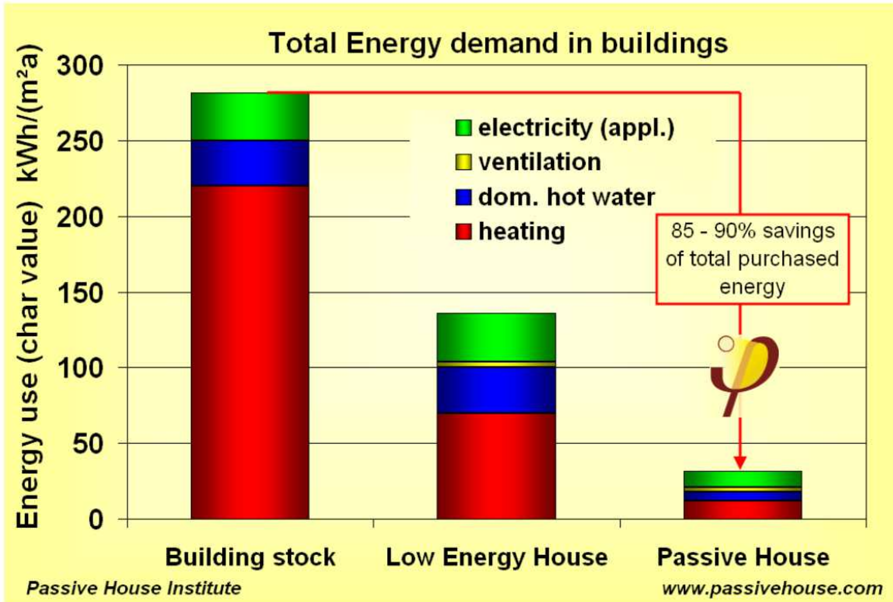
Research
on Energy Efficient Building
Quality Assurance, Tools and
Professional Training

Business Case Seminar Impact of boundary Conditions

Witta Ebel
PASSIVE HOUSE INSTITUTE
Darmstadt/Germany

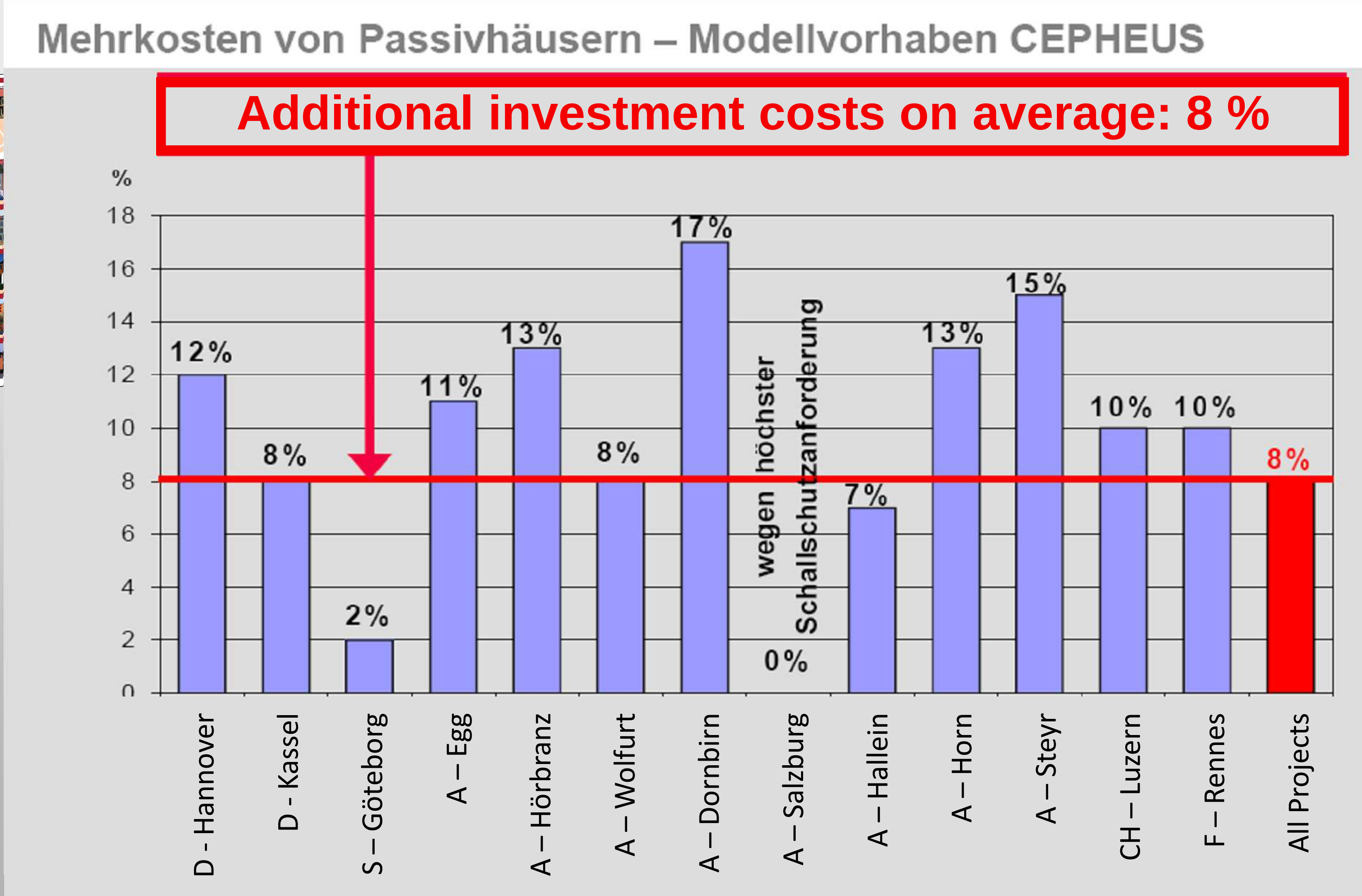
International Passive House Conference



Leipzig 16 April, 2015

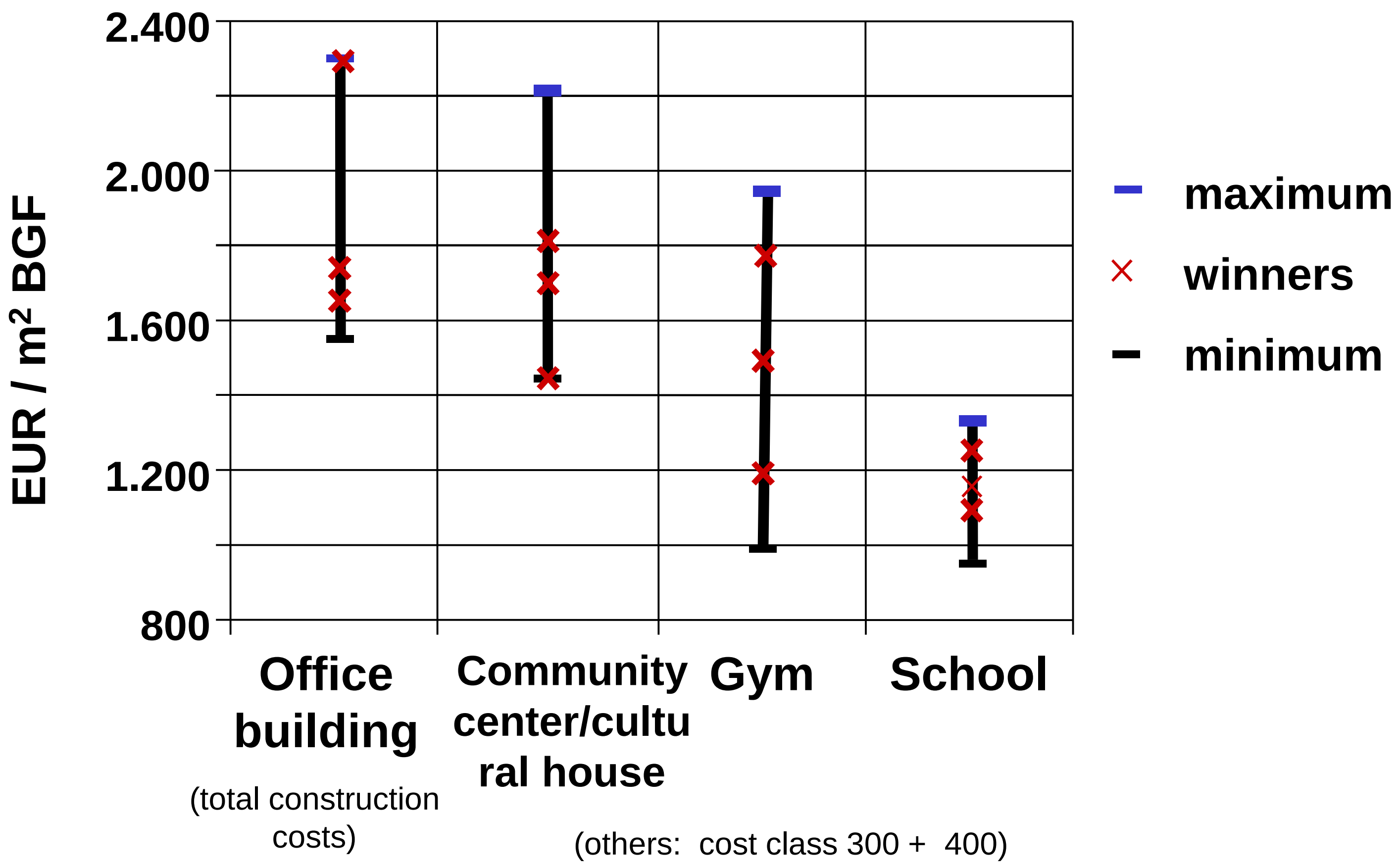
www. passivehouse.com

Additional investment costs



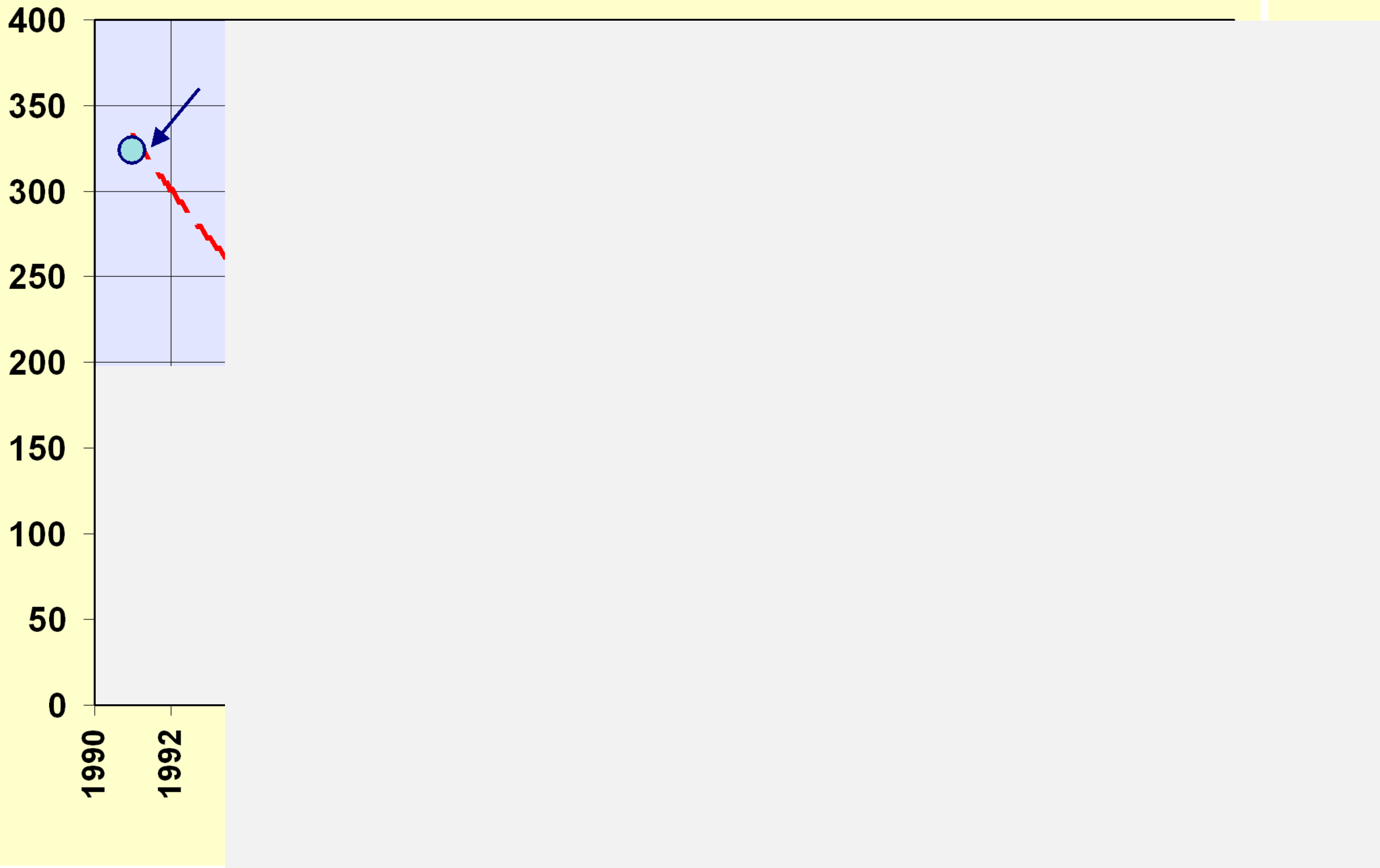
Range of specific construction costs

(evaluation of architectural competitions)



