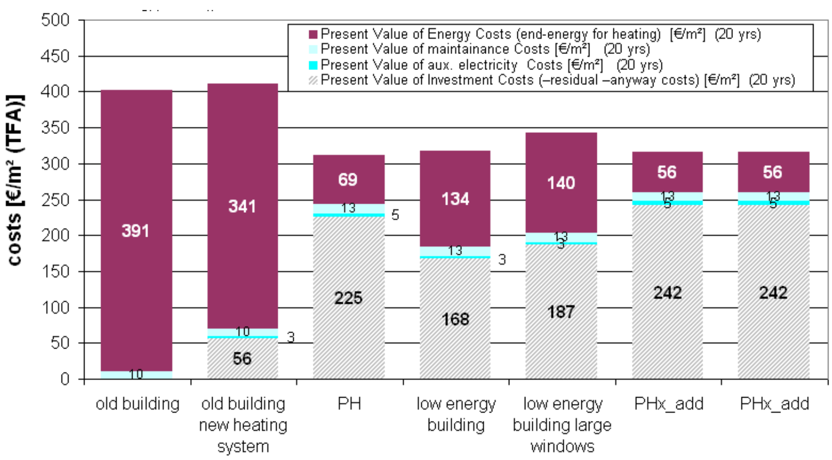
Passive House Institute

Economic Passive House buildings



business case seminar Leipzig Thu, April 15, 2015

Speaker: Berthold Kaufmann, Passive House Institute

economics …

Passive House Institute

Introduction:

- general economic aspects: how to discuss budget with investor
- how to manage construction costs (;-)
- accumulation discounting to get insight & overview
- simple financial (credit) mathematics

PHPP: energy & cost calculation combined

- new features to compare several options (variants) of construction
- how to compare energy data with …. financial / cost issues

IEA Annex 61 (Alexander Zhivov) Deep Energy Renovation

Discussion about how to get reliable building (cost) data

general economic aspects

please note: we do real estate business!

- 'sustainable' business implies that there are no extremely high and/or short time returns possible.
- This is explicitly true for investments in energy efficiency!
  These investments offer a long term return over the whole life time of the components or buildings as life cycle costs are minimized.

this goes in line with long lifetime of building components!

but we have to admit: any budget is limited(!)

- we need to discuss with investor:
  the extra costs for Passive House yield long term returns, ok!
- but they are in competition with other 'nice to have' things during the building process
- better building envelope has to be paid right now when the building is realized (or renovated), these investments cannot be done later on

an important part of profit is high living comfort in good quality buildings

Parameters of economic feasibility

Can hardly be assessed financially:

- aesthetic aspects
- better living comfort
- better air quality
- aspects of safety
- environmental criteria
- social effects

Living in a Passive House

Source: Informationsgemeinschaft Passivhaus D, Broschüre „Aktiv für mehr Behaglichkeit"

Can be reasonably assessed financially:

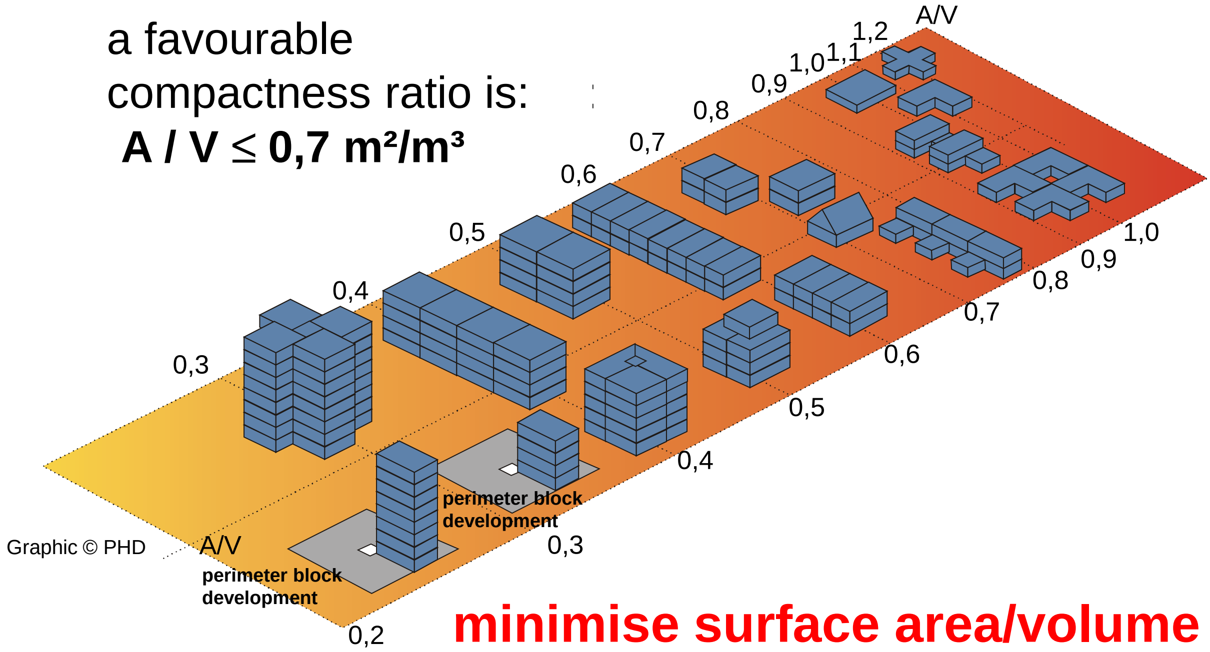
- amount of investment
- useful lifetime
- interest rate on capital
- annual energy consumption
- service and maintenance costs
- development of energy prices

Learning in a Passive House
Schule in Aufkirchen, Foto: G. Vallentin
Architektengruppe Wallbrunn-Grotz-Vallentin-Loibl, Emling

Cost saving by A/V-ratio

- compact building shape helps to save construction costs AND energy losses
- larger (apartment) buildings are better than very small ones

a favourable
compactness ratio is:
A / V ≤ 0,7 m²/m³



Graphic © PHD

minimise surface area/volume

Avoiding thermal bridges saves energy

- most thermal bridge designs are quite cheap to realize

Thermal separation at the brickwork's base with porous concrete, wood, PUR scantling, foam glass slabs

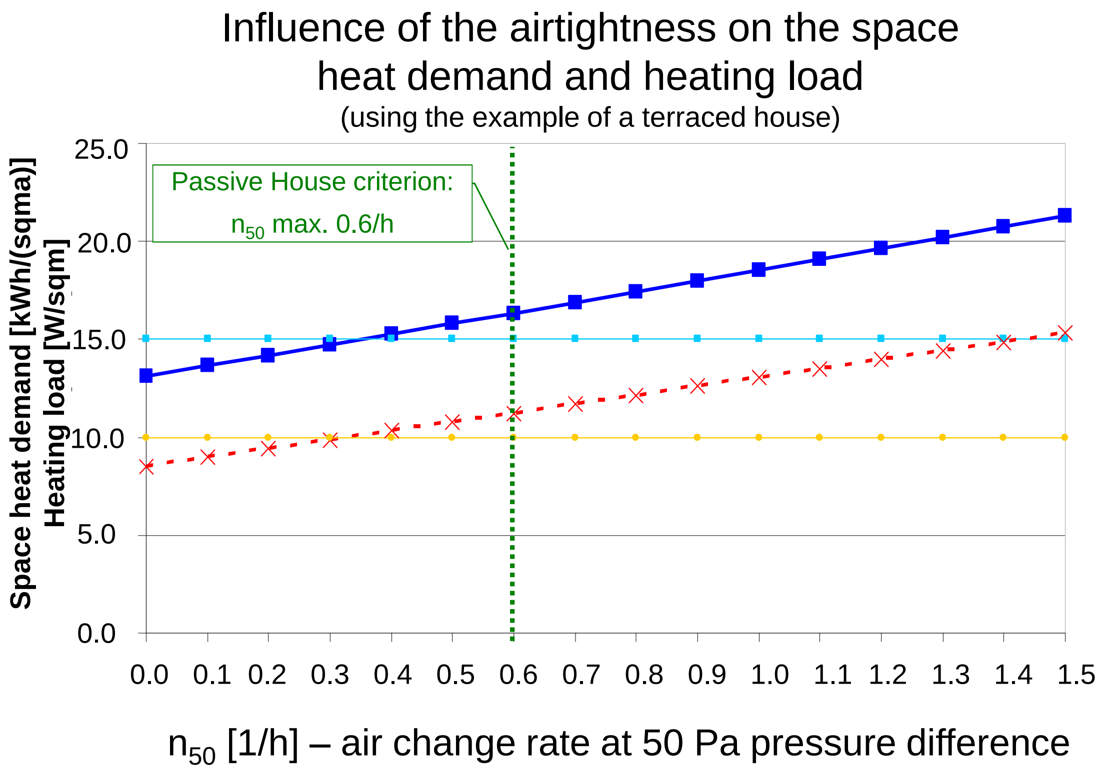
Thermal separation at base point of reinforced concrete walls (large buildings): Reduction of thermal bridge effect by splitting up into supporting columns.

Windows within insulation level, not within brickwork.

