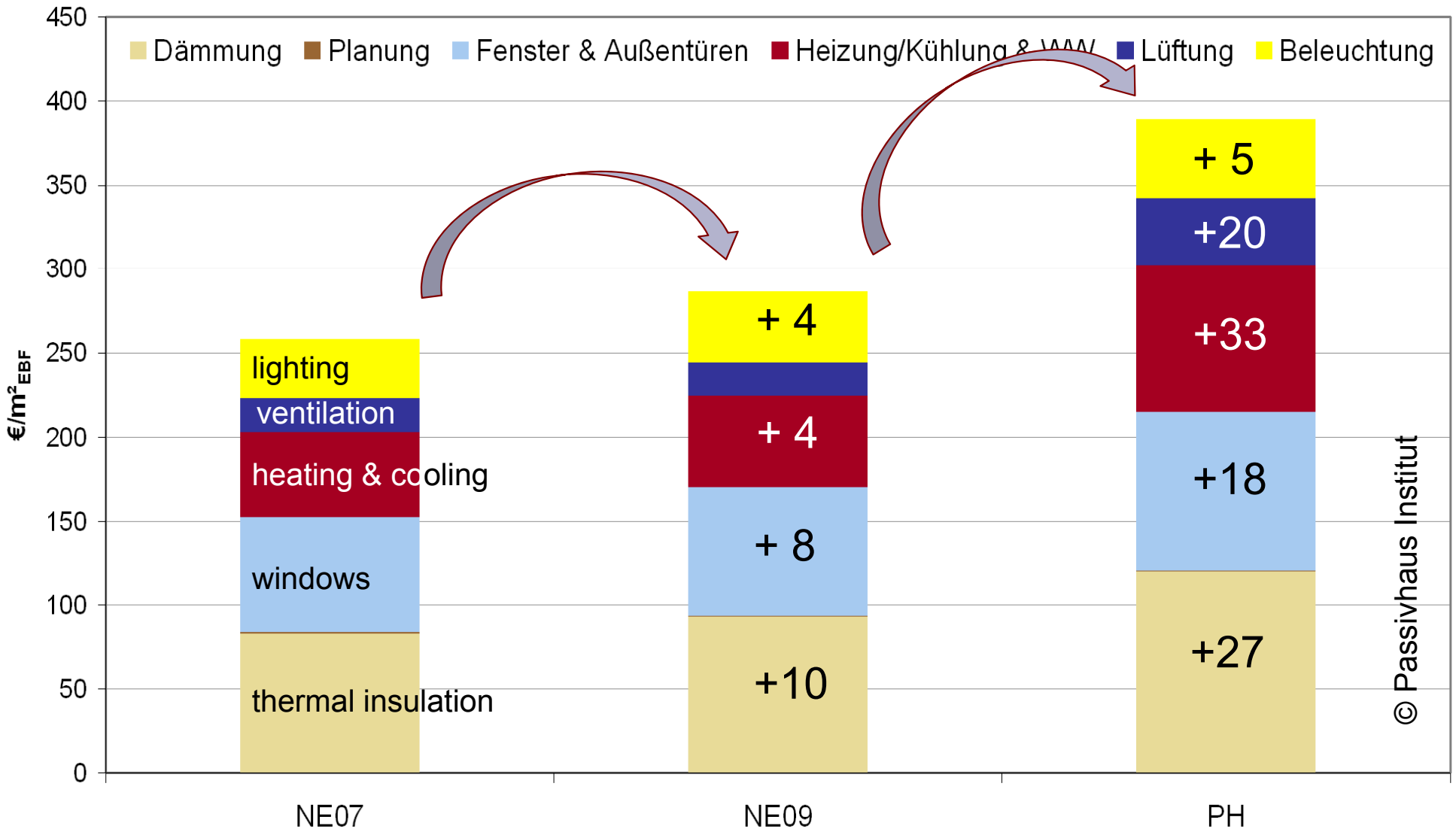
Passive House

- U_{wall} = 0.12 W/m²K
- 3 pane glazing insulated frames U_w = 0.86 W/m²K
- Concrete core activation, ground probes, heat pump (summer+winter)
- Internal gains: 4,77 W/m²
- Air tightness: 0,5 /h
- Hot water decentralized (electric)
- Lighting: 2 W/(100lx*m²) installed;
- Fluorescent lamps with electronic starter;
- **With special light design**

see Anne Huse, PH-conference 2010

Investment costs go slightly up ...