Source: [ebök 2004]

Investment costs | *Learning curve*

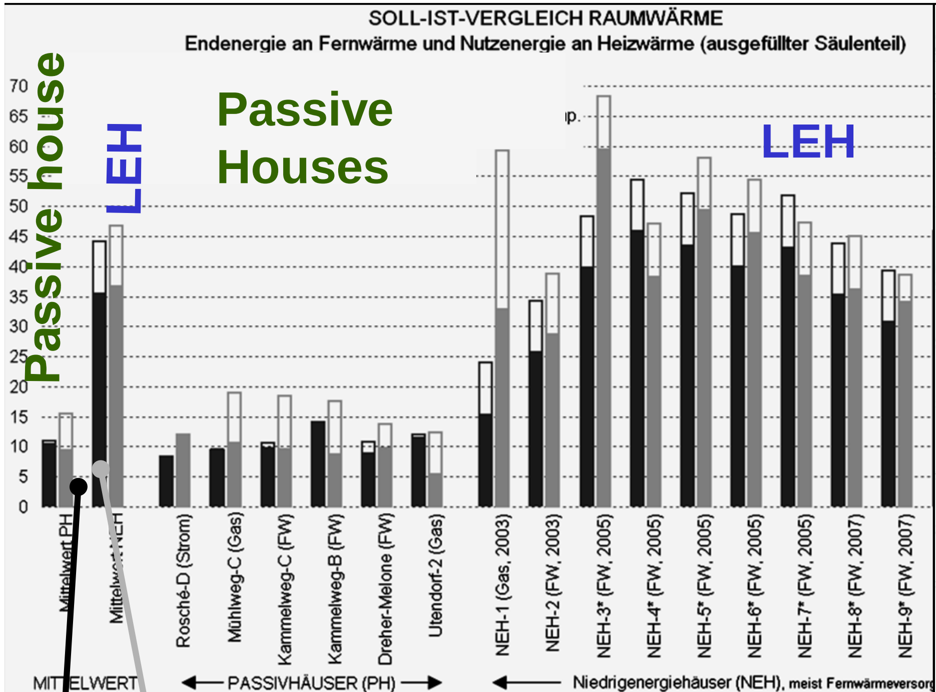


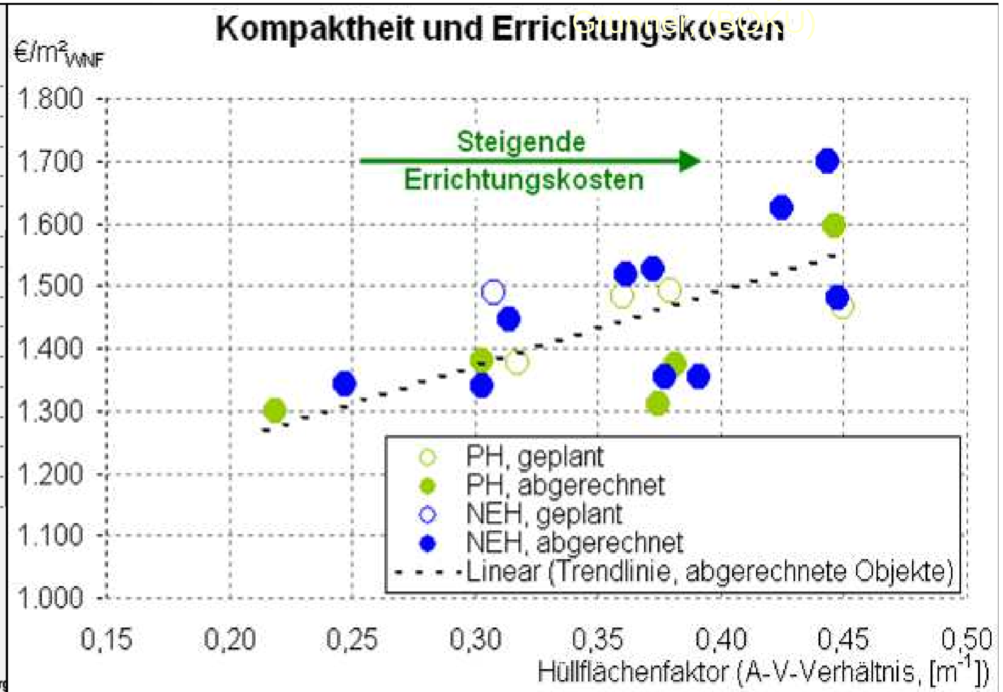
…Additional Investment ….?

Passivhaus Institut

Energy Monitoring of existing Passive House developments in Vienna

14th International Conference





Measured

calculation

Documented Cost Difference

PH – NEH near zero!

Payback vs. Efficiency Life Cycle Costs

~~Payback time:~~ $$\frac{\textit{Investment cost}}{\textit{yearly savings of energy costs}}$$

- ***Long Life cycle Typical: 30 – 50 years***
  - ***High quality investment with long life time***
  - ***Dynamical Methods Costs of capital, changing prices***
  - ***Return after end of payback period***
  - ***Sustainable investment?***

Consequence → Life cycle costs

Economy | *Present value*

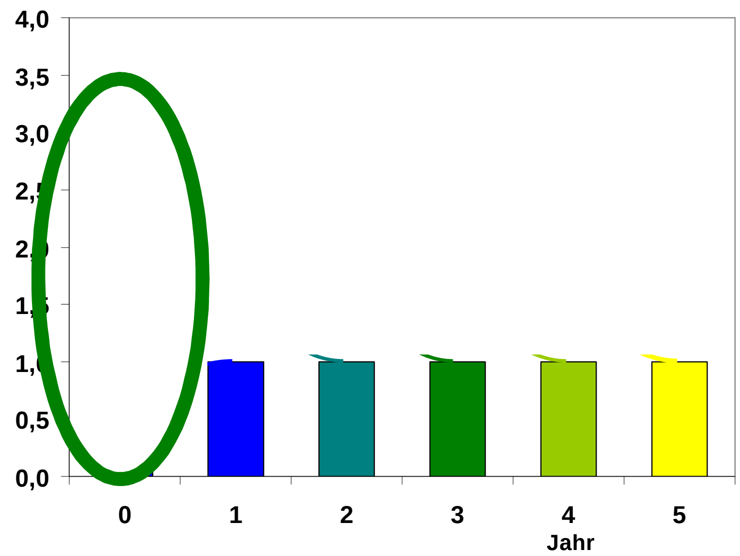
Principle: Future income / costs are **discounted and added**.

example:

Energy costs E_i in year i , i= 1,..n

Present value = $\sum_i^n E_i/(1+p)^i$,

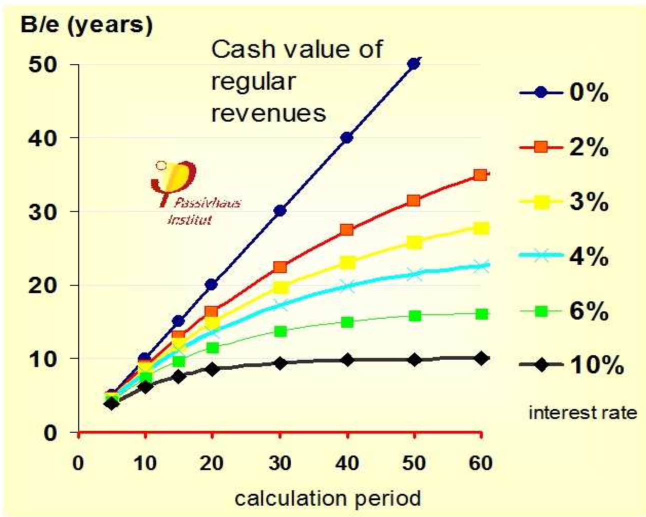
Present value = **Sum of discounted revenues**



Market capitalisation

Cash value factor

$$B(p,n) = \frac{1-(1+p)^{-n}}{p}$$



Economy / *Life cycle costs*

How costs arise

- Expenditures are made to achieve benefits (e.g. comfortable houses)
- Follow-up costs for operating: maintenance, energy

  End of use (?) – not planned, far in the future, costs or earnings?

Life cycle costs

- total costs over life time
- cost arise at different times : cannot be added (→ dynamical methods)

Investment theory

- The benefits become a good of the market. Investments are made to earn revenues for the benefits sold on the market. The goal of the investor is to achieve a profit on the market.

Investment theory | *Basic principles*

Economical assessment: *always in Alternatives*

- An investment should be at least as **attractive as its alternatives** that are available on the capital market
- Surpluses are only **gains**, when they are higher than for an alternative, economically comparable, capital asset
- The benchmark is the **return on comparable assets** (classification: risk; subjective assessment can involve non economical factors, too)
- In a perfect capital market there is only one **interest rate** (= price for capital)
- Costs and revenues (payments) become comparable with present values
- Investments should be profitable on the long run → positive /nonnegative **net present value** (= profit)
- As long as capital (incl. debt) is available, it is economically profitable to make **ALL investments** up to a net present value = 0

Other methods based on discount principle – owner perspective
DCF methods, VOFI's: optimization of individual financing, tax, funding, liquidity

Economical assessment: *always in Alternatives*

Investment Costs *Only the difference is relevant*

Maintenance costs *ceteris paribus*

Energy Costs *significantly changed*

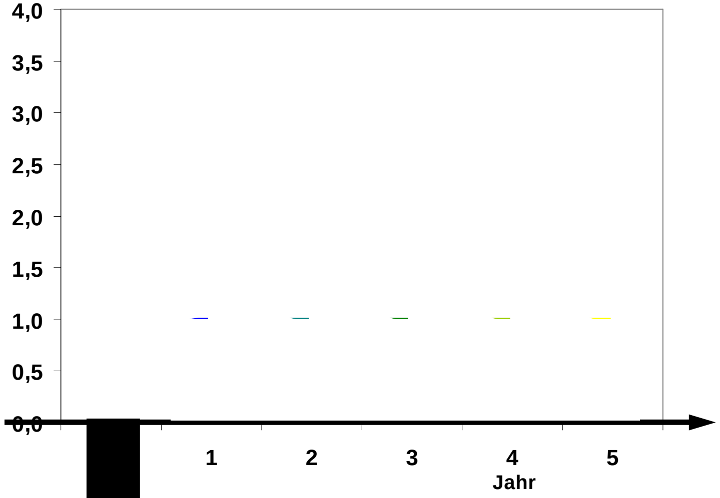
Life time and calculation period? *+/- 50 a*

Total cost balance

Net present value (NPV)

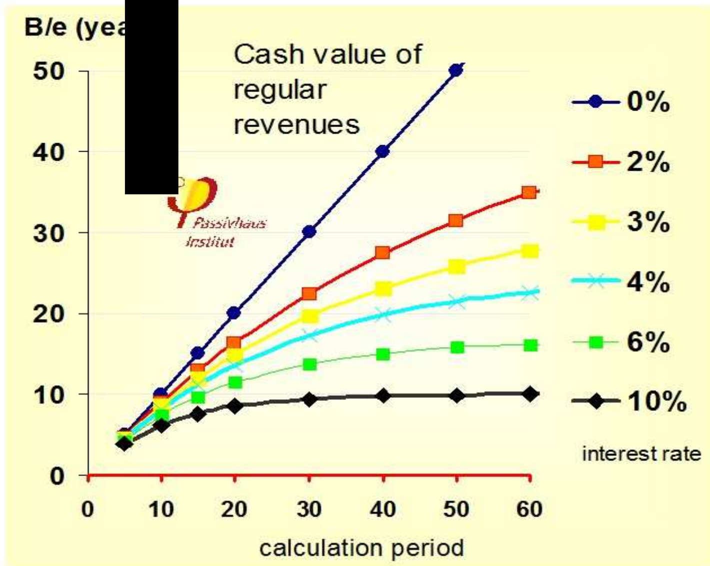
= sum of all discounted incomes and costs

= profit (as present value)



Cash value factor

$$B(p,n) = \frac{1-(1+p)^{-n}}{p}$$



NPV ≥ 0: investment is profitable

NPV < 0: loss!

Economy | *Boundary conditions*

Capital costs: additional investment for efficiency

Interest rate

- **Investment in efficiency is a risk-free investment**
- **low „risk adjusted“ interest rate**
- **results in high return of investment**
- **real interest rate $p_{real} = (1 + p_{nom}) / (1 + i_{Infl}) - 1 \approx$ max 2,5 % p.a.**

Energy costs: rising; average over calculation period

performance standard?

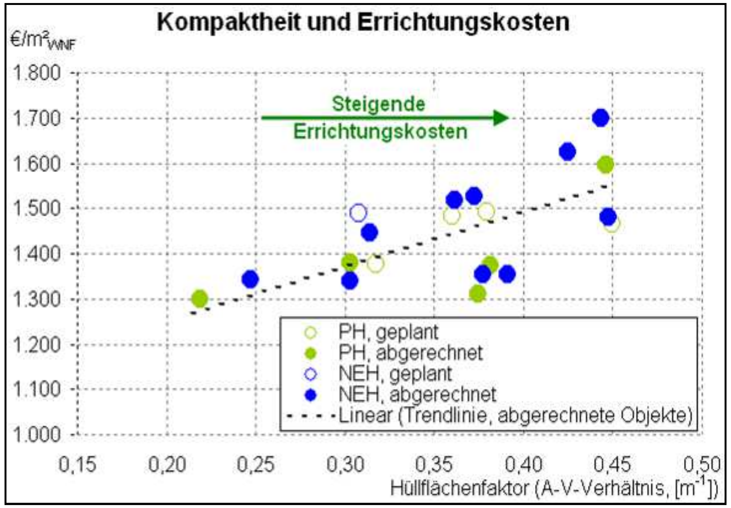
Calculation period n : Life cycle! 40,50 ore more years

- When calculated over a shorter period shorter:

Regard residual values of investment!