Source: PHI | PHD

Reduction of costs, airtightness

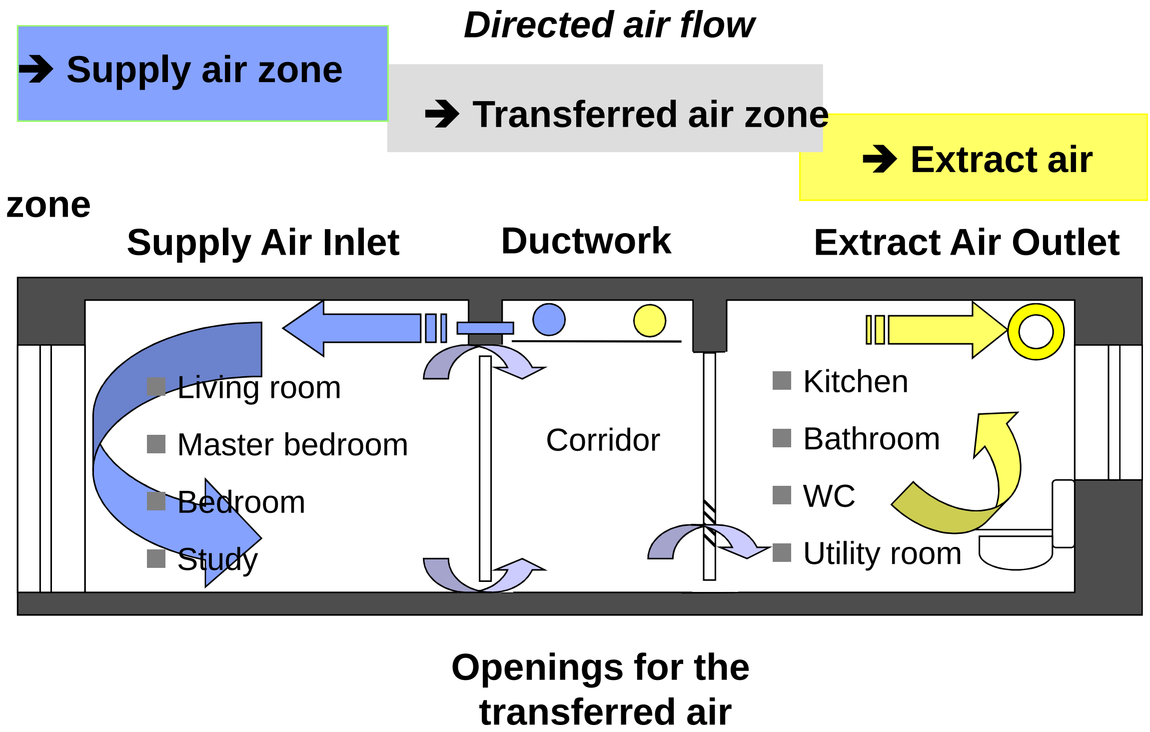
- airtightness is rather cheap with respect to saved energy!



Source: PHI

Reduction of costs, building services

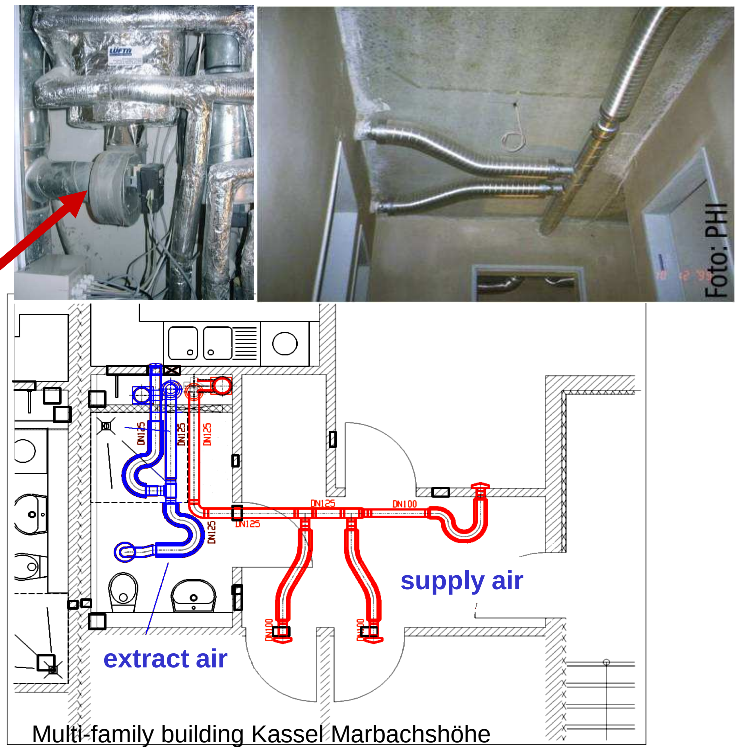
- compact ventilation system helps saving costs



Source: Pfluger PHI; PHD

Reduction of costs, building services

- Central unit roof: counter-flow HE, P_0-fans, filter
- Vertical distribution with chutes, silencers and fire flaps
- Junction for each flat with supply- and extract-air. Individual control fans and heating coil
- Supply- and extract-air in suspended ceiling
- Flexible bend silencers (avoids forming parts)
- Supply-air openings as jet nozzles in the architraves

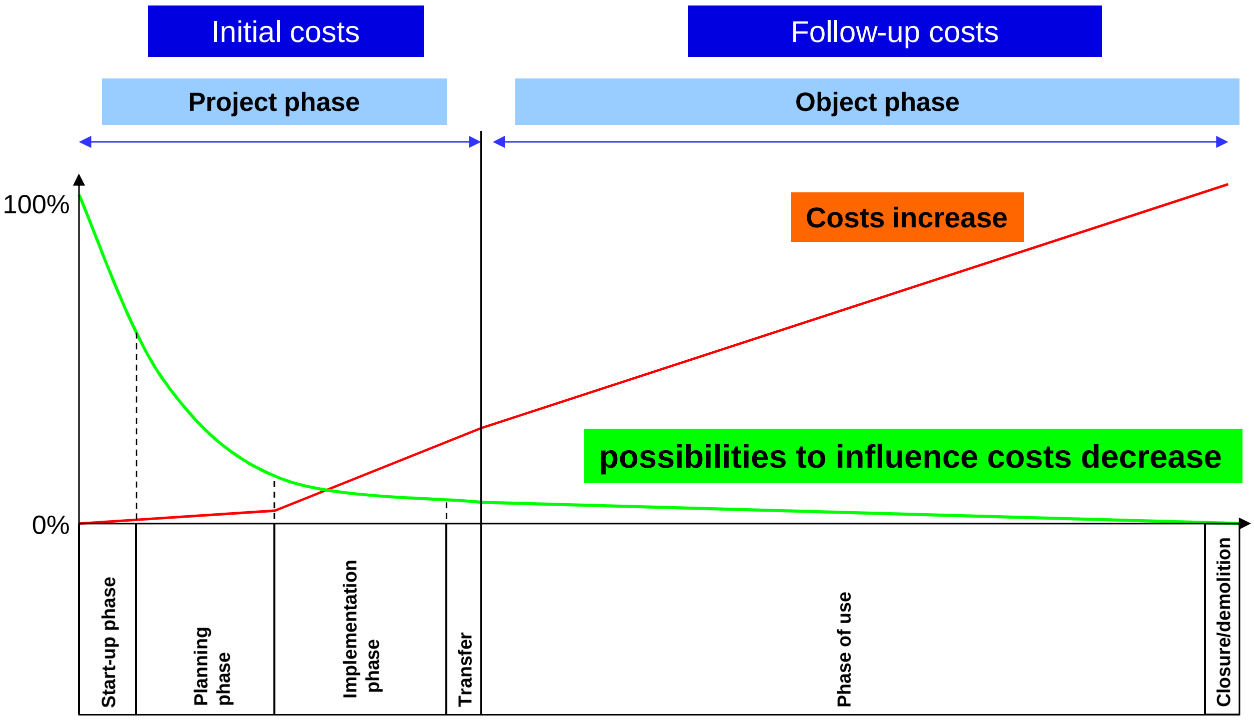


Multi-family building Kassel Marbachshöhe
Ventilation design: Innovatec, Kassel
Scientific guidance and evaluation: Passive House Institute

Source: [CEPHEUS-PI 16]

costs over a building's total life-cycle

- costs may be significantly influenced in the beginning of planning
- later on there is only limited influence



Source: similar [Kosten im Hochbau]

Accumulating and discounting

- How can we get control on costs?

- we have to look on all costs!
- we have to take into account 'cost' of capital: interest

- the earlier savings are deposited the higher is their future value if taking into account capital interest

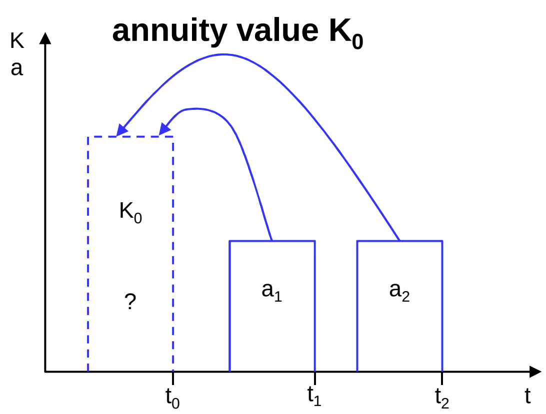
- accumulating annual payments to present value… discounting present value to yearly payments…
- helps to compare payments due on different dates
- helps to compare both: investment & running yearly costs

Net present value from yearly payments

- Question: how to compare annual payments in the future with an investment/payment today?

- Net present value or capital value = sum of discounted deposits and disbursements of an investment on a reference date.