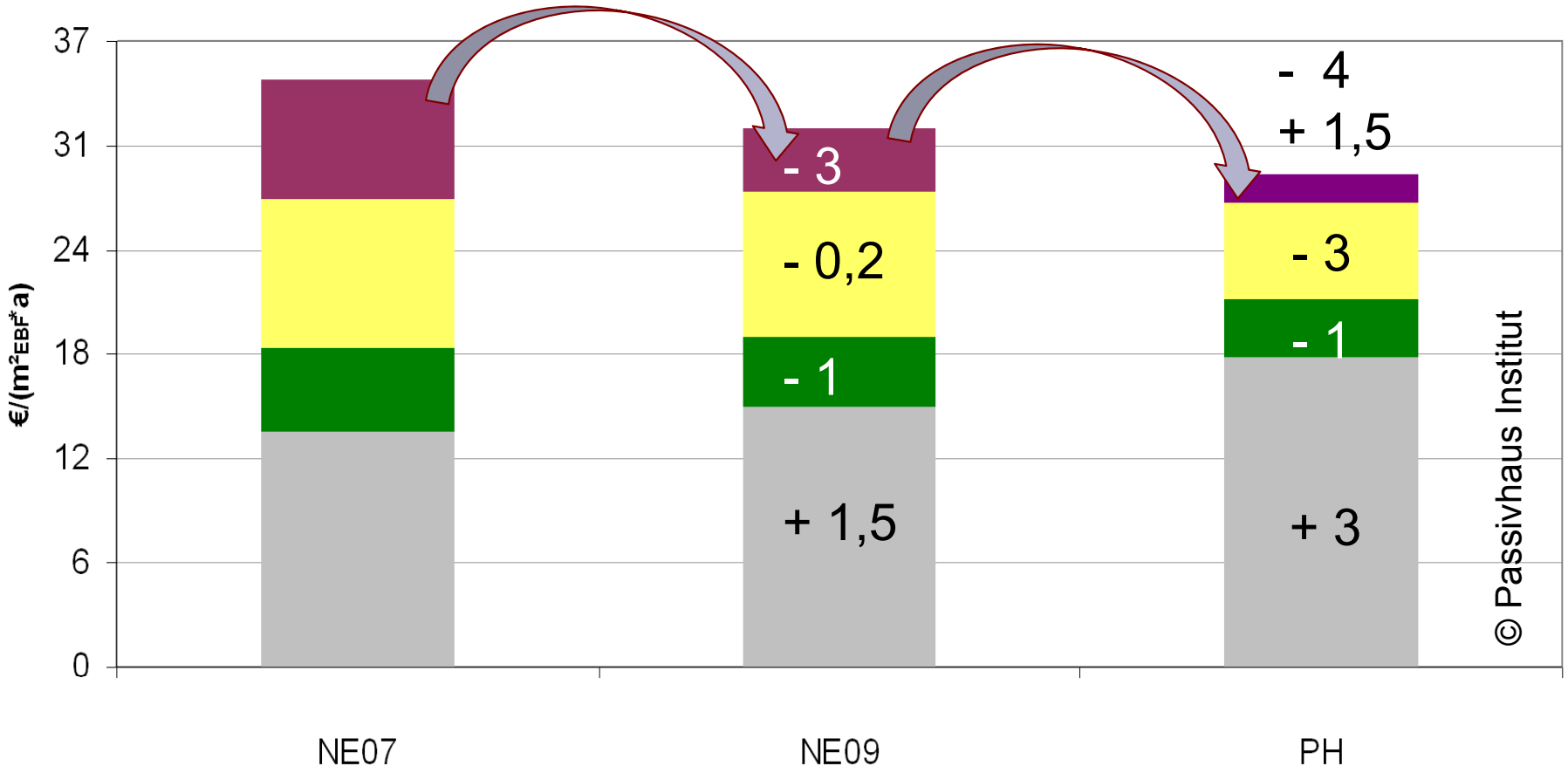
- only energy related costs taken into account and shown!



see Anne Huse, PH-conference 2010

... vs annual payments (total costs) reduced

- total lifecycle costs depend on interest rate & energy price



- investment cost (without residual value)
- electricity cost (lighting, cooling...)
- gas for heating
- maintainance cost
- heat pump electricity cost heating&cooling

Summary / Conclusion: Passive Houses are economically reasonable

general analysis and thesis:

- Energy prices and interest rates will probably not be 'high' at the same time

this chance we have to take:

- if energy prices are high, you should avoid high energy consumption(!)
- low interest rates and high energy prices favour the higher investment for better building quality (energy efficiency)
- instead of burning (expensive) fossil fuels.
- hence Passive House (special) or energy efficiency (in general) is a profitable investment

third party advantages (win win win):

- micro economy: local manufacturer (payed work for many people)
- macro economy: government (more taxes, welfare, ...)
- environment (less CO_2 ...)
- user (higher comfort, less cost that is like an old age provision!)

Conclusions: it's economcally reasonable to change.....

Examples for Passive Houses at some selected locations in Europe

- thermal insulation helps in anyway
- U-values might be lower, but not in the roof!

	Mannheim	To	Ma	Seville	Palerm
Insulation wall [cm]	25	20	10	8	6
Insulation roof [cm]	35	25	25	20	20
Insulation basement [cm]	2	15	6	0	0
U window frames [W/(m²K)]	0.72	0.72	0.72		
U-value glazing [W/(m²K)]	0.7	1.2	1.2		
Humidity control for cooling	no	yes	no	no	yes
Heating demand [kWh/(m²a)]	15.6	14.8	12.7	4.6	3.1
Sensible cooling [kWh/(m²a)]	0	0.8	0.4	4.2	7.2
Latent cooling [kWh/(m²a)]	0	2.3	0	0	7.2

insulated frame & double low-e glazing for thermal comfort

roof always well insulated

floor slab not insulated

construction determined by winter conditions

significant cooling required

Less frame insulation

for more information see www.passipedia.org