Boundary conditions | *capital costs*

Investment costs



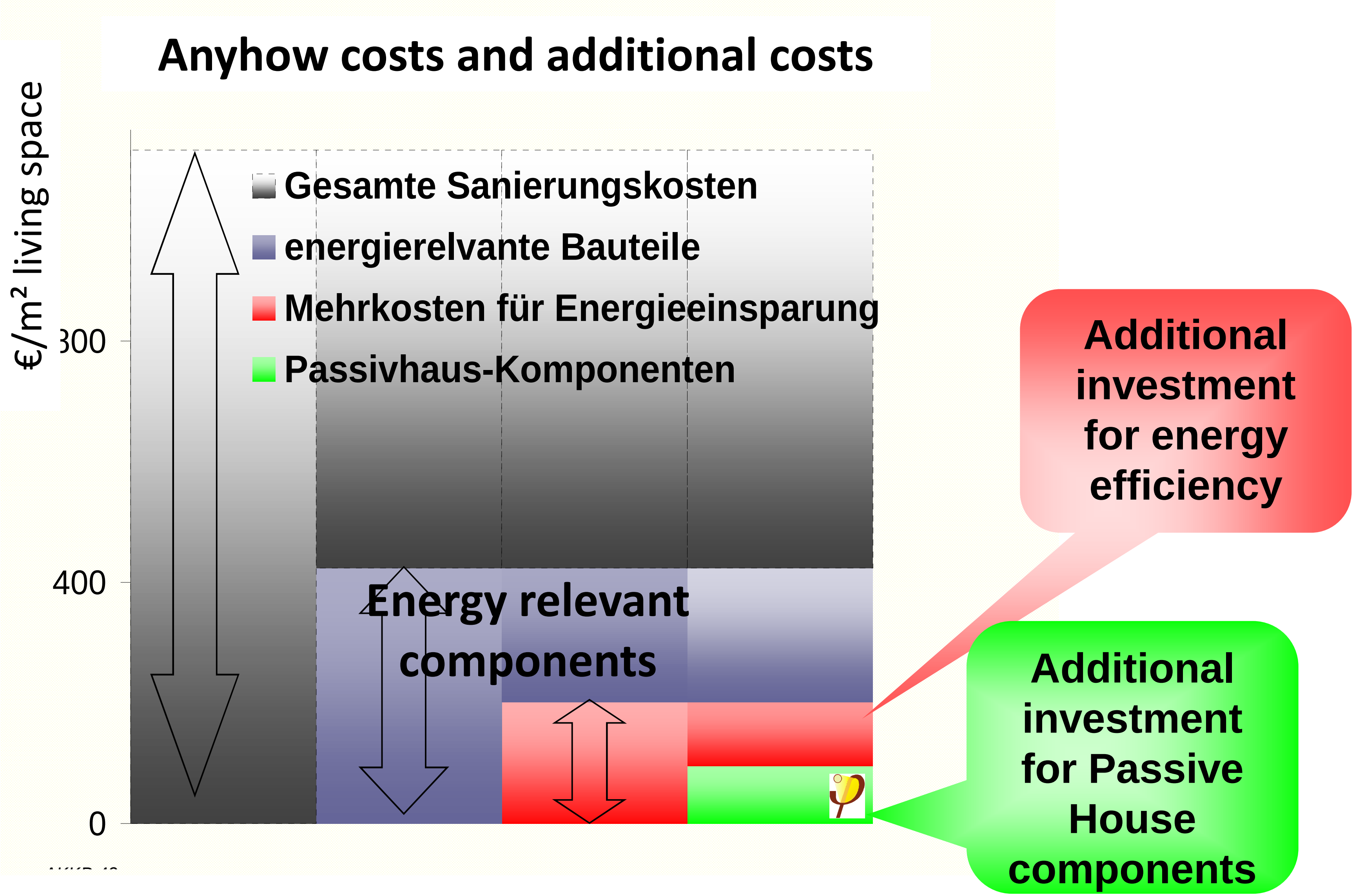
- Well adapted design!

- Only additional costs for efficieny

- Residual values

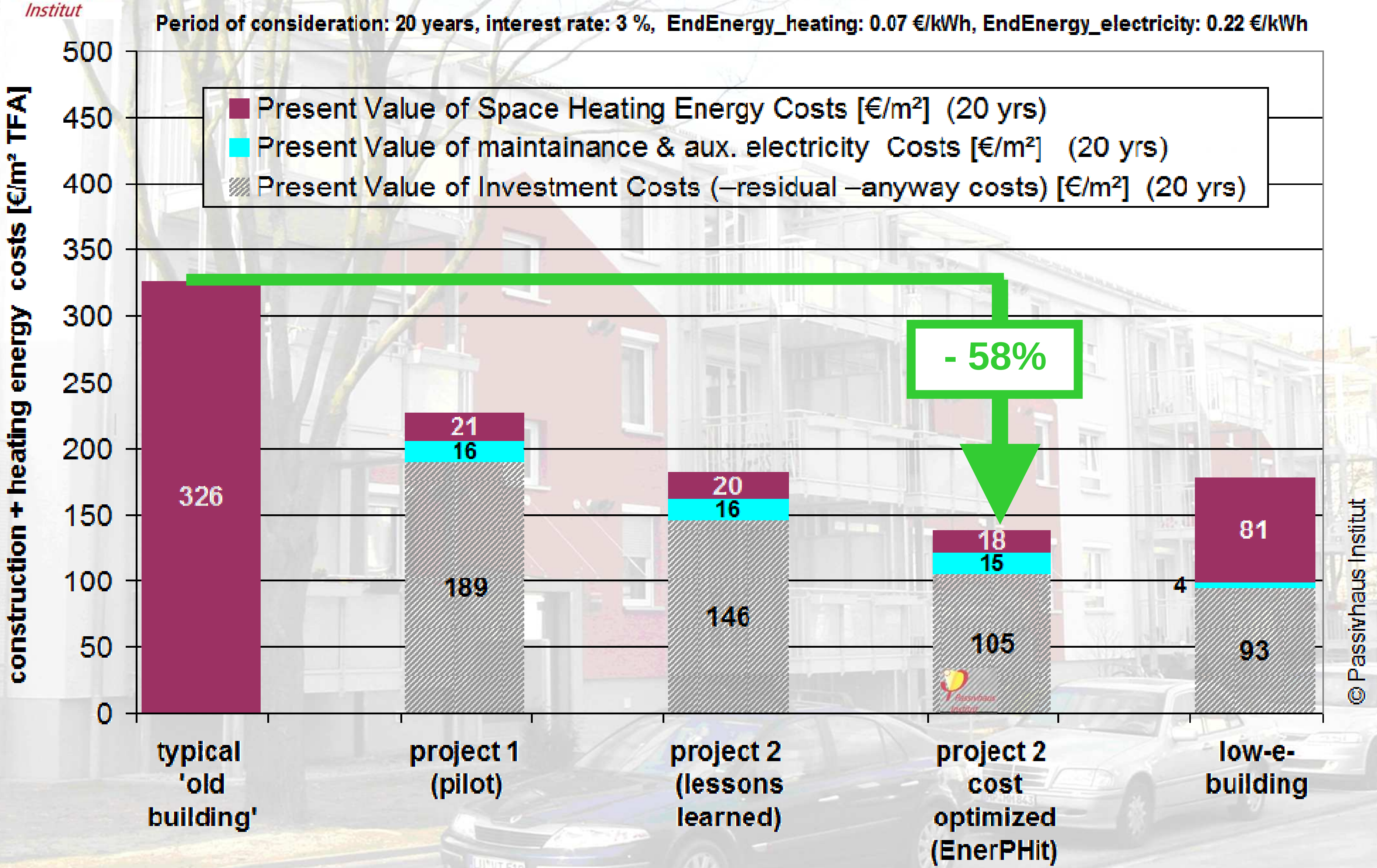
Yearly capital costs: Annuities, with life span.

What counts: *additional investment costs*



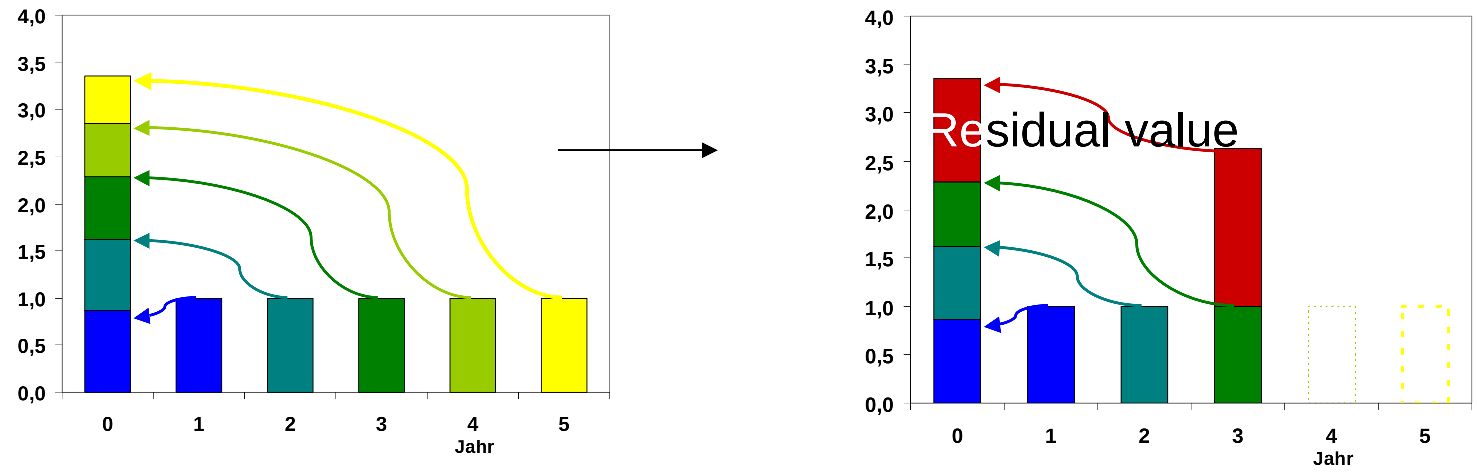

When you do it, do it right!
Ludwigshafen Schlesierstraße

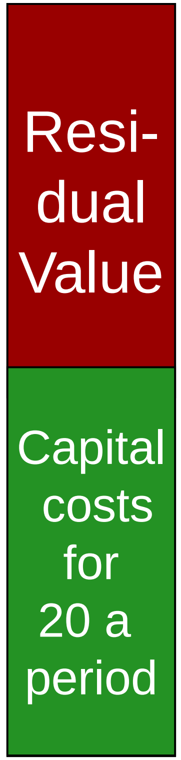
When you do it, do it right!



Residual values

- Calculation period n and lifecycle N can be different
- Different life cycles for partial investments (components) – STEP by STEP
- **Residual value = Investment – economic depreciation** is an „Income“ at the end of the calulation period n





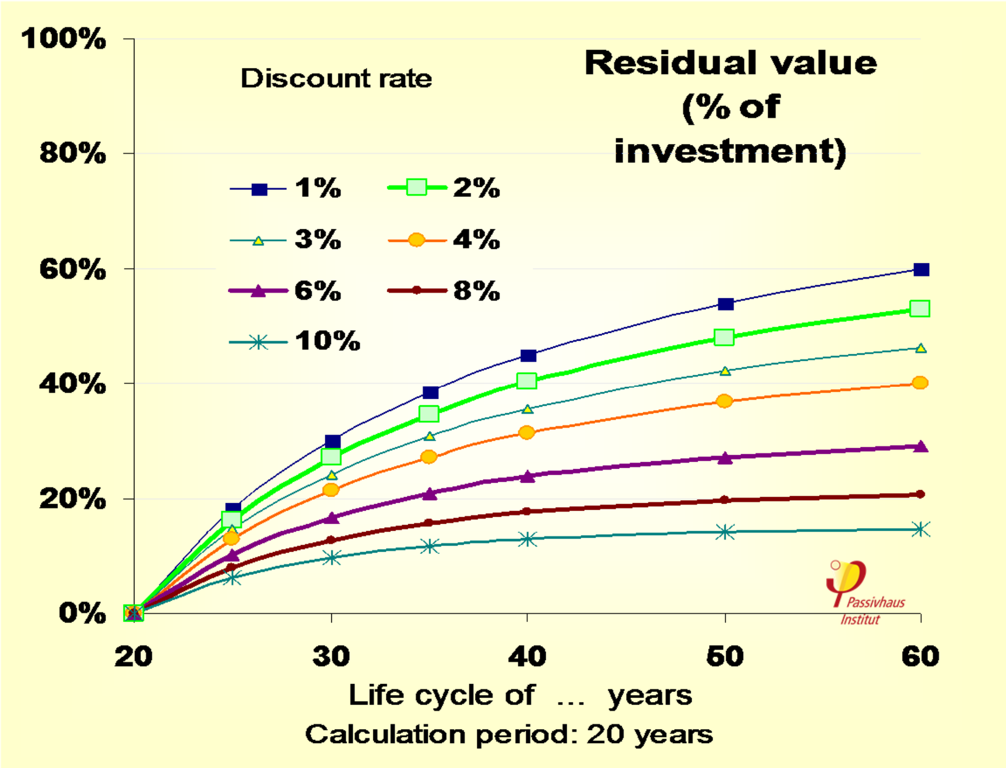
$$1 - \text{CashValueFactor}_n / \text{CashValueFactor}_N$$