- Reference date: generally t_0 = starting date (today)



Source: PHD, graphic similar [Wöhe]

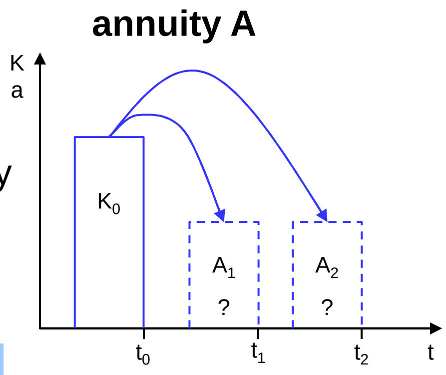
Annuity: annual payment for investment (credit)

- the (constant) annual payment to accumulate capital

annuity A = constant annual payments
to payback K_0 (credit) or to take out of K_0
or to et K0 annually payed (mortgage)

present value K_0 = present value factor * annuity

annuity A = PV of K_0 * 1 / present value factor
= PV of K_0 * annuity factor a



reciprocal of present value factor = annuity factor a

present value factor:

annuity factor a

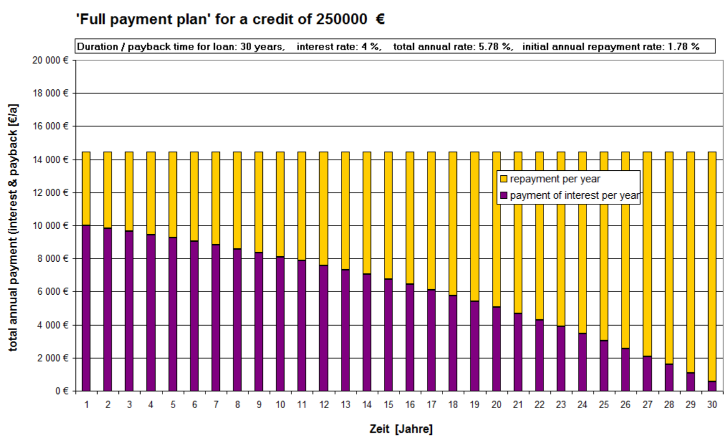
$$A = K_0 \cdot 1 / \frac{1-(1+p)^{-n}}{p} = K_0 \cdot \frac{p}{1-(1+p)^{-n}}$$

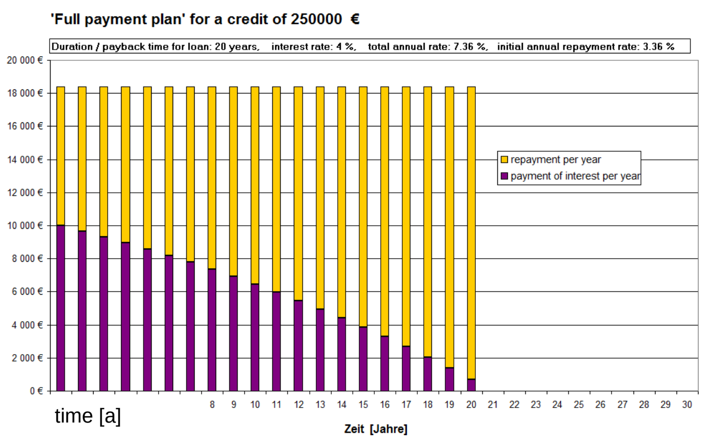
Source: PHD, graphic similar [Wöhe]

Annuity from interest and repayment

annual payment = interest + repayment

- example: credit of 250 000 €
- Interest rate: 4.5 % payback period: 30 a
- annual payment: interest + repayment
- principle of fixed annual payment: During the payback period of a loan the repayment rate increases whilst the interest rate drops





example: standard building vs. Passive House

- Standard building: heating 70 kWh/m² DHW 25 kWh/m²a

Final energy $Q_{E,}$ = TFA * (heating + hot water) / efficiency factors	200 m² * (70 + 25) kWh/(m²a) * 1.31	24 823 kWh/a
Gas price	0,08 €/kWh	
Annual energy costs	Q_E * P = 24 823 kWh * 0,08 €/kWh	1 985,89 €/a

- Passive House building: heating 15 kWh/m² DHW 25 kWh/m²a

Final energy $Q_{E,}$ = TFA * (heating + hot water) / efficiency factors	200 m² * (15 + 25) kWh/(m²a) * 1.19	9 558 kWh/a
Gas price	0,08 €/kWh	
Annual energy costs	Q_E * P = 9 600 kWh * 0,08 €/kWh	764,64 €

Difference of yearly energy costs	1 985,89 €/a – 764,64 €/a	1 221,25 €/a

- Present value from yearly difference is budget for ee-actions:

$$K = 1221€ \cdot \frac{1-(1+0.035)^{-30}}{0.035} = 22.461\ €$$

Source: PHD

Overview interest factors

Accumulation factor	Discount factor	Present value factor	Annuity factor
$(1+p)^t$	$\frac{1}{(1+p)^t} = (1+p)^{-t}$	$\frac{1-(1+p)^{-n}}{p}$	$\frac{p}{1-(1+p)^{-n}}$
	Equals the reciprocal value of the accumulation factor	Corresponds to the accumulated discount factors of the considered time period	Reciprocal value of the present value factor
Which final value does a current payment Z_0 have at a future date t?	Which present value Z_0 does a future payment Z_t have?	Which present value does an annually constant payment R_n have?	How high is the annuity R_n, that is to be paid from a present value Z_0?

What kind of insulation thickness pays off?

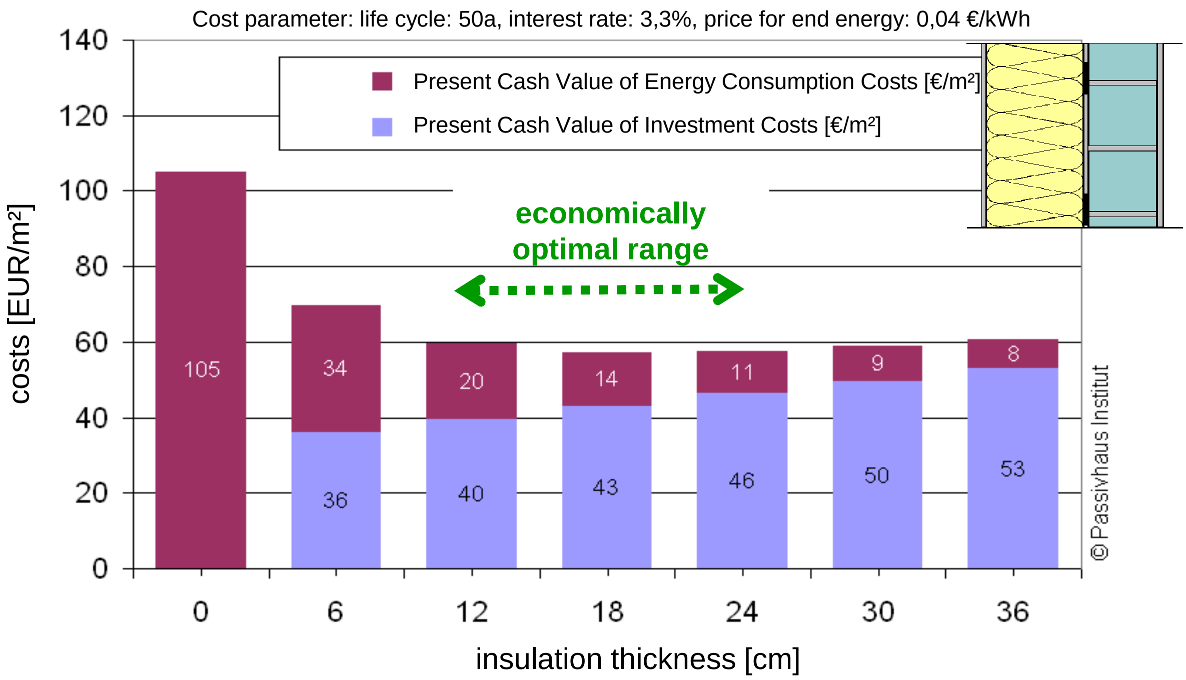
What is the optimum of energy saving measures and capital costs?

How much does a new coat of paint or new exterior rendering cost?

Source: BK

total lifecycle cost analysis (ETHICS)

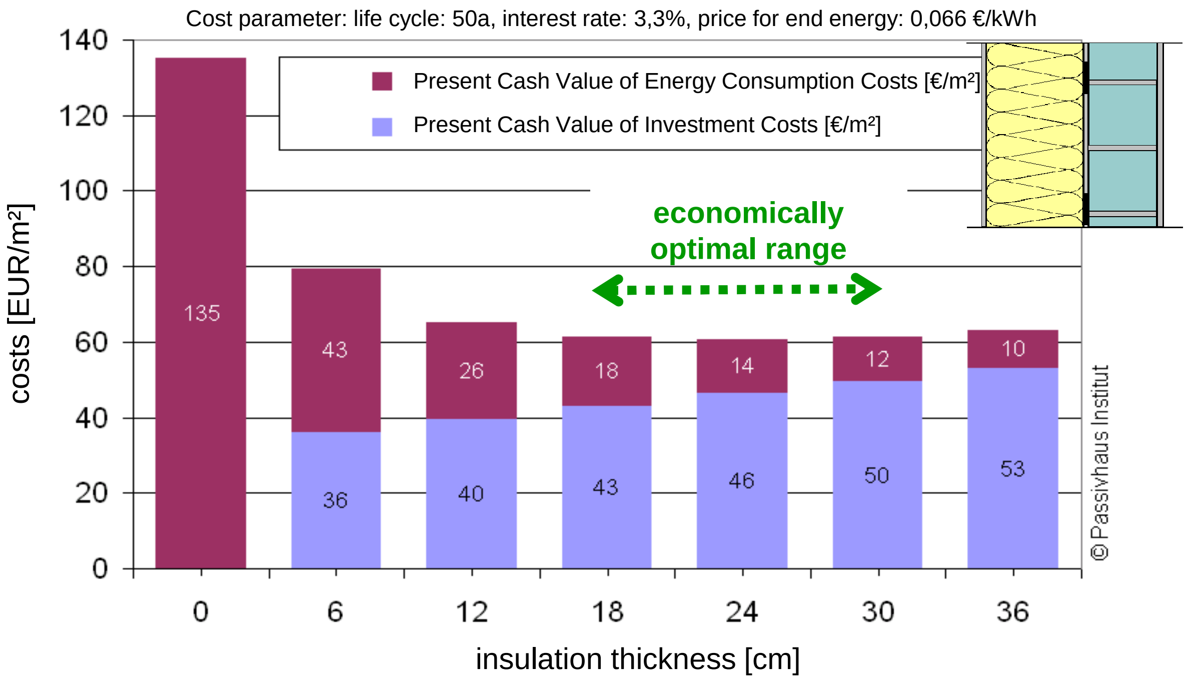
- boundary conditions as in the past (before 2004)



Source: PHI

total lifecycle cost analysis (ETHICS)