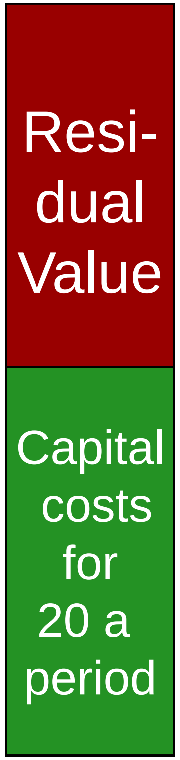
Example: calc. Period 20 yrs, life cycle 50 yrs, int. rate 2,5% p.a

Residual Value 1 - 15.6 a / 28.4 a = 45% Residual Value

Residual values

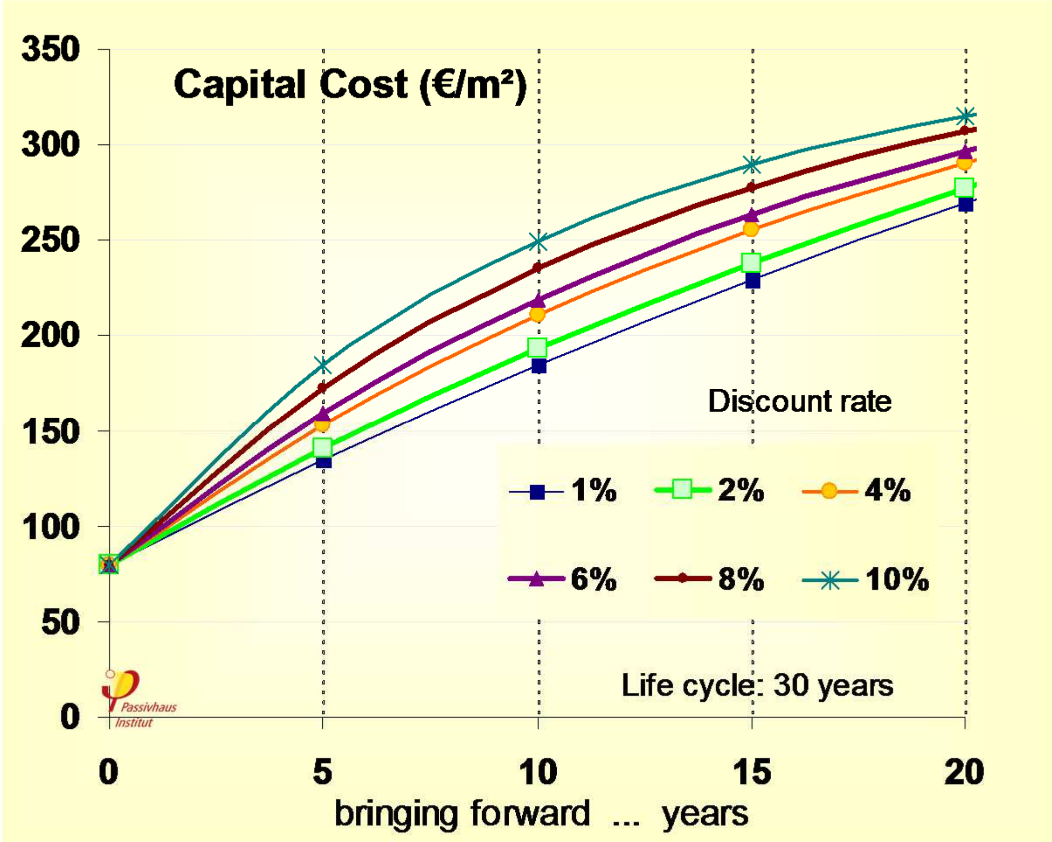
- Calculation period n and lifecycle N can be different
- Different life cycles for partial investments (components) – STEP by STEP
- **Residual value = Investment – economic depreciation** is an „Income“ at the end of the calulation period n





Capital Cost: The point in time – and step by step

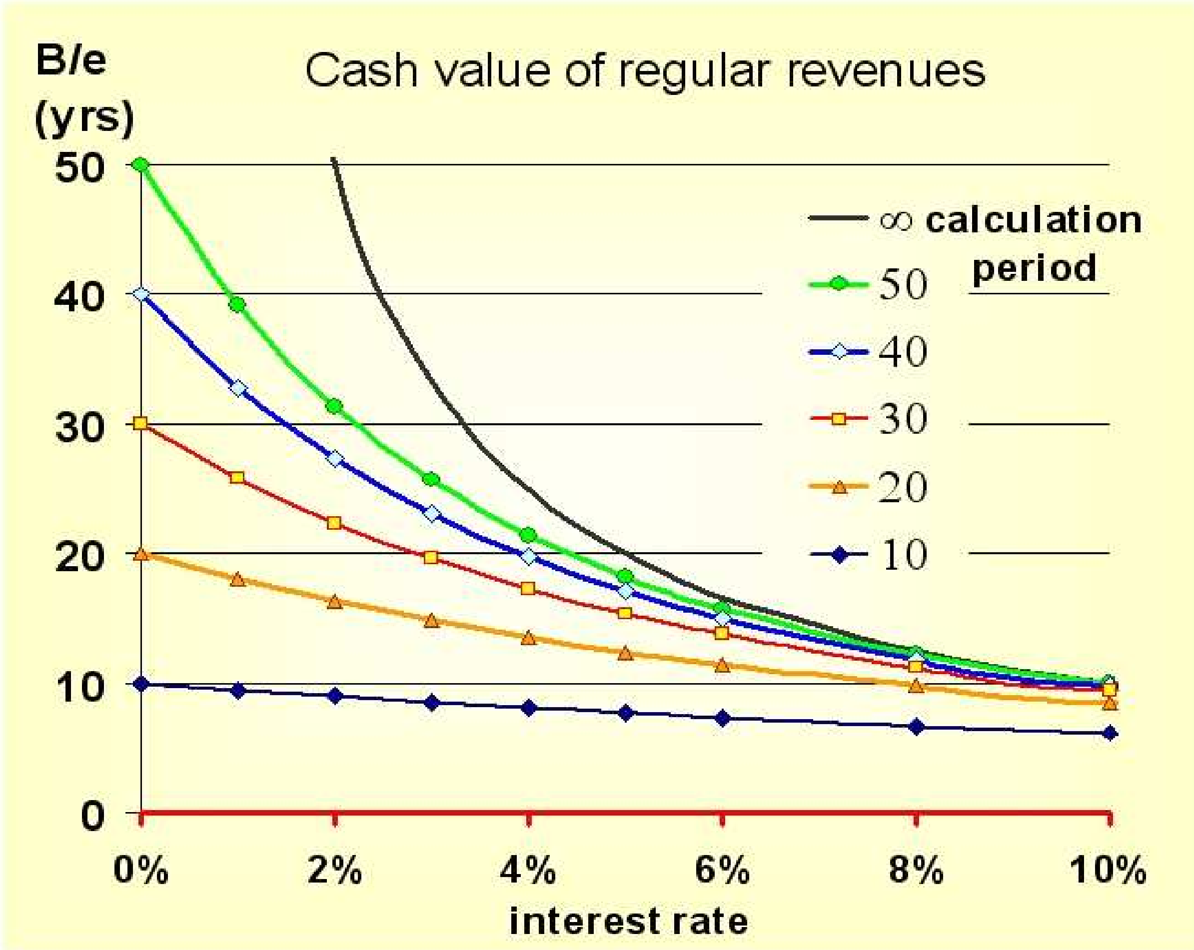
- At the end of lifetime energetic measures can easily be linked, which makes the measures economically attractive (principle of coupling): Only additional investment counts.
- When lifecycle is not yet over, the residual values of anyhow costs have to be added to the investment.
- **Step by step**: renovation according to the lifecycle: No residual values of anyhow costs.
- For each step: „when you do it, do it right“ – and plan the next measures.



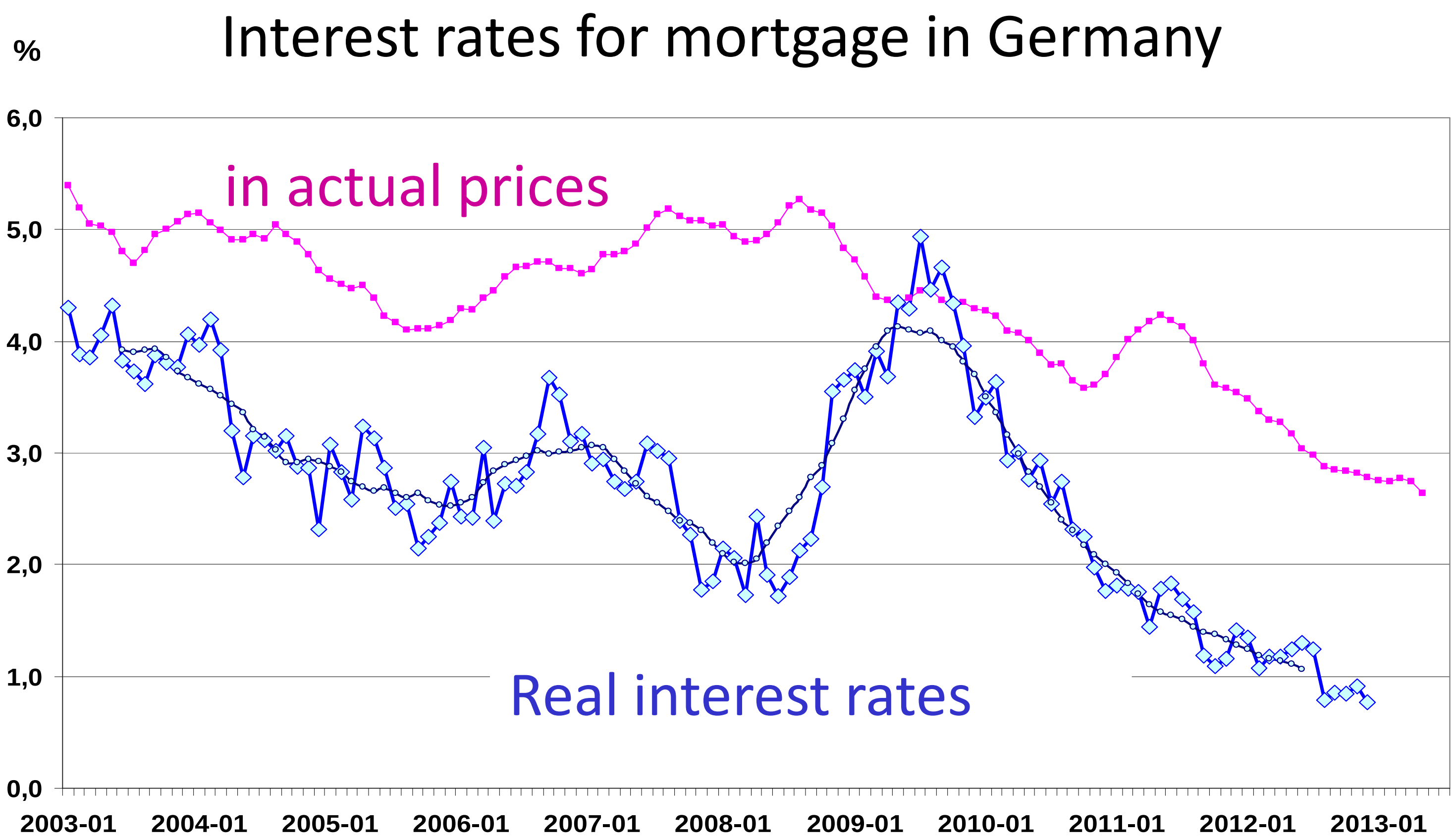
The economical effect of bringing forward the renewal of windows (2013) with Passive House windows: Additional capital cost

Parameter | *required rate of return*

- Required rate of return is the calculatory interest rate (discount rate)
- High required rates of return
  - Lead to high capital costs (amortisation + interest)
  - depreciate revenues
- Investment is less profitable



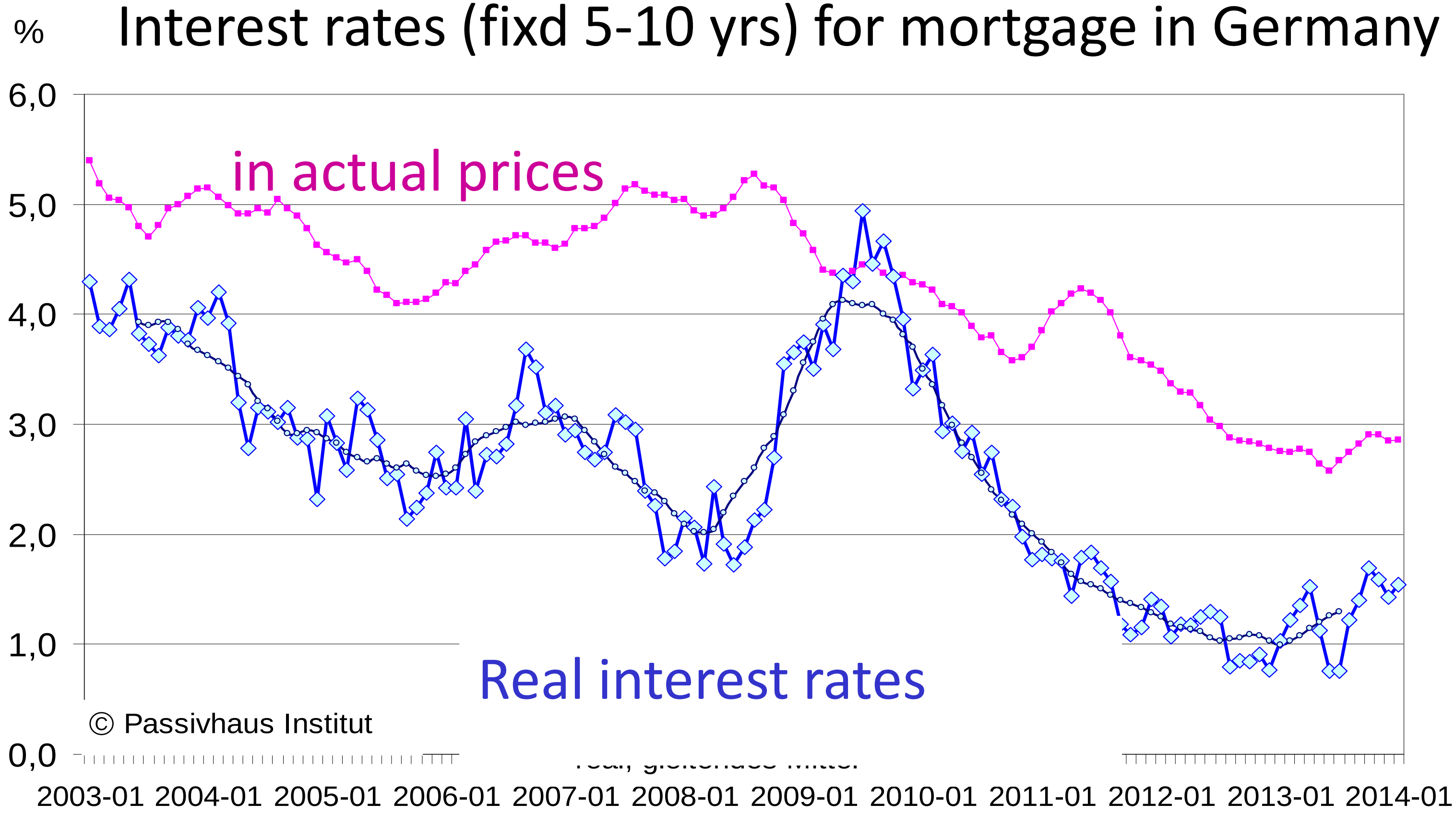
Paramter | *Interest rate on debt*



$$p_{real} = \frac{p_{nom} - i}{1 + i}$$ (p interest rate, i inflation)

Paramter | *Interest rate on debt*

Interest rates (fixd 5-10 yrs) for mortgage in Germany



$$p_{real} = \frac{p_{nom} - i}{1 + i}$$

(p interest rate, i inflation)

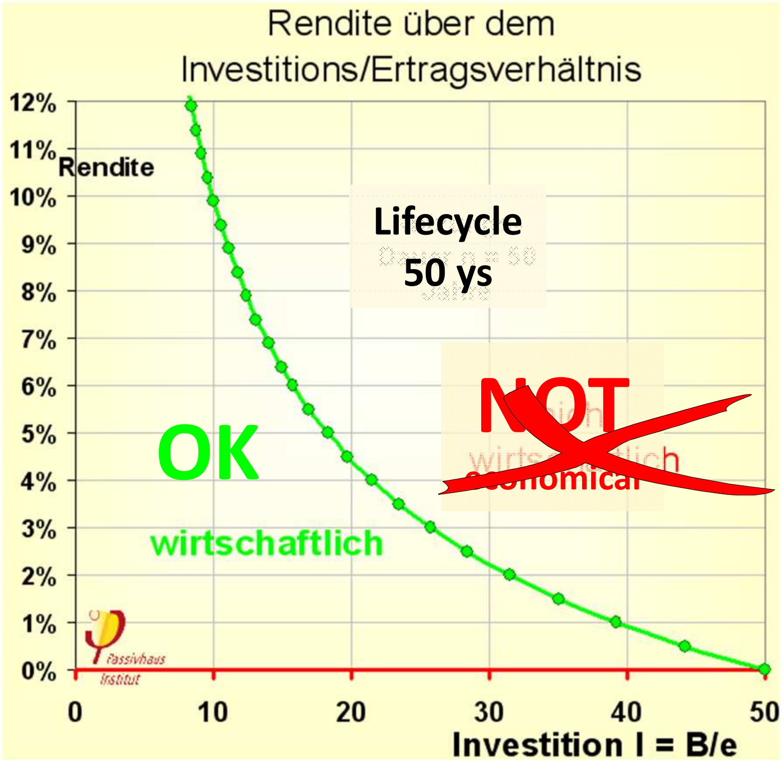
Parameter: | *required rate of return*

- Revenues E count only with their present value

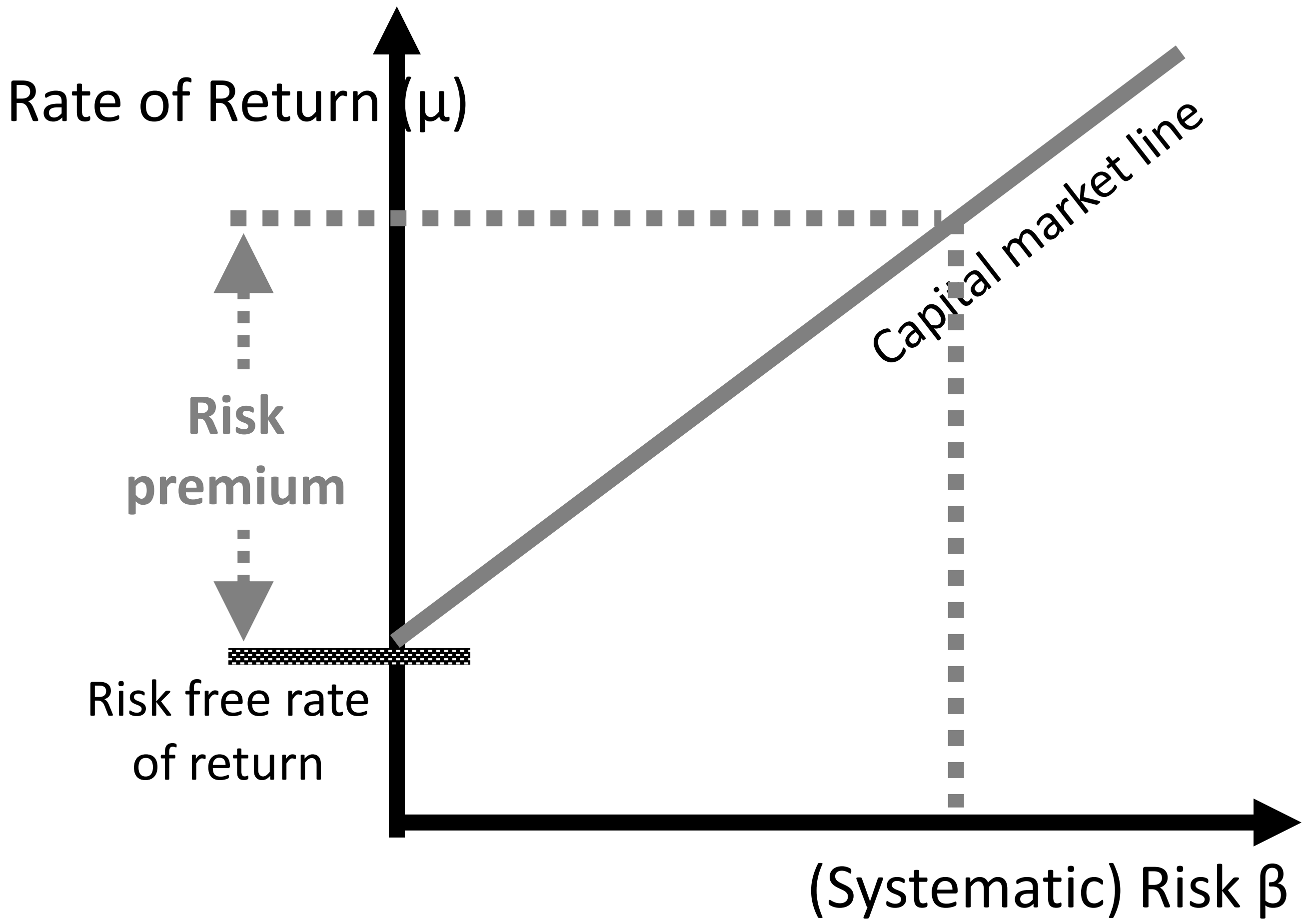
  E* Discount factor = $E * {}^{1}/(1+p)^{n}$
  (income in n years)

  ➢ **High interest rate → low discount factor for revenues → low (present) value of the investment!**

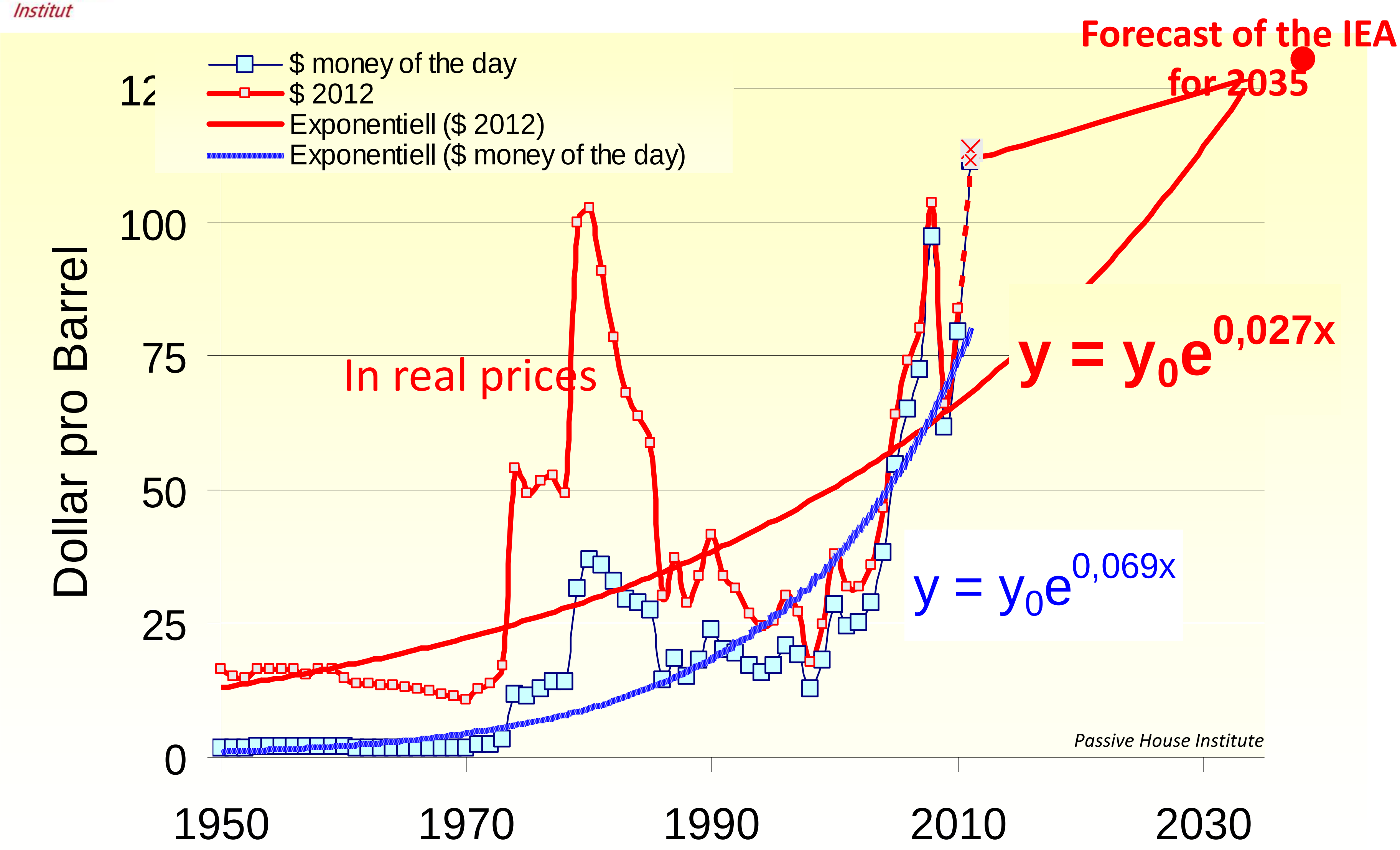
- Discount rate?
  - debt: credit interest rate
  - Equity: Opportunity costs (revenues from alternative comparable assets) = required rates of return
  - comparable = same risks