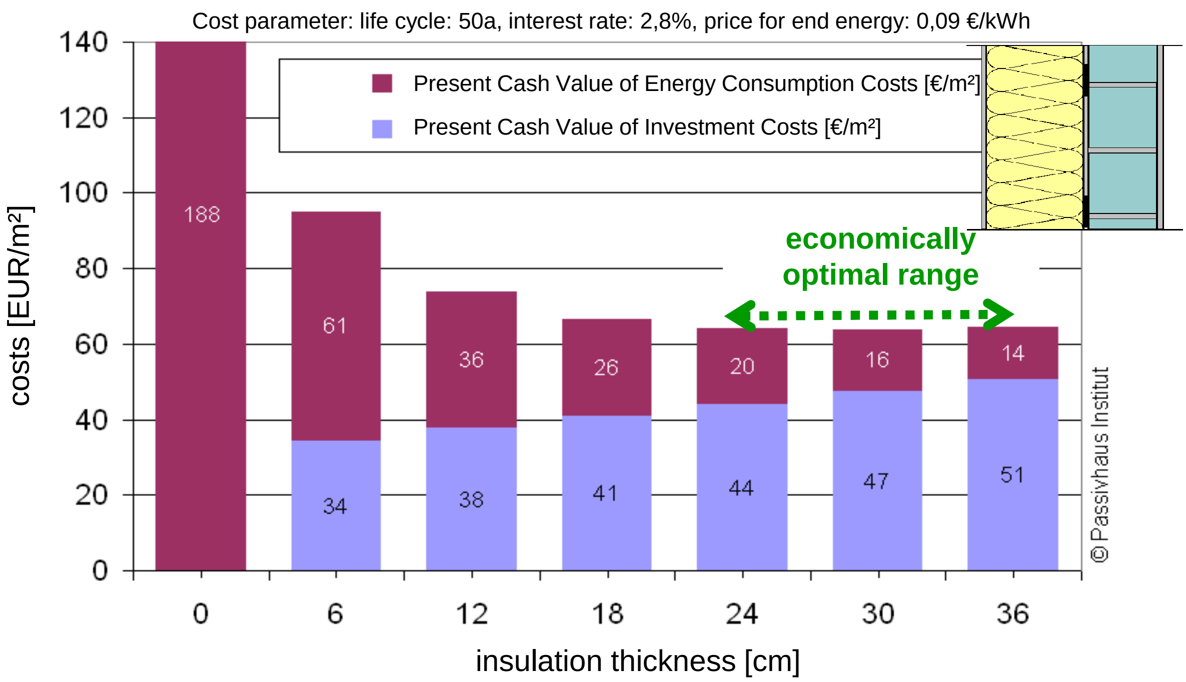
- boundary conditions as reported for German government (BBR 2008)



Source: PHI

total lifecycle cost analysis (ETHICS)

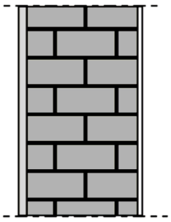
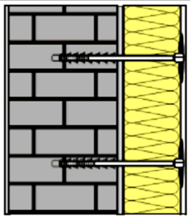
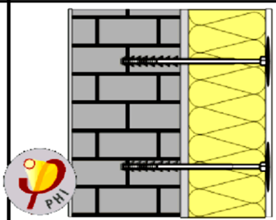
- boundary conditions as today (2012)



Source: PHI

total lifecycle cost analysis (ETHICS)

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
st 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

Source: PHI

what cost – what boundary conditions?

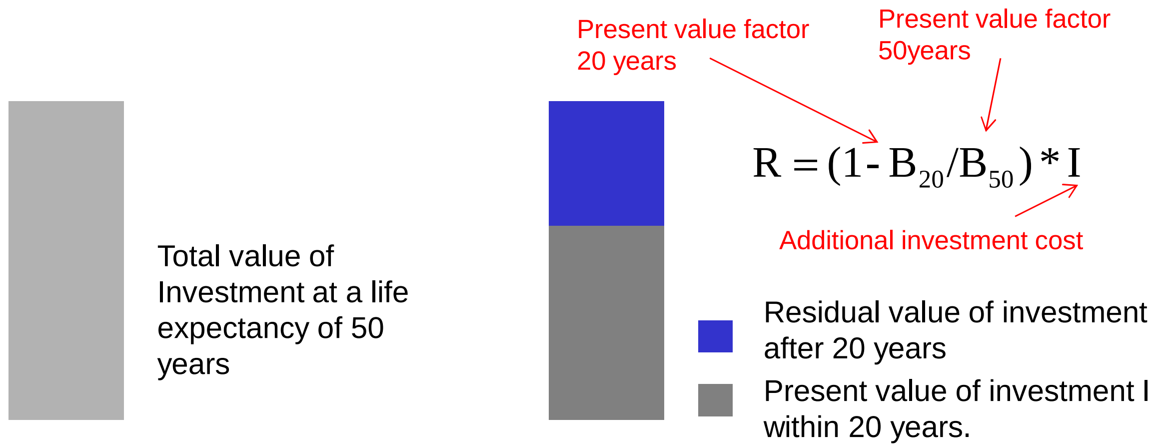
- Only **energy related investment costs** are accounted for
  "anyway-costs" are excluded from the calculations
- The **residual value** of a component is deducted,
  if the life time is longer than the time period under consideration
- **No extra energy price increase**
  instead **average future energy price estimate for calculation period**
- Calculation of **'price of saved energy'** €/kWh
  compare that to the current / future energy price: .... €/kWh
- Calculation of **full lifecycle costs** (energy + invest)
  bundles of actions may be compared economically

further boundary conditions needed to evaluate total lifecycle costs

- Real interest rate: 2,0 % (inflation-adjusted)
- Time period under consideration: 20 a
- Lifetime of the components 15 / 20 / 30 / 50 a
- final energy for heat price for a kWh 0,10 €/kWh (end energy)
- Electricity costs 0,20…29 €/kWh
- climate region as location of building (PHPP)

Residual value

- Measures for thermal insulation have product lives of 30, 50 years or longer.
- Loans usually have a duration of 20 years, at most (constant interest rate).
- A building component with an expected lifetime of 50 years still has a residual value equal to 39% of the original capital cost after a time period of 20 years (3.5% real interest rate).
- This residual value can be deducted when calculating the relevant investment costs.



Source: PHI | PHD

Looking at individual measures

Measures concerning the building envelope

- The lifetime expectancy of components used for a building’s envelope are very high: 30...50...100 years
- The renewal cycle of the building’s envelope is therefore comparatively long.

Subsequent measures for thermal insulation are mostly only economically viable if they are implemented at the same time as other renovation works that are required anyway.

- Combine the business: couple anyway needed renovation with measures for energy efficiency, or with new buildings:
- … you should implement all trendsetting thermal insulation measures that are already affordable today

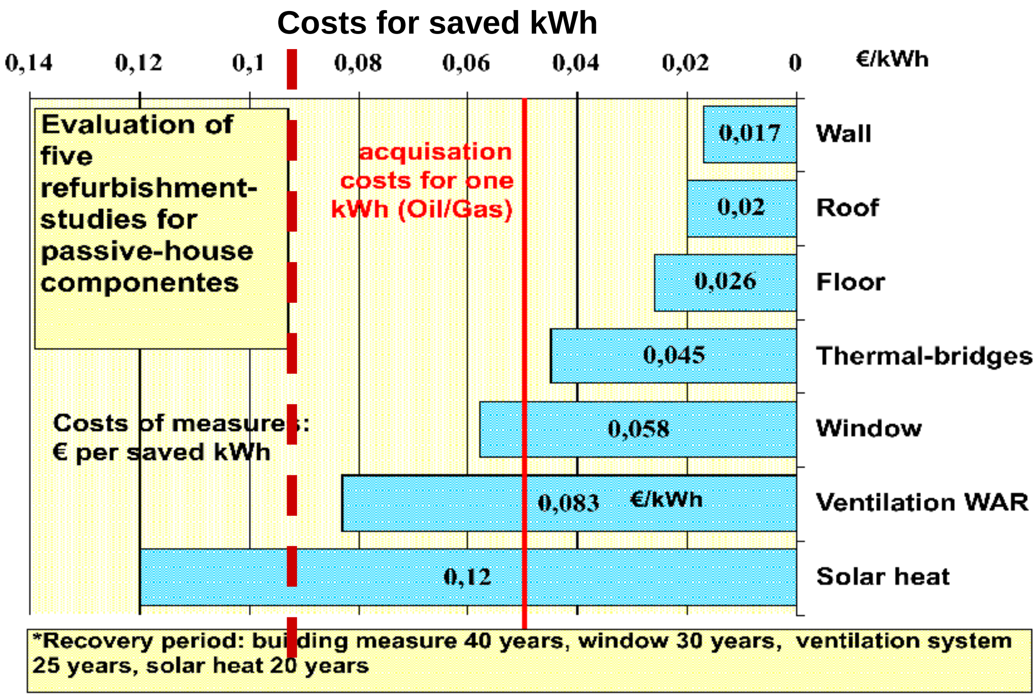
Compared to measures concerning the HVAC (shorter lifetime):

- The renewal cycles for technical systems are clearly shorter 15...20 years (e.g. heating systems)
- technical components need to be replaced at an earlier stage, it is therefore not necessarily profitable to use the newest technology.

Source: PHI | PHD

example: cost for saved kWh

- EnerPHit renovation, Nuremberg, Jean-Paul-Platz
- construction costs as of 2006
- energy costs ….



Source: Schulze-Darup

PHPP 9.1 with including cost calculation

we want to compare energy cost savings with extra investment cost for better building

- annual energy cost bill → → present cash value
- one first invest (by credit) – present cash value
- both has to be added up → total life cycle cost

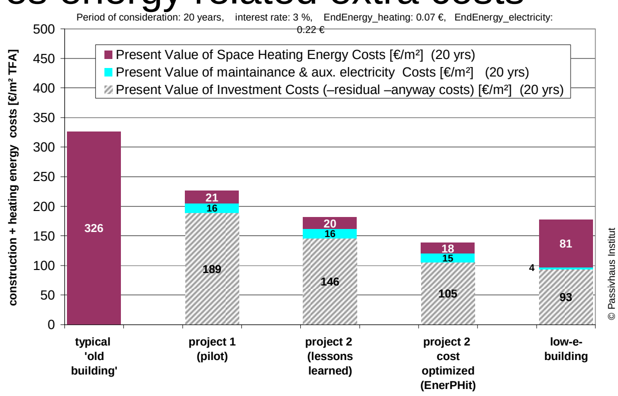
Energy balance calculation (PHPP) provides energy costs

- by energy price [€/kWh]

Investment cost data acquisition gives energy related extra costs

what cost to be accounted for?

- exclude anyway costs
- subtract residual value [20 a]



further boundary conditions:

- interest rate [% p.a.]

PHPP 9.1…

… includes variants to compare cots and savings

several variants may be defined by

- old building (high energy demand) as reference
- several variants after retrofit
  - thermal insulation (thickness & thermal conductivity)
  - windows (glazing & frame)
  - ventilation system

cost data may be entered / calculated directly

- annual savings recalculated to cash value
- applicable to status quo (old building) before renovation

You may get your PHPP 9.1

– if we can get your project data....(;-)

PHPP version 9.1

- exact internal gains evaluation
- applicable to status quo
  old building before renovation
- building envelope: thermal insulation (losses)
  windows (gains +losses)
- building service: ventilation (with heat recovery)
  heating systems
  hot water preparation

		hier die aktive Variante wählen >>>>>>>	3-Passivhaus mit WPK	Bestand	Mäßiger Wärmeschutz	Passivhaus mit WPK	Passivhaus Erdgas	Passivhaus mit WPK + Solarthermie	Passivhaus Erdgas + Solarthermie
	Ergebnisse	Einheit	3	1	2	3	4	5	6
	Heizwärmebedarf	kWh/(m²a)	12.4	355.1	88.8	12.4	12.6	12.4	12.6
	Eingangsgrößen	Einheit	Wert	1	2	3	4	5	6
	Bauteilschichten	U-Werte							
a	Innendämmung Dämmschicht	W/(mK)	0.028		0.04	0.028	0.028	0.028	0.028
		mm	80		45	80	80	80	80
b	Außenwand Dämmschicht	W/(mK)	0.04		0.04	0.04	0.04	0.04	0.04
		mm	275		100	275	275	275	275
c	Dach Dämmschicht	W/(mK)	0.04	0.1	0.04	0.04	0.04	0.04	0.04
		mm	400	200	100	400	400	400	400
d	Kellerdecke Dämmschicht	W/(mK)	0.04	0.1	0.04	0.04	0.04	0.04	0.04
		mm	250	50	50	250	250	250	250

Energy cost data evaluation…

- … from PHPP energy balance calculation
- numbers for each subset

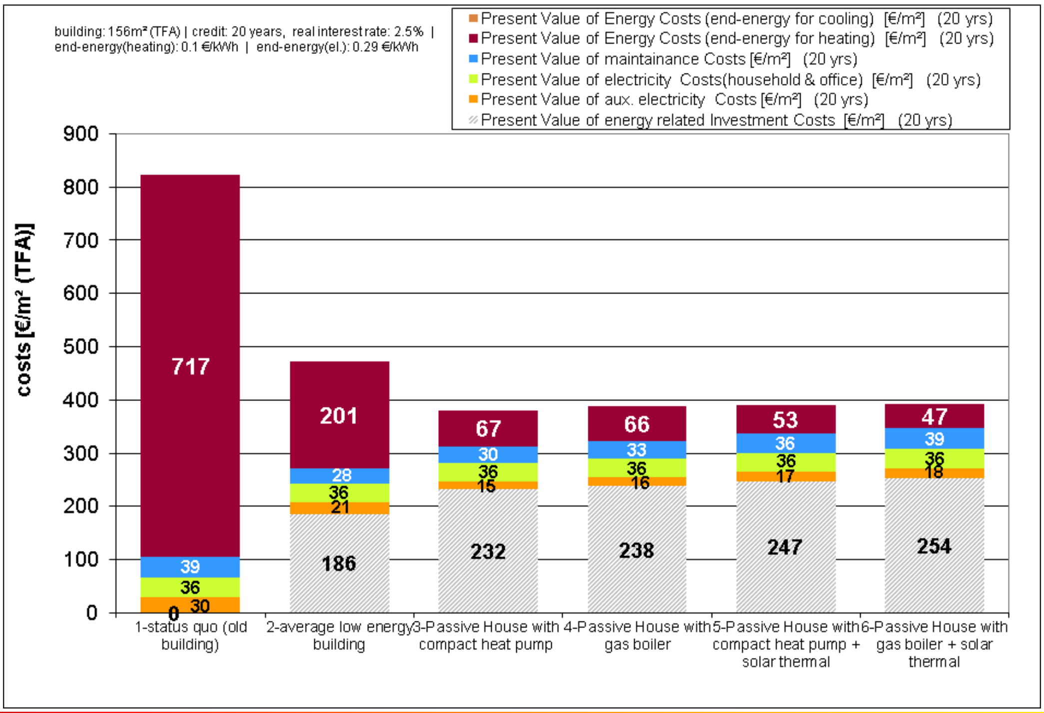
	1-status quo (old building)	2-average low energy building	3-Passive House with compact heat pump	4-Passive House with gas boiler	5-Passive House with compact heat pump + solar thermal	6-Passive House with gas boiler + solar thermal
annual energy demand after renovation [kWh/m²a]						
electricity compact system	0.0	0.0	14.8	0.0	11.8	0.0
electricity heat pump	0.0	0.0	0.0	0.0	0.0	0.0
district heating	0.0	0.0	0.0	0.0	0.0	0.0
wood and other biomass	0.0	0.0	0.0	0.0	0.0	0.0
mineral gas	0.0	129.2	0.0	42.2	0.0	29.9
mineral oil	459.9	0.0	0.0	0.0	0.0	0.0
solar thermal	0.0	0.0	0.0	0.0	12.8	11.4
electricity (direct)	0.0	0.0	0.0	0.0	0.0	0.0
other sources	0.0	0.0	0.0	0.0	0.0	0.0
aux electricity (ventilation, circulation pumps etc.)	6.7	3.9	2.7	3.1	3.2	3.4
electricity for cooling	0.0	0.0	0.0	0.0	0.0	0.0
aux. electricity for cooling	0.0	0.0	0.0	0.0	0.0	0.0
electricity for dehumidification	0.0	0.0	0.0	0.0	0.0	0.0
aux. electricity for dehumidification	0.0	0.0	0.0	0.0	0.0	0.0
electricity for houshold & office appliances	8.0	8.0	8.0	8.0	8.0	8.0
aux electricity (ventilation summer)	0.0	0.7	0.6	0.5	0.6	0.5
gas for cooking & drying (household)	0.0	0.0	0.0	0.0	0.0	0.0
heating power of heat complete supply system	**26.7**	**10.2**	**4.5**	**4.5**	**4.5**	**4.5**
annual energy costs (seperate for energy carrier)						
Energy costs heating (electricity) [€/m²a]	0.0	0.0	4.3	0.0	3.4	0.0
energy costs district heating [€/m²a]	0.00	0.00	0.00	0.00	0.00	0.00
energy costs heating (gas) [€/m²a]	0.00	12.92	0.00	4.22	0.00	2.99
energy costs heating (oil) [€/m²a]	45.99	0.00	0.00	0.00	0.00	0.00
energy costs heating (wood & other biomass) [€/m²a]	0.00	0.00	0.00	0.00	0.00	0.00
energy costs aux. elelctricity [€/m²a]	1.95	1.35	0.96	1.04	1.10	1.13
energy costs cooling [€/m²a]	0.0	0.0	0.0	0.0	0.0	0.0
energy costs electricity for houshold & office appliances [€/m²a]	2.3	2.3	2.3	2.3	2.3	2.3

construction cost added

	1-status quo (old building)	2-average low energy building	3-Passive House with compact heat pump	4-Passive House with gas boiler	5-Passive House with compact heat pump + solar thermal	6-Passive House with gas boiler + solar thermal
annual energy costs (seperate for energy carrier)						
Energy costs heating (electricity) [€/m²a]	0.0	0.0	4.3	0.0	3.4	0.0
energy costs district heating [€/m²a]	0.00	0.00	0.00	0.00	0.00	0.00
energy costs heating (gas) [€/m²a]	0.00	12.92	0.00	4.22	0.00	2.99
energy costs heating (oil) [€/m²a]	45.99	0.00	0.00	0.00	0.00	0.00
energy costs heating (wood & other biomass) [€/m²a]	0.00	0.00	0.00	0.00	0.00	0.00
energy costs aux. elelctricity [€/m²a]	1.95	1.35	0.96	1.04	1.10	1.13
energy costs cooling [€/m²a]	0.0	0.0	0.0	0.0	0.0	0.0
energy costs electricity for houshold & office appliances [€/m²a]	2.3	2.3	2.3	2.3	2.3	2.3
here you may enter detailed cost data	0.00	1.00				
specific costs of actions or components: several parts may be specified optionally, sum is						
costs thermal insulation as invoiced [€]	0	11057	14281	14281	14281	14281
thickness of insulation [mm]	0	100	275	275	275	275
costs per thickness [€/m³]		100	100	100	100	100
outside wall area [m²]	184	184	184	184	184	184
fixed basic costs thermal insulation (glue, nails, etc) [€/m²]		50	50	50	50	50
cost1: [€/m² TFA] Thermal Insulation outside wall	0	71	92	92	92	92
cost2: [€/m² TFA] Thermal Insulation roof	0	11	27	27	27	27
cost3: [€/m² TFA] Thermal Insulation cellar ceiling	0	18	27	27	27	27
cost7: [€/m² TFA] windows	0	80	92	92	92	92
cost4: [€/m² TFA] air tightness			5	5	5	5
cost5: [€/m² TFA] ventilation system	0	30	70	70	70	70
cost6: [€/m² TFA] heating system	0	90	60	70	86	96
cost8: [€/m² TFA] xxx						
Extra costs PH building [€/m²] lump sum if no detailed data available						
Sum: Costs for Action[€/m²] TFA	**0**	**300**	**373**	**383**	**398**	**409**
Residual Value of Investment Costs [€/m²] TFA	0	114	141	145	151	155
Investment Costs minus Residual Value [€/m²] TFA	**0**	**186**	**232**	**238**	**247**	**254**
Annual maintainance Costs (building service)						
maintainance costs [€/m²a] (1.5 % of investment of building service components)	2.5	1.8	2.0	2.1	2.3	2.5
Present values (for 20 years only)						
Present Value of energy related Investment Costs [€/m²] (20 yrs)	0	186	232	238	247	254
Present Value of aux. electricity Costs [€/m²] (20 yrs)	30	21	15	16	17	18
Present Value of electricity Costs(household & office) [€/m²] (20 yrs)	36	36	36	36	36	36
Present Value of maintainance Costs [€/m²] (20 yrs)	39	28	30	33	36	39
Present Value of Energy Costs (end-energy for heating) [€/m²] (20 yrs)	717	201	67	66	53	47
Present Value of Energy Costs (end-energy for cooling) [€/m²] (20 yrs)	0	0	0	0	0	0
Sum of present values of total Costs [€/m²a]	**822**	**473**	**380**	**388**	**390**	**393**