Parameter: | *required rate of return*

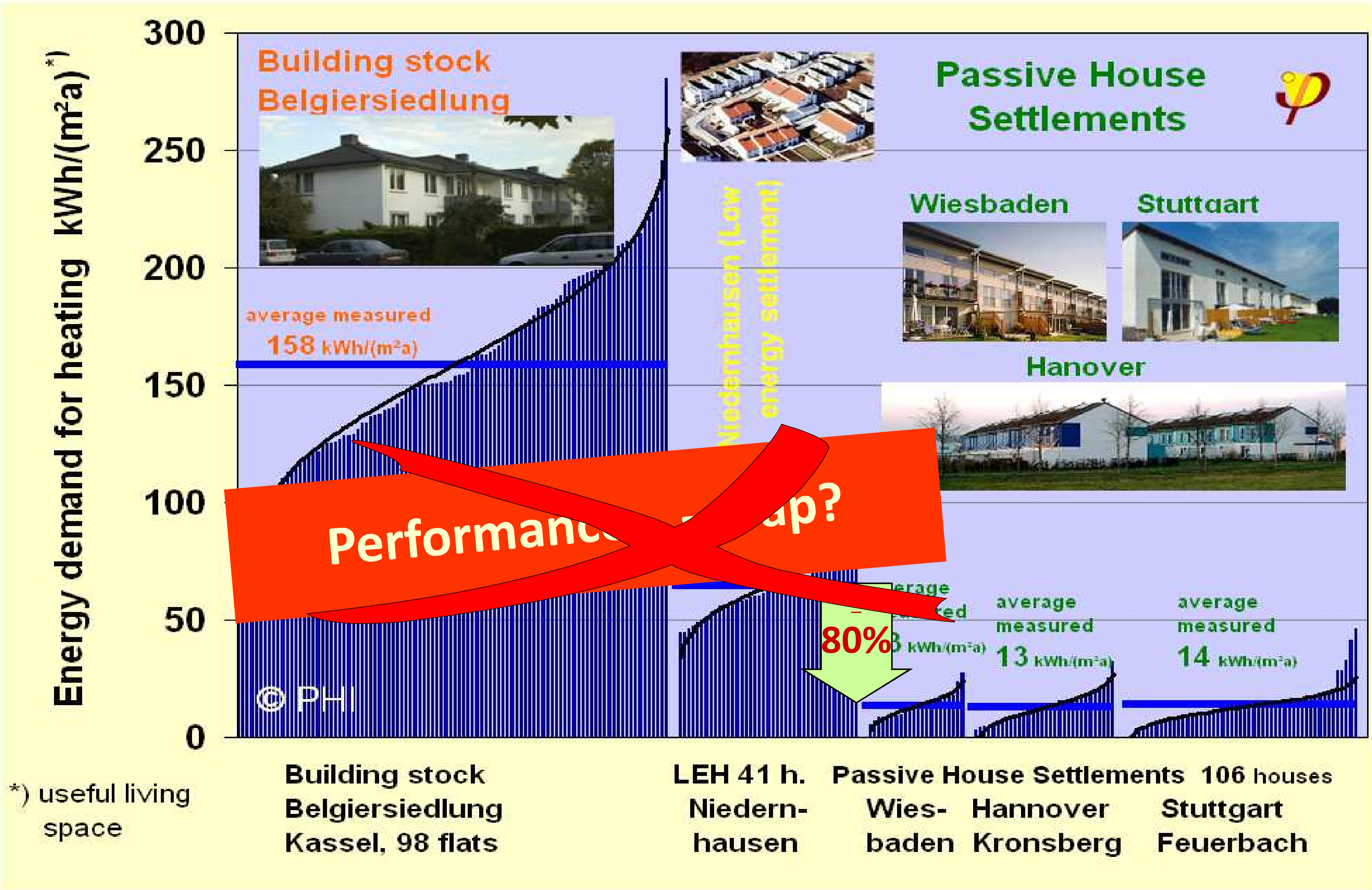


Boundary conditions | *Energy price ?*



AKKP 42

Saved Energy costs| *reliable performance through quality*



Energy performance | *reliably low energy consumption*

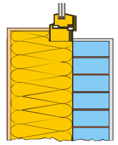
Well Defined Standard and Quality Assurance

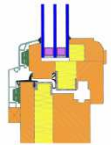
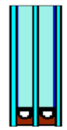
- **Quality assurance of design and during construction**

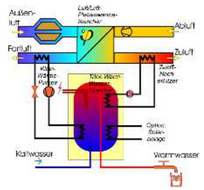
PHPP Design Tools



- **Quality assurance for materials and components**
  - Identification of relevant parameters
  - Measurement and calculation procedures
  - Documentation and integration in whole building performance calculation



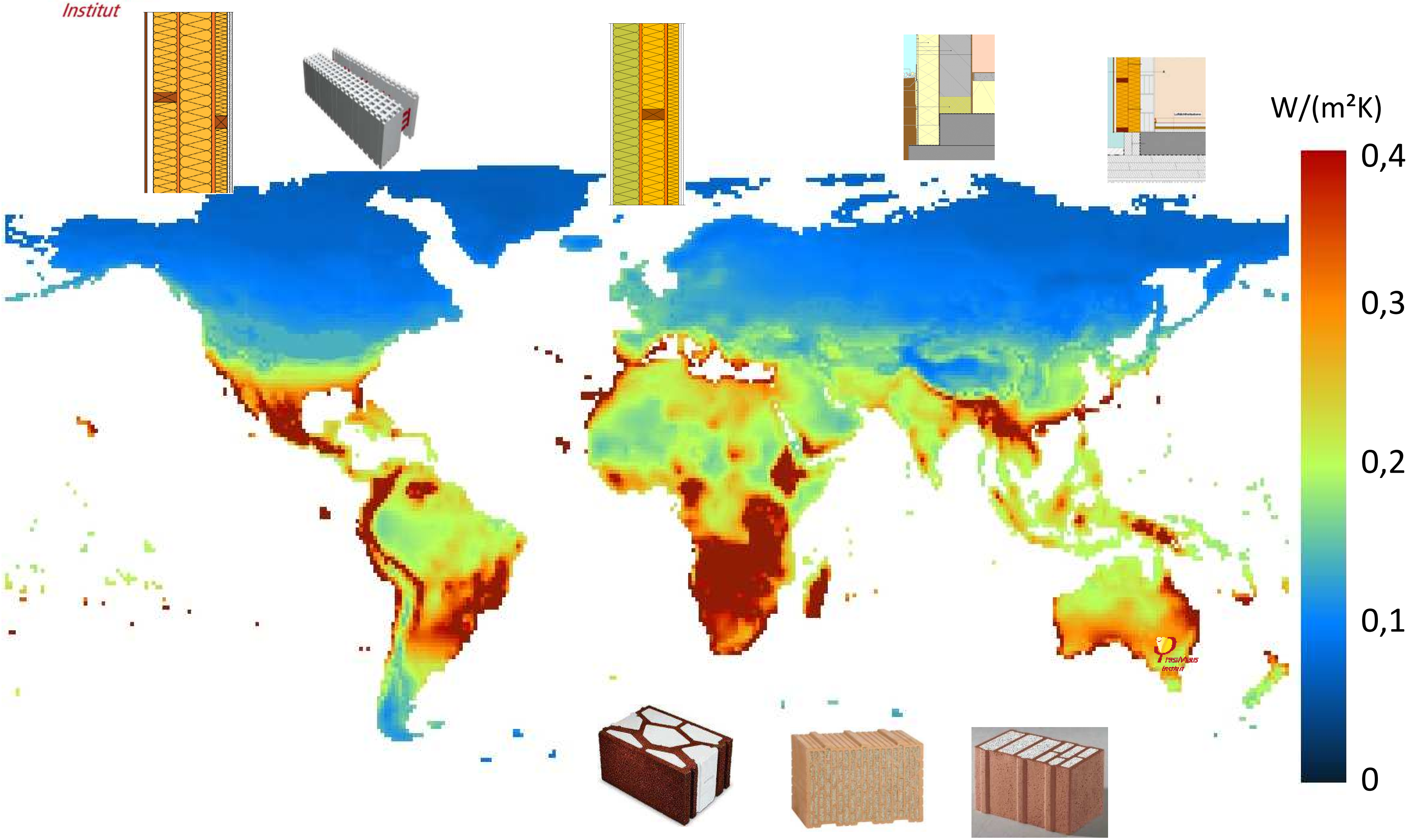





Comp. and systems: reliable performance data

- **Capacity building:**
  - **Training and Certification of**
  - **Designers / Consultants / Craftsmen**

Cost optimal level of U-values (external Walls)

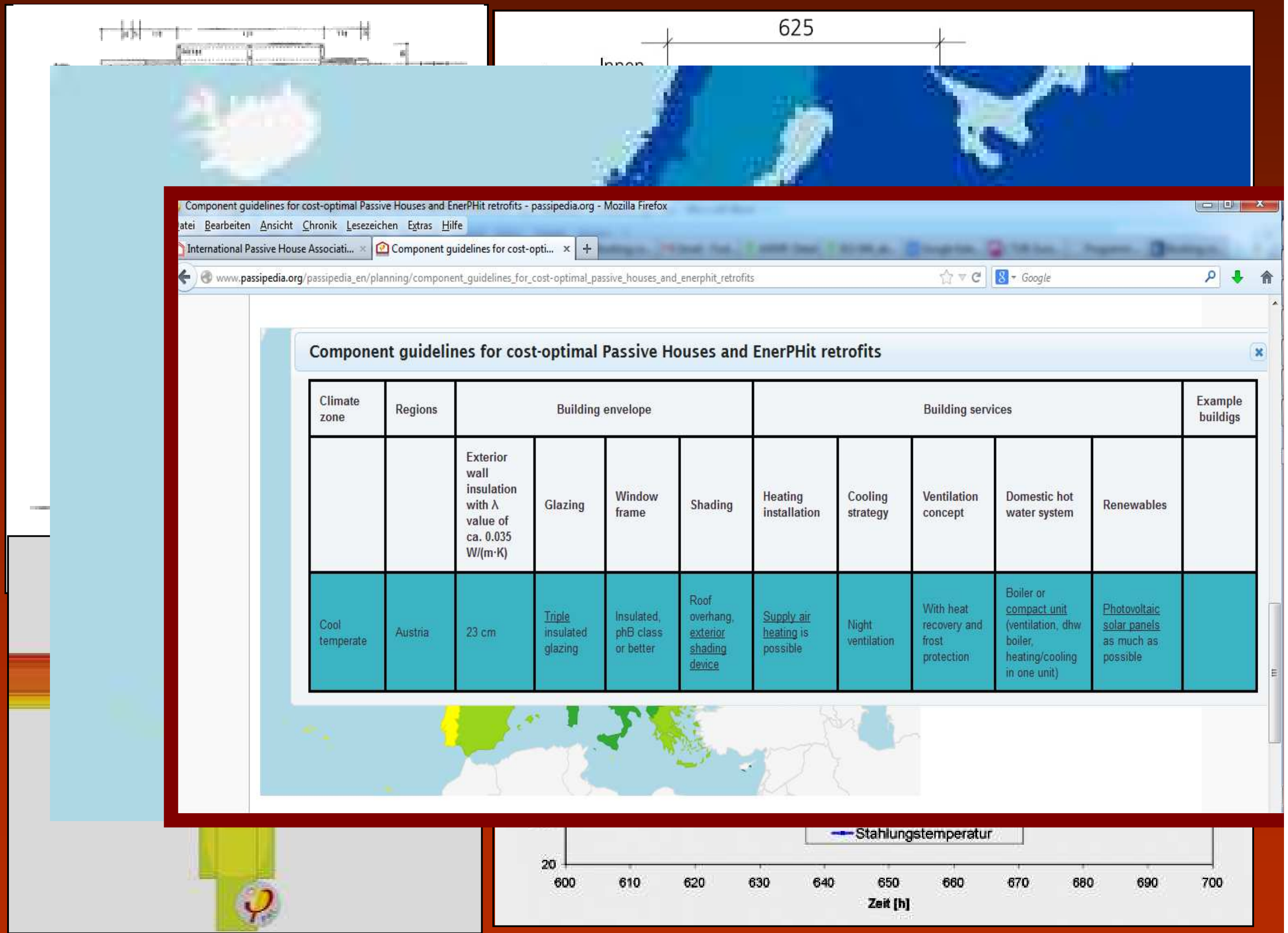


passipedia

Cost optimal construction | *clickable map*

Part 1: General information to the public

Part 2: Information and tools for members



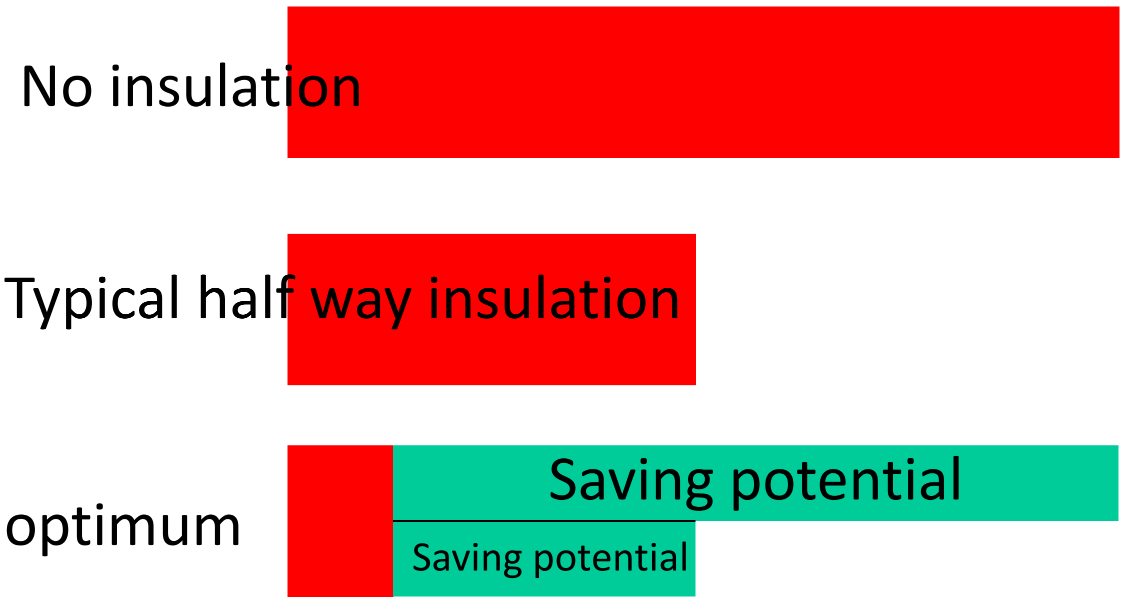
Climate zone	Regions	Building envelope				Building services					Example buildigs
		Exterior wall insulation with λ value of ca. 0.035 W/(m·K)	Glazing	Window frame	Shading	Heating installation	Cooling strategy	Ventilation concept	Domestic hot water system	Renewables	
Cool temperate	Austria	23 cm	Triple insulated glazing	Insulated, phB class or better	Roof overhang, exterior shading device	Supply air heating is possible	Night ventilation	With heat recovery and frost protection	Boiler or compact unit (ventilation, dhw boiler, heating/cooling in one unit)	Photovoltaic solar panels as much as possible	

PASSIVE HOUSE INSTITUTE

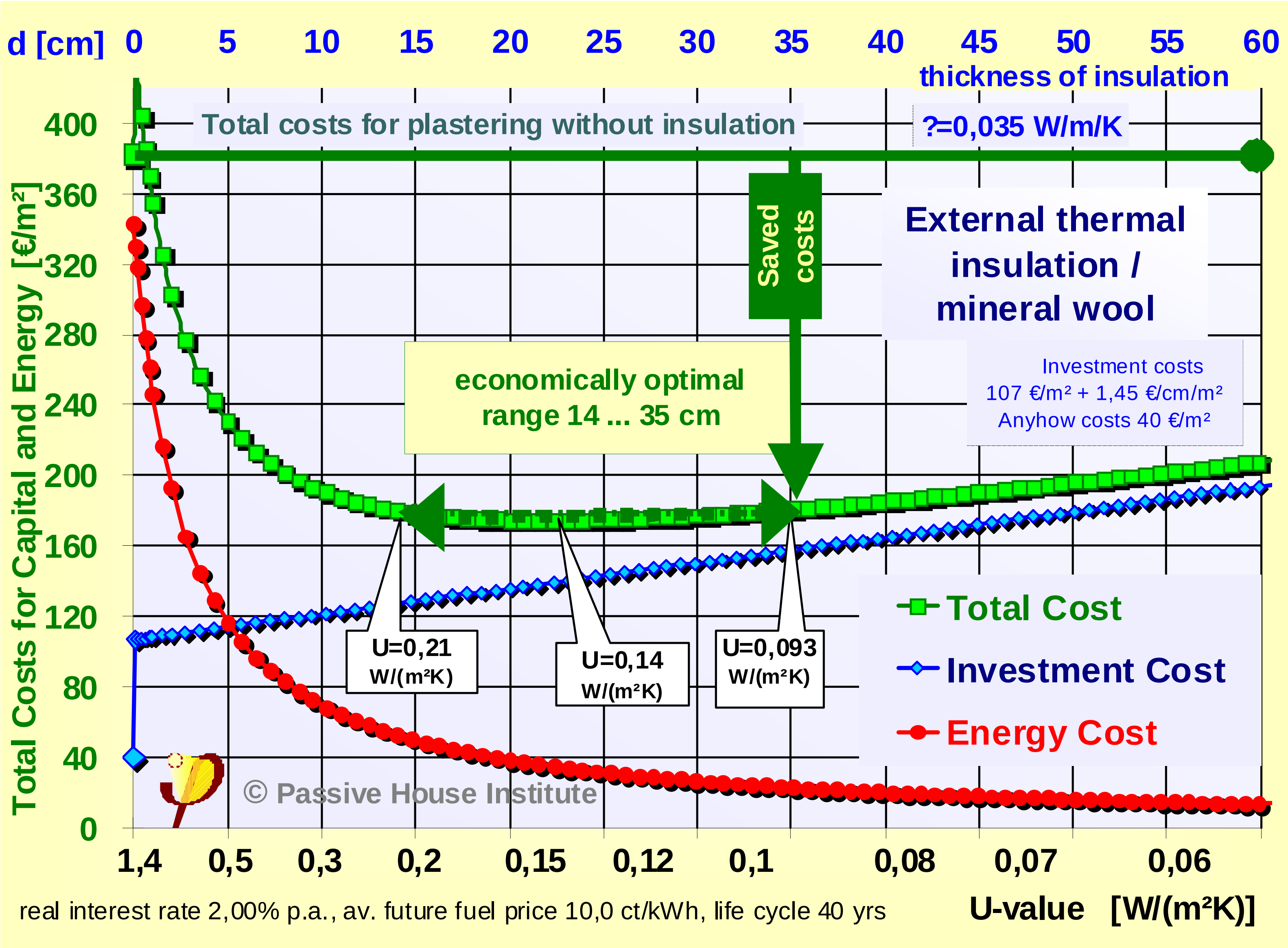
http://www.passipedia.org/passipedia_en/planning/component_guidelines_for_cost-optimal_passive_houses_and_enerphit_retrofits

Boundary conditions | *Energy costs define the possible investment*

- **Saved energy: where do we start?**
- **Energy Price and energy price development**
- **Performance**



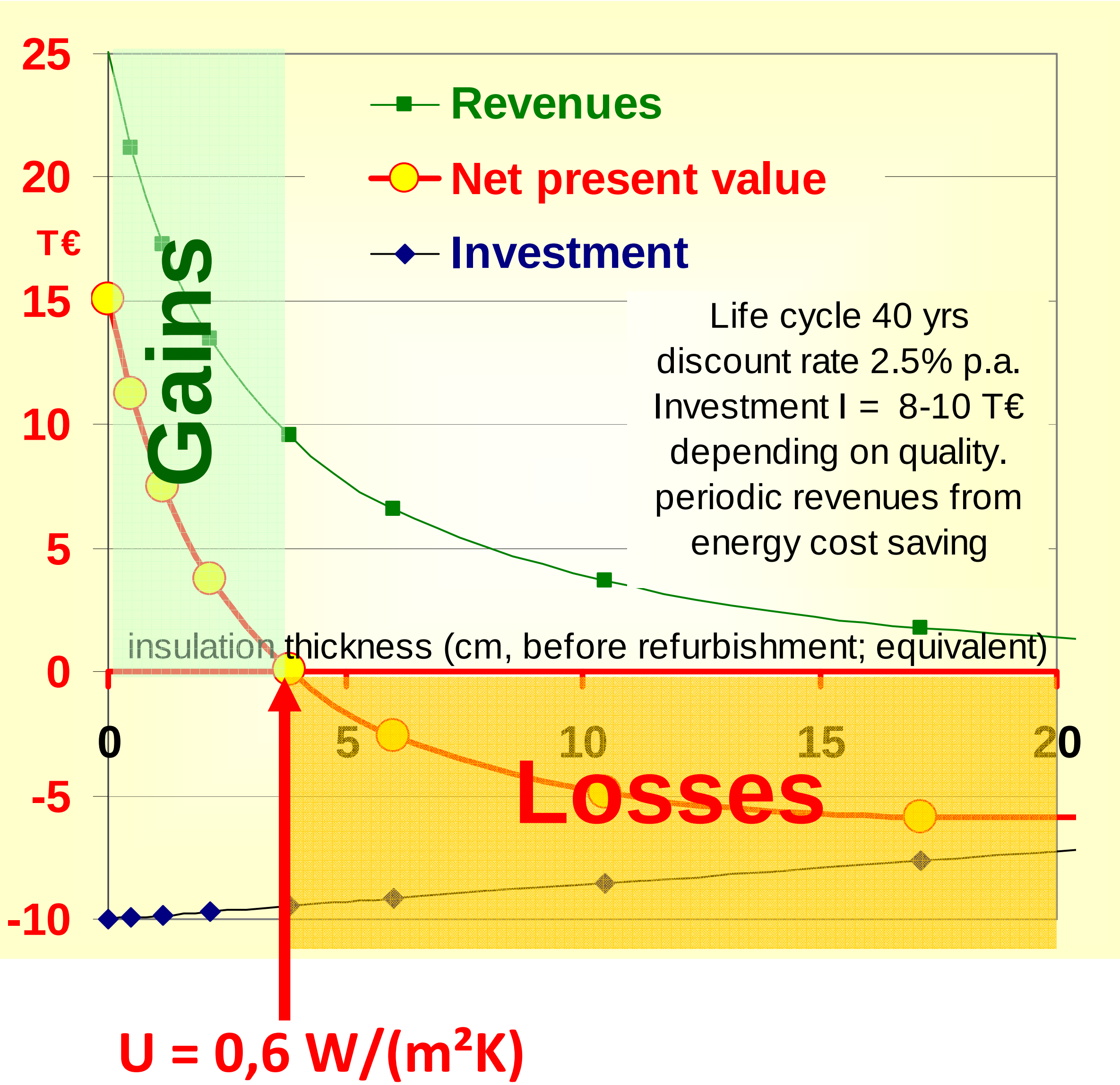
Optimization of Life cycle costs | *insulation*



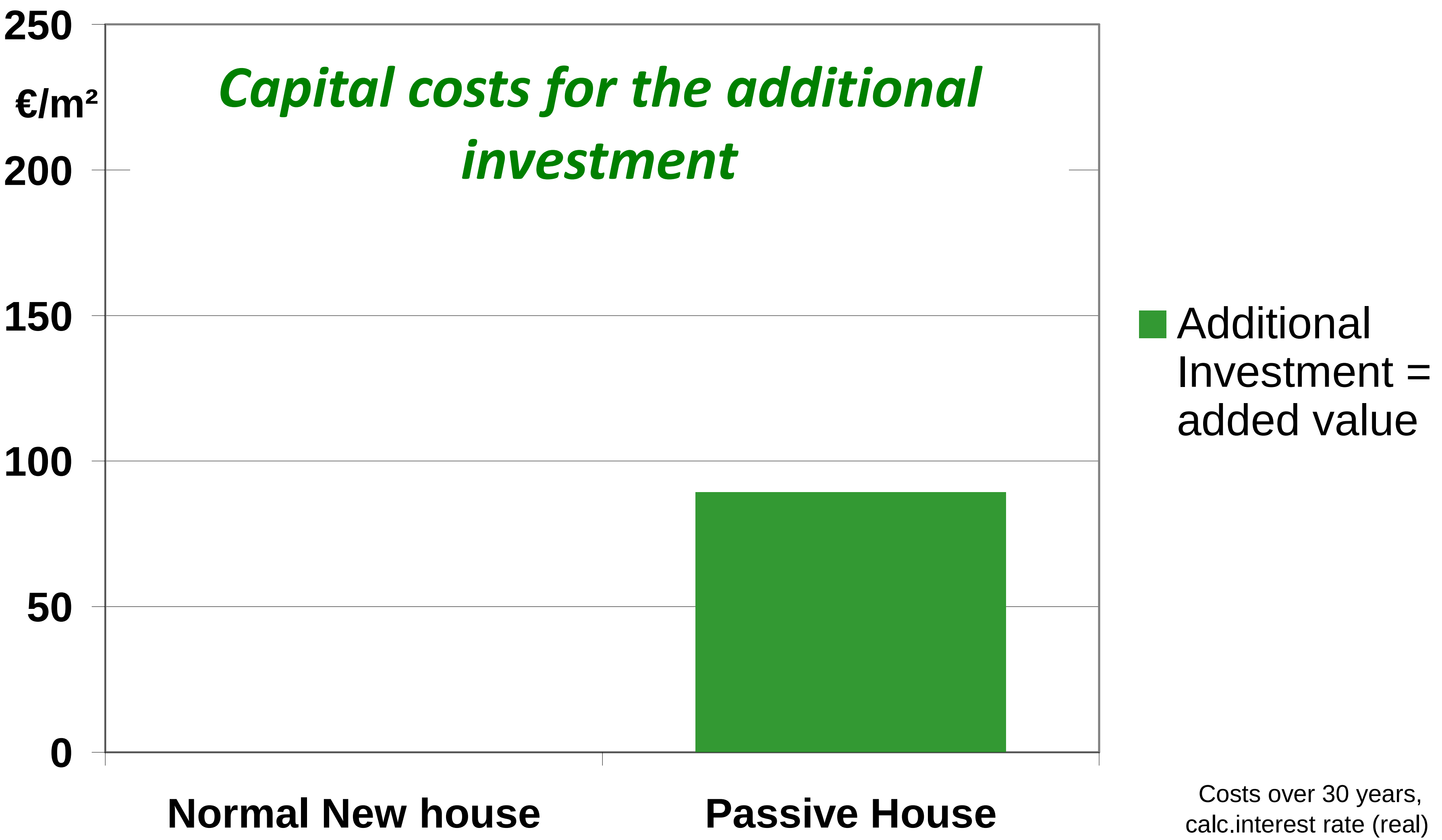
Parameter: Influence of starting point

- The energetic quality limits the cost saving potential and, therefore, the revenues of the investment
- Medium quality is a barrier to economically attractive investments
- Therefore: sustainable quality instead of substandards

„When you do it, do it right“

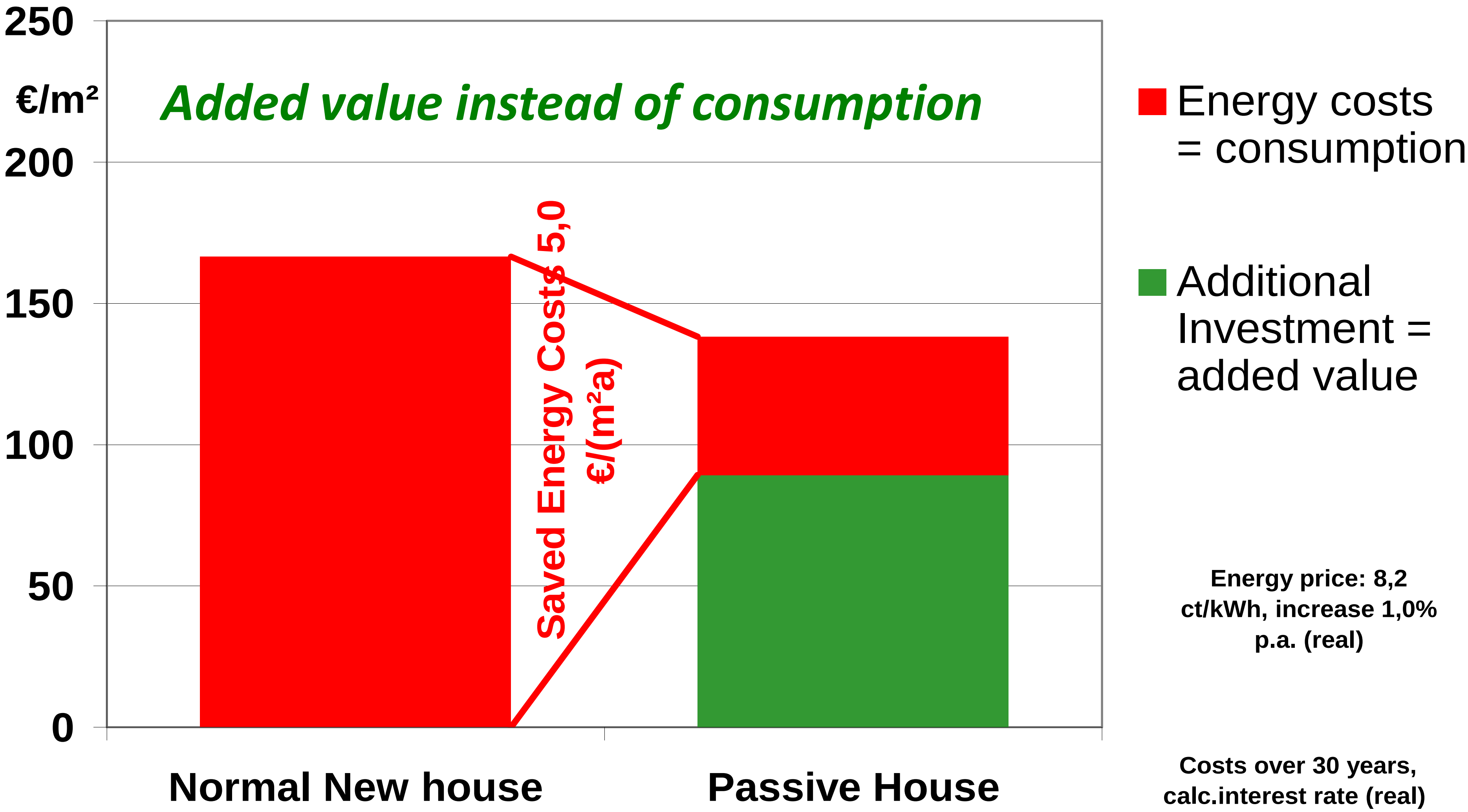


Economy: Life cycle costs



Costs over 30 years, calc.interest rate (real) 1,68% p.a.

Economy: Life cycle costs

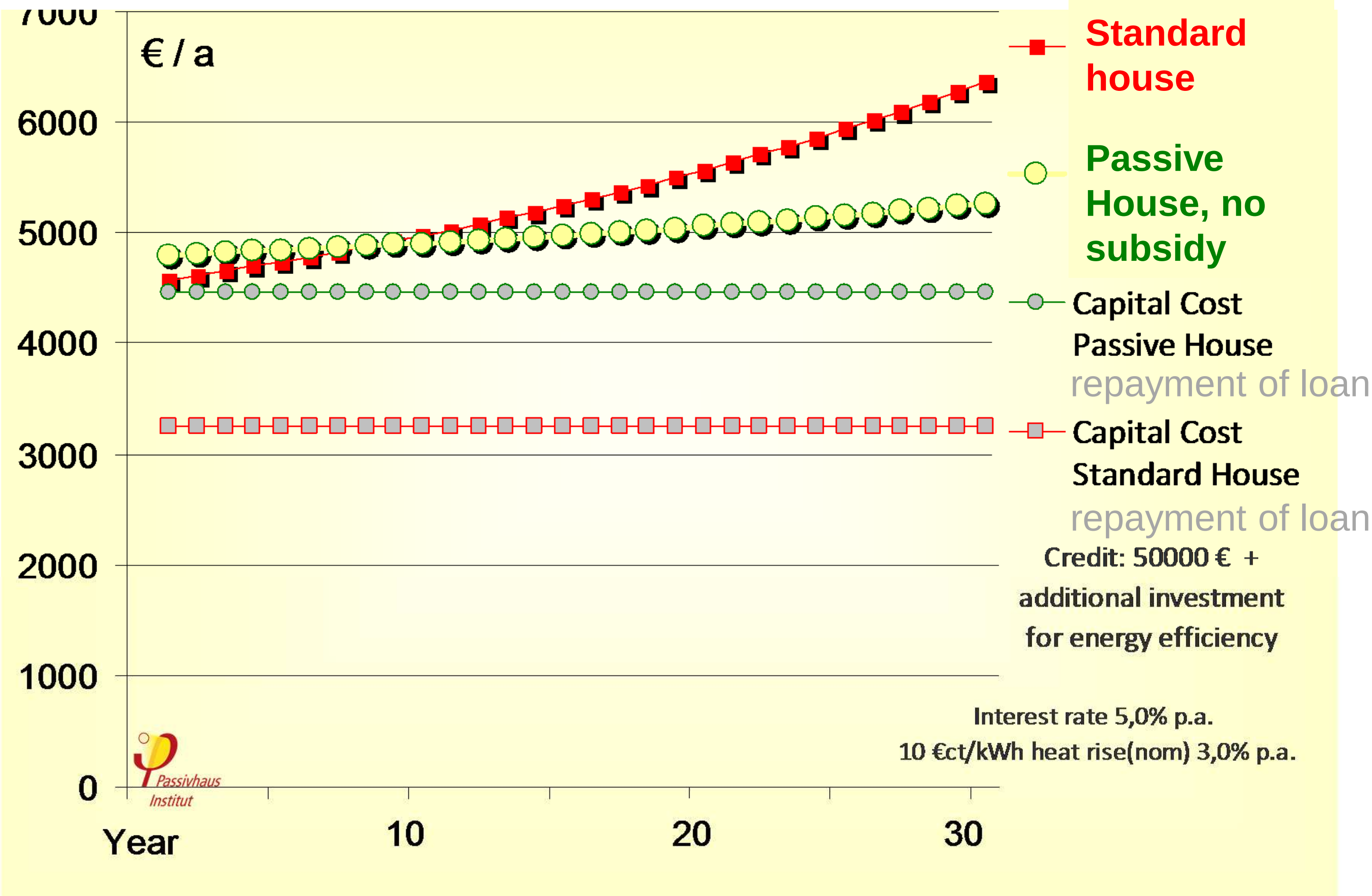


Energy price: 8,2 ct/kWh, increase 1,0% p.a. (real)

Costs over 30 years, calc.interest rate (real) 1,68% p.a.

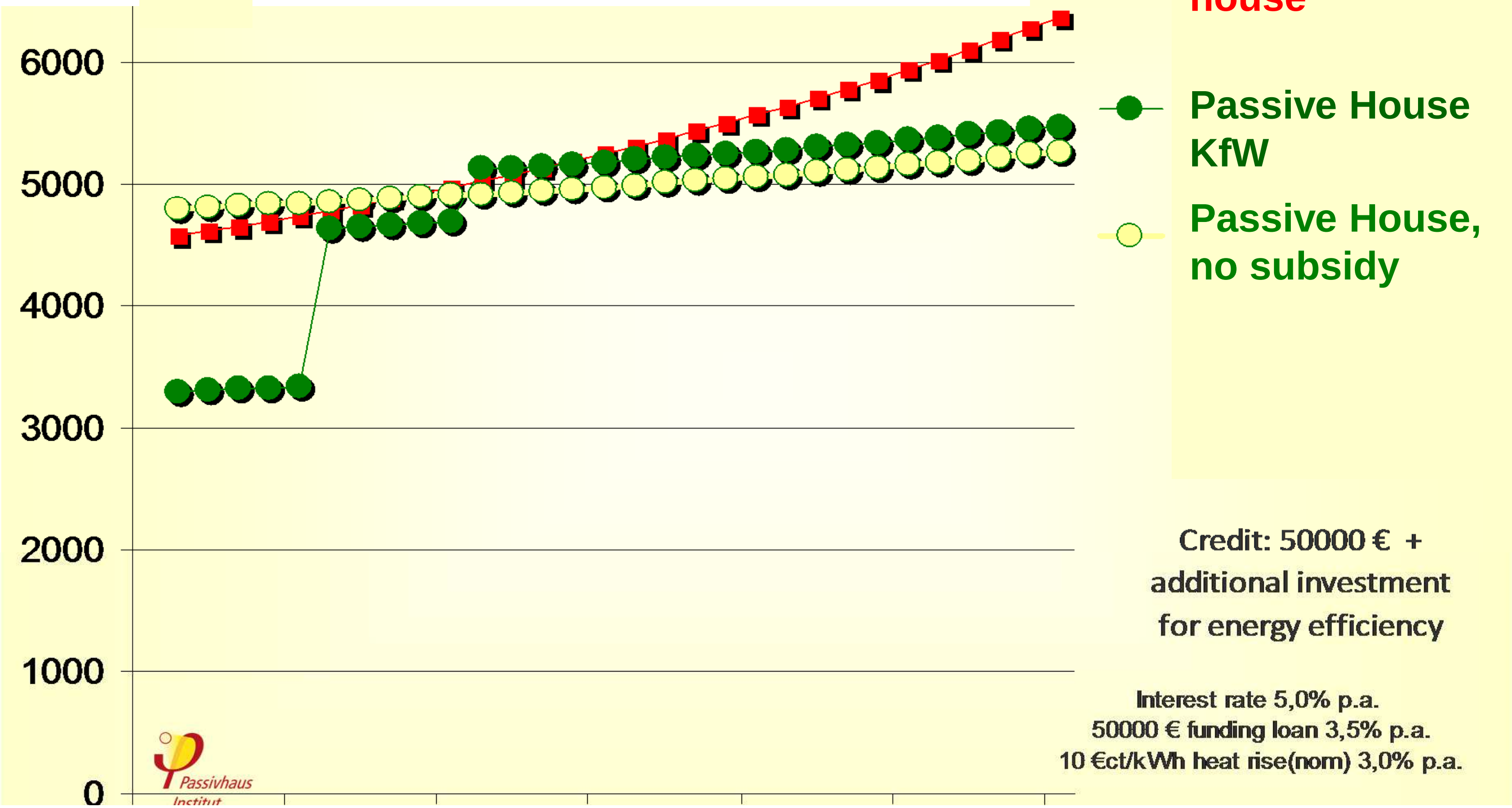
Financing | *Total annual costs compared*

Comparison of costs for a standard new building and a Passive House over 30 years.
Financial burden for debt service and energy.



Financing | *Total annual costs compared*

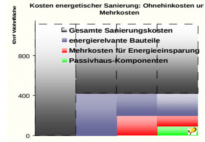
Comparison of costs for a standard new building and a Passive House over 30 years. The Passive House is subsidised by reduced rates of interest. Financial burden for debt service and energy.



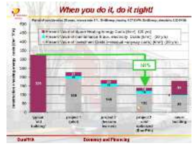
Assumptions: subsidies by KfW-loan (50 000 Euro); interest rate (mortgage) 5% p.a. = calculatory interest rate (expected rate of return); interest rates funding bank (analog KfW) (nominal) 3,50% p.a., for 10 years fixed; Fuel price: 8.4 ct/kWh, electricity:25 ct/kWh, rise in energy prices 3,0% p.a. (nominal).

Economy of Energy Efficiency: Summary

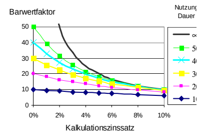
- Capital Cost