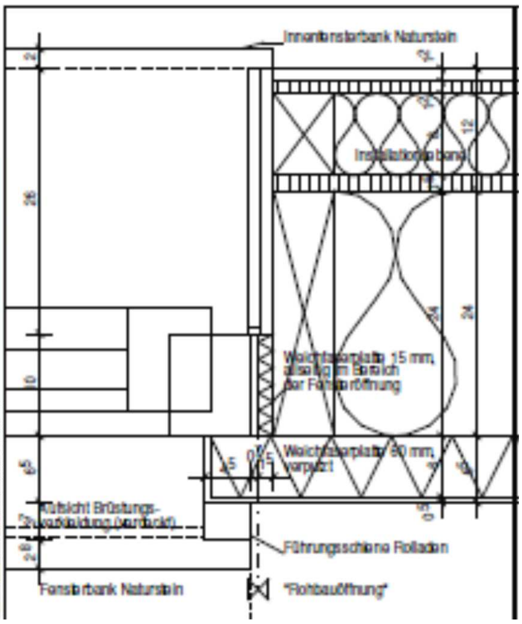
result: full lifecycle costs

- for each subset (variant) of different energy standard



example: new built row house

- Row house: lightweight wooden construction 184 m² TFA
- Rendered facade (wood fiber board)
- Windows: 30 m² (plastic)
- Shading (south facing windows)
- District heating



Architect: Zielke

Source: AKKP 42 Ökonomie

Costs compared: new built row house

Passive House Institute

- Row house: lightweight wooden construction 184 m² (EBF)
- construction costs (KG 300&400): 1144 €/m² (gross)
- costs for PH components (accounted): 322 €/m² (gross)
- Low energy building (LEH, theoretically): 240 €/m² (gross)
- Difference PH – LEH: 82 €/m² (gross)

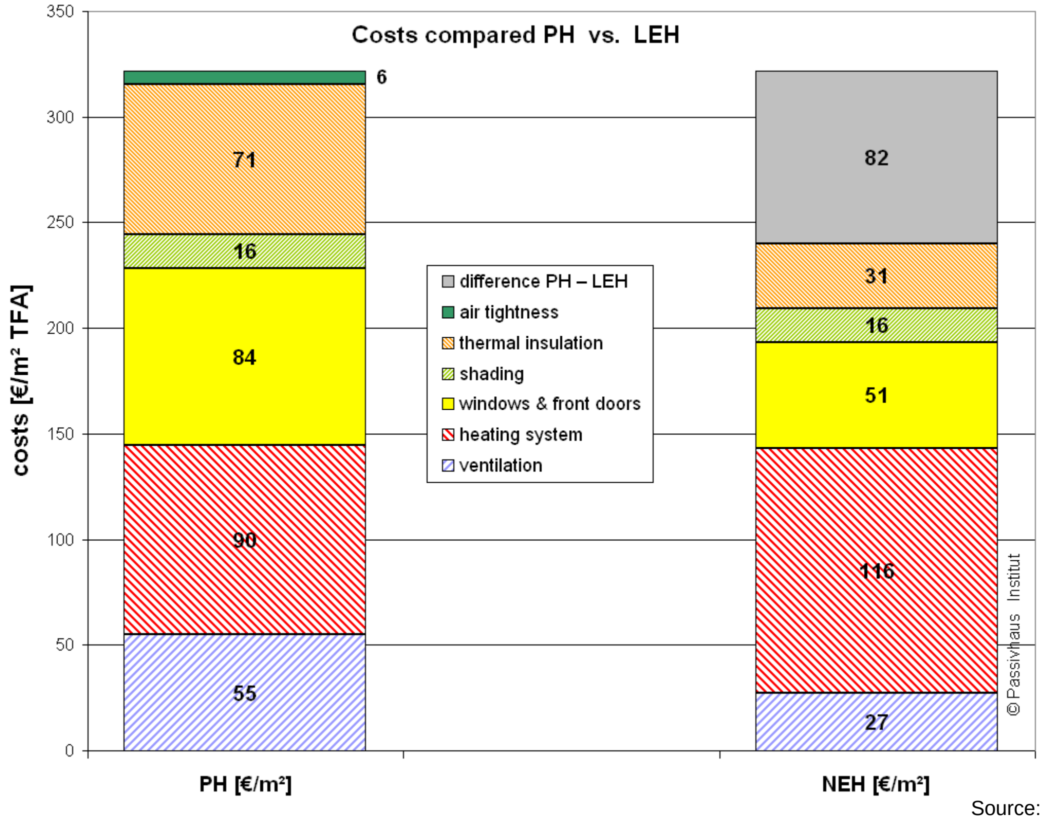
Reihenmittelhaus als Passivhaus, Grundversion								
Passivhaus, RMH: abgerechnete Kosten 2007 / 2008					NEH, RMH identische Massen ? Kosten recherchiert			
Energiebezugsfläche: 184 m²	[€]	[€/m²] EBF	Bt.Fl. [m²]	[€/m²] Bt.Fl.	[€]	[€/m²] EBF	[€/m²] Bt.Fl.	Bemerkung
Lüftung	**9 752**	53			5 000	27		nur Abluftanlage
Standard Frostschutzheizregister (elektrisch)	**350**	2			0	0		kein Frostschutz
Heizkörper	**1 168**	6			3 900	21		mehr HK
FW-Anschluss 6 kW (Baukostenzuschuß)	**6 838**	37			8 617	47		FW-Anschluss (15 kW)
FW-Anschluß (Installation, Sekundär)	**2 743**	15			2 743	15		wie PH
Wärmeverteilleitungen	**3 629**	20			4 500	24		mehr Wärmeverteilleitungen
Wärmeverteilleitungen (Dämmung)	**1 330**	7			700	4		weniger Dämmung
WW-Speicher	**833**	5			833	5		WW-Speicher
Fenster	**11 603**	63	30	387	7 500	41	250	Standardfenster (EnEV)
Verschattung (nur Süd)	**2 909**	16	21	136	2 909	16	136	wie PH
Haustür	**3 773**	21	3	1258	1 800	10	600	Standardhaustür (EnEV)
Dämmung Keller	**4 867**	26	100	49	2 250	12	23	dünnere Dämmung
Dämmung Außenwand	**4 320**	23	80	54	1 800	10	23	dünnere Dämmung
Dämmung Dach	**3 888**	21	72	54	1 620	9	23	dünnere Dämmung
Luftdichtheit	**1 176**	6	294	4	0	0	0	kein Aufwand Luftdichtheit
Summen:	59 178	322			44 172	240		
		Differenz: PH ? NEH			15 006	82		

Source: AKKP 42 Ökonomie

Costs compared: new built row house

Passive House Institute

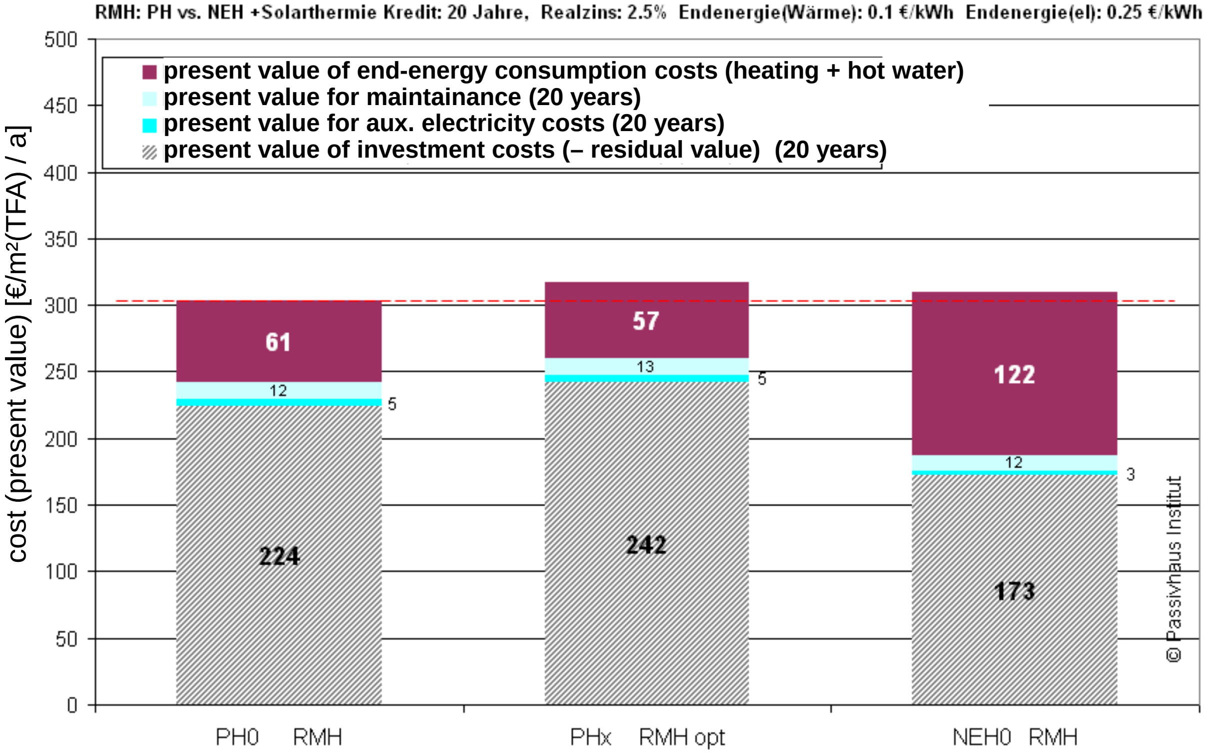
- moderate extra costs for Passive House compared to LEH(NEH)



Source: AKKP 42 Ökonomie

Costs compared: new built row house

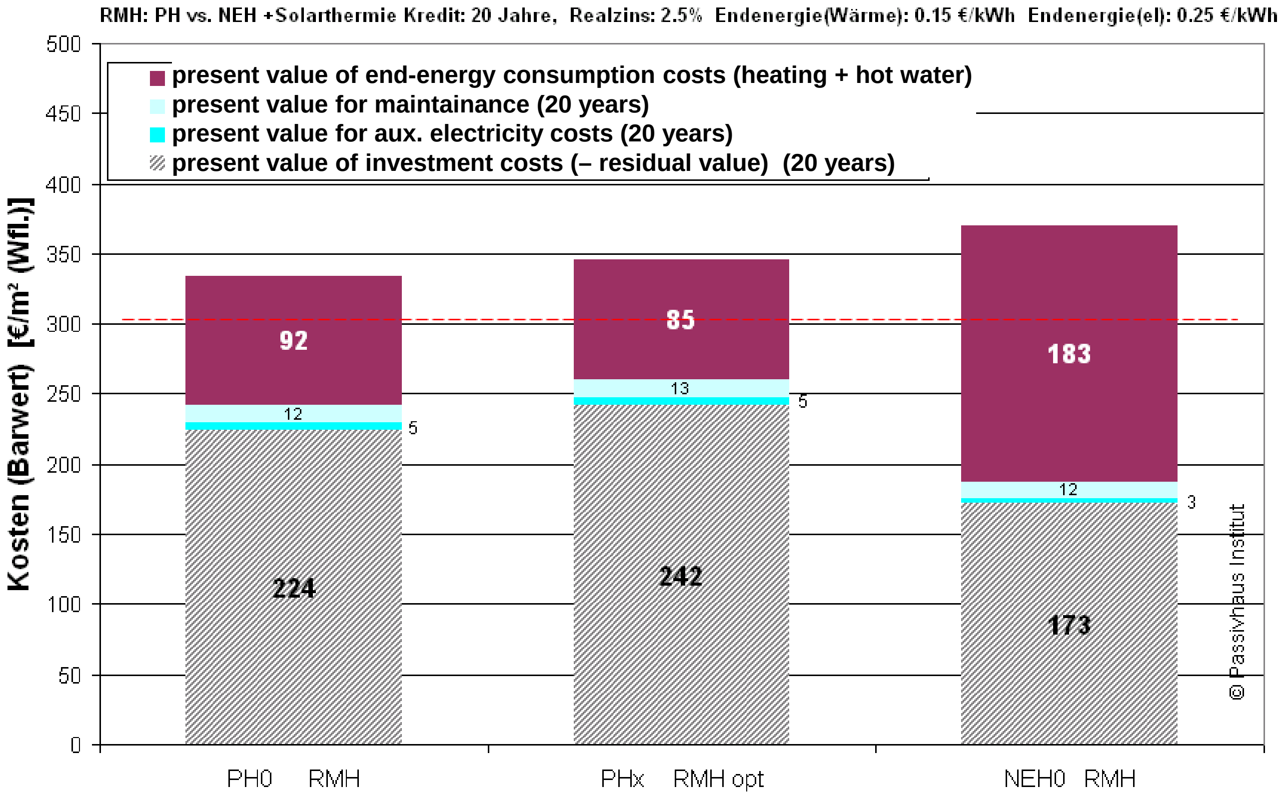
- Energy costs as today (2012):
  PH and LEH (NEH) almost equal



 basic economic calculation & implementation in PHPP

Passive House compared…

- higher energy prices (0.15 €/kWh): significant advantage for PH



 basic economic calculation & implementation in PHPP

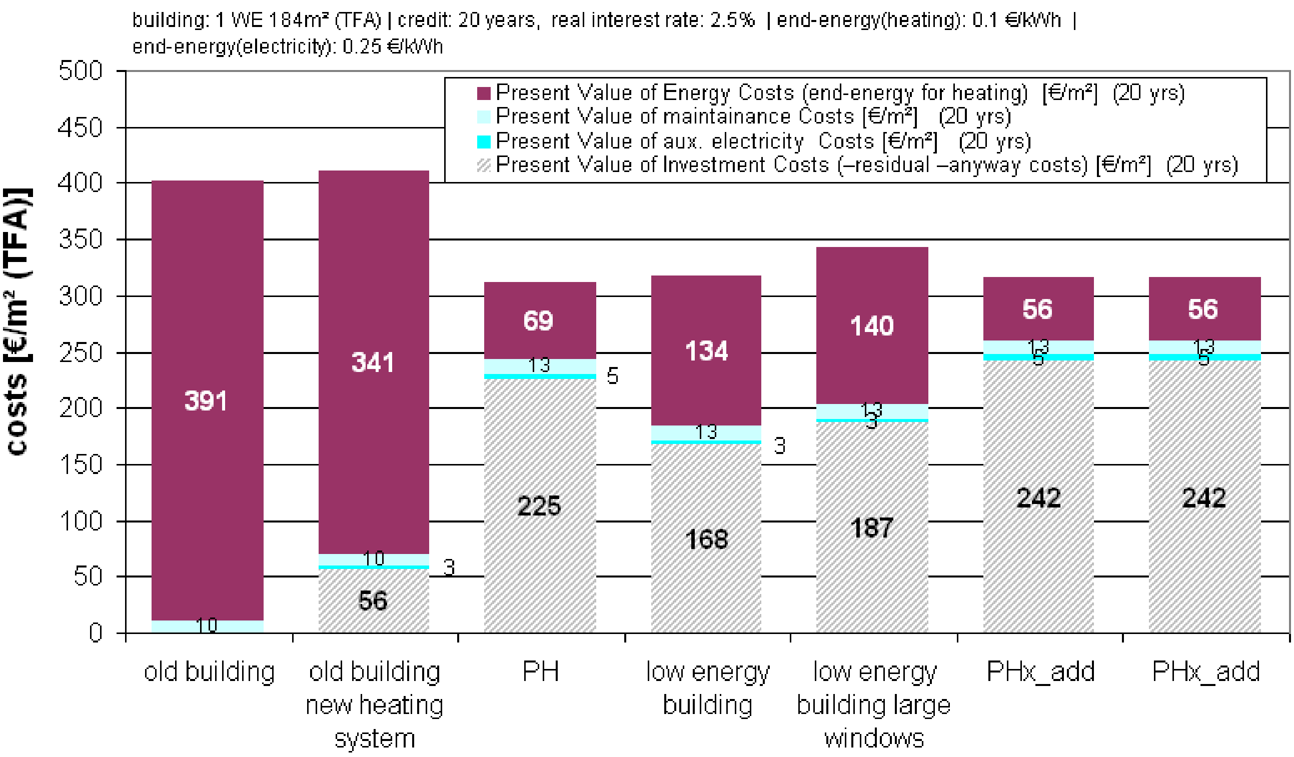
how to proceed

- do a cost data acquisition for each 'variant'   PHeco (tool)

'PHeco' Tool for cost calculation and economic evaluation of energy saving actions in building refurbishment ©_Passive House Institute, no guarantee, no support, feedback is welcome to mail@passiv.de	0	1	2	3	3	4	5
yellow: enter values	Maßnahme0	Maßnahme1	Maßnahme2	Maßnahme3	Maßnahme3	Maßnahme4	Maßnahme5
green: results	Altbau (neue Heizung)	PH	NEH	NEH (große Fenster)	PHx_add	xxx	xxx
blue-green: summarized results	action0	action1	action2	action3	action3	action4	action5
orange: explanation	old building	old building new heating	PH	low energy building	low energy building large	PHx_add	PHx_add
default settings: input energetic data of building							
space heat demand old building [kWh/m²a] (TFA) ((typically 150 kWh/m²a or taken from PHPP calculation))	**150.0**	**150.0**	**150.0**	**150.0**	**150.0**	**150.0**	**150.0**
marginal efficiency number (PHPP or generally = 1.5)	1.50	1.50	1.50	1.50	1.50	1.50	1.50
space heat demand of building afterwards [kWh/m²a] (TFA) ((from PHPP calculation))	**150.0**	**150.0**	**15.0**	**50.0**	**55.0**	**10.0**	**10.0**
marginal efficiency number after action (PHPP or generally = 1.2)	1.50	1.30	1.20	1.20	1.20	1.20	1.20
heating energy for hot water preparation [kWh/m²a]	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**	**20.0**
marginal efficiency number (PHPP or generally = 1.5)	1.50	1.30	1.20	1.20	1.30	1.20	1.20
marginal efficiency number after action (PHPP or generally = 1.2)	1.30	1.20	1.30	1.30	1.20	1.20	1.20
annual energy demand after action							
End-Energy Space Heating & Hot Water preparation (old building) [kWh/m²a]	**255.0**	**251.0**	**249.0**	**249.0**	**251.0**	**249.0**	**249.0**
End-Energy Space Heating & Hot Water preparation (after action) [kWh/m²a]	**251.0**	**219.0**	**44.0**	**86.0**	**90.0**	**36.0**	**36.0**
aux. electricity for ventilation system [kWh/m²a] (TFA) ((from PHPP calculation))		0.74	1.38	0.74	0.74	1.38	1.38
data needed for rescaling of specific numbers of area							
number of Appartments in building	**1**	**1**	**1**	**1**	**1**	**1**	**1**
surface area of component [m²]	184	184	184	184	184	184	184
treated floor area (TFA) of building [m²]	184	184	184	184	184	184	184
here you may enter detailed cost data							
specific costs of actions or components: several parts may be specified optionally, sum is performed	alle Kosten	alle Kosten	alle Kosten	alle Kosten	alle Kosten	alle Kosten	alle Kosten
costs1: [€/m²]			322	240	268	346	346
costs2: (optional)		80					
costs3: (optional)							
costs4: (optional)							
Sum: Costs for Action[€/m²] COMPONENT AREA	**0**	**80**	**322**	**240**	**268**	**346**	**346**
Part of Anyway Costs (will be subtracted, e.g. costs for outside rendering) [€/m²]							
Sum: only energy related Investment Costs [€/m²]	**0**	**80**	**322**	**240**	**268**	**346**	**346**
Total Investment Costs [€/m²] TFA	**0**	**80**	**322**	**240**	**268**	**346**	**346**
Residual Value of Investment Costs [€/m²] TFA	0	24	97	72	81	104	104
Investment Costs minus Residual Value [€/m²] TFA	**0**	**56**	**225**	**168**	**187**	**242**	**242**
Annual maintainance Costs							
maintainance costs [€/appartment/a] (e.g. for ventilation system)	120.00	120.00	150.00	150.00	150.00	150.00	150.00

results for further (renovation) variants

- only heating renovated…
- PH modified… LEH modified



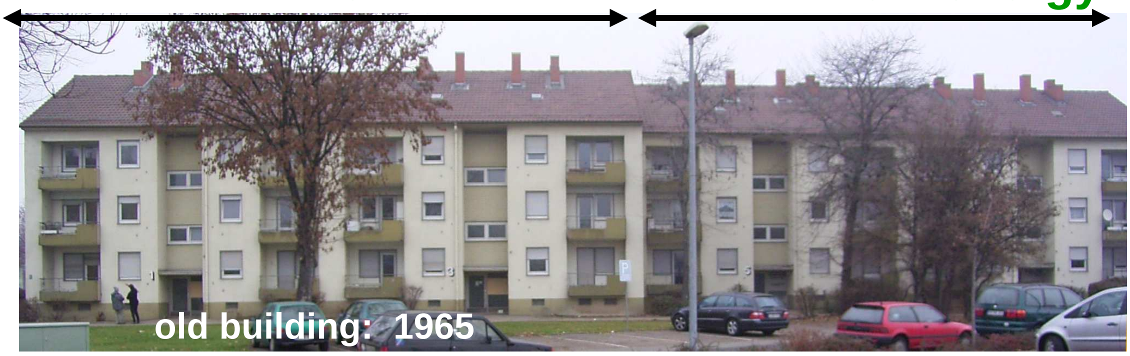
example: full lifecycle costs of renovation

- Ludwigshafen 'Hoheloogstraße'
- 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

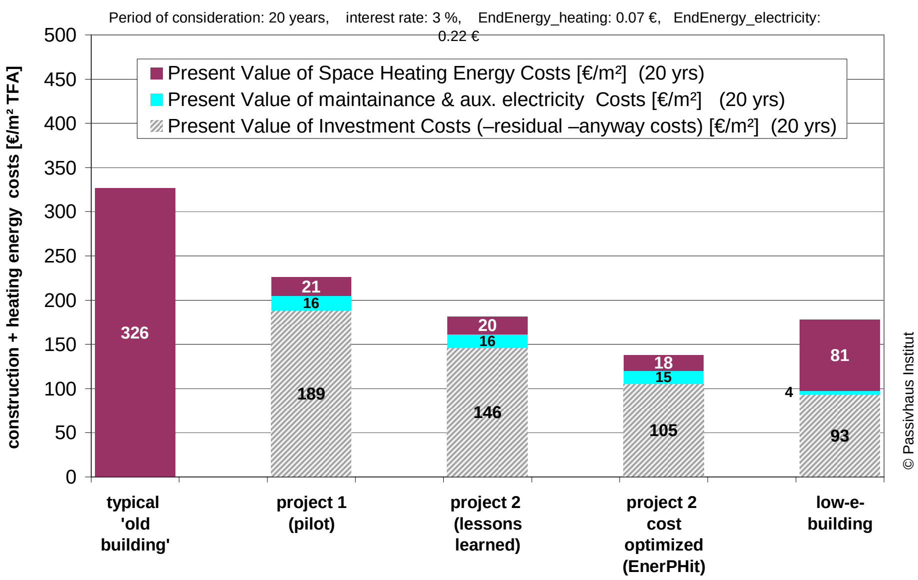
'EnerPHit' 'low-energy'



result: full life cycle costs…

… comparison 'EnerPHit' with 'low-energy

- cash value of energy consumption costs for 20 years (final energy: 0.07 €/kWh)
- cash value of maintenance costs for 20 years
- cash value of ee-investment minus 'anyway' costs minus residual value (20 years)



recent project: IEA Annex 61

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'Business models for deep energy renovation'

The situation must evaluated carefully: recently high energy prices…

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

why do so few actors really do?

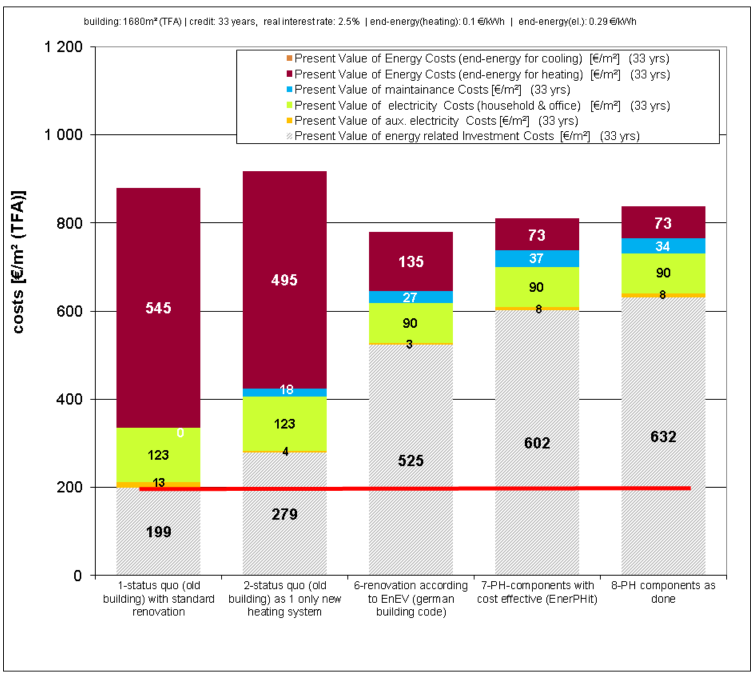
possible approaches how to solve this dilemma:

- 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
- ((cost effective passive houses: a concept for social housing))

IWU office building

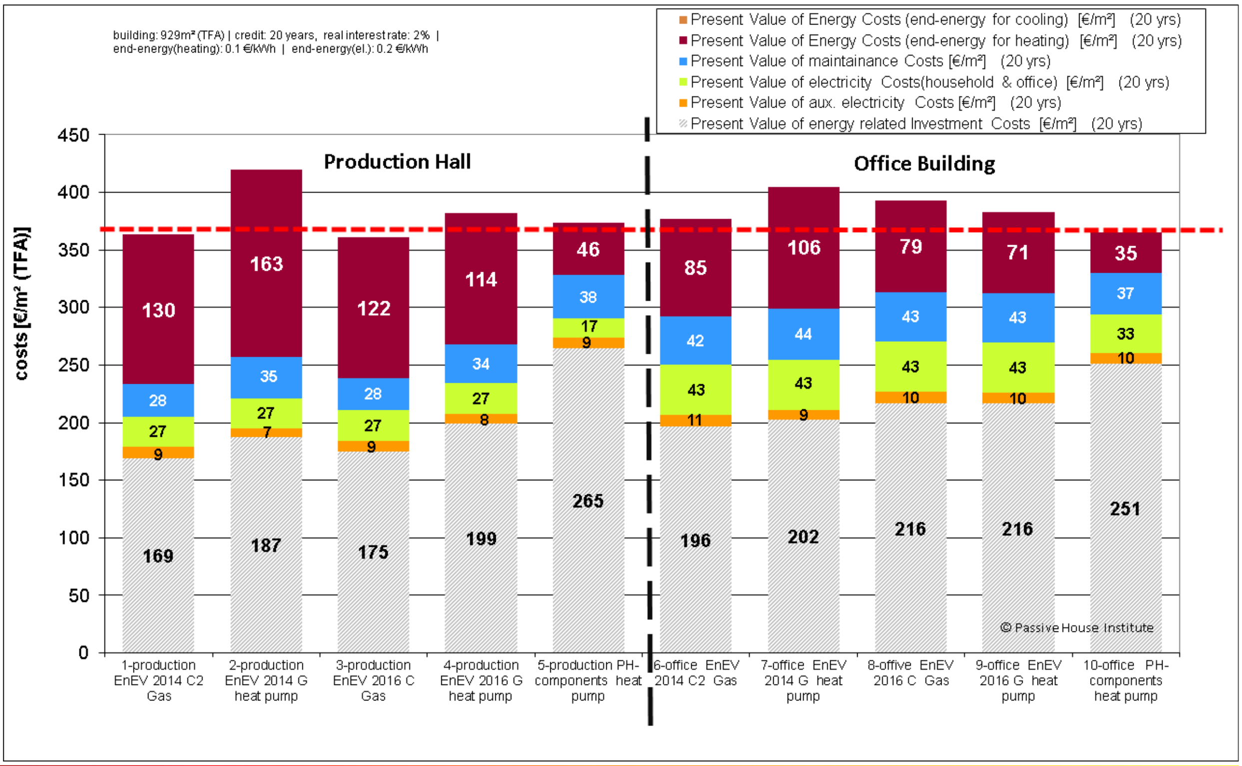
Passive House Institute

- see as well Martina Riel, KEA, session xxx Friday afternoon
- Alexander Zhivov, next presentation about IEA Annex 61
- cost data out of invoicing (800 €/m² TFA)



Vollack production hall & office building

- fictious building to identify best cost effective setup
- see presentation Ingo Höffle, Friday afternoon



the risk of energy efficiency…

… an argument for the bank ... and its customers?

- The interest rate always includes an risk surcharge.
- as a Passive House resident/builder lowers is not as strongly affected by high/rising energy prices and therefore has more money left to pay off his loan(!)
- The (breakdown) risk taken by the bank is therefore lower in the case of a Passive House.
- This should consequently be worth a discount on the interest rate(?)

→ possible model: eco-rating

Source: PHI

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 high energy prices high … interest rates low:

- investment in EE has priority to energy consumption

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

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 win):

- micro economy: local manufacturer (paid 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 economically reasonable to change.....

thank you ...

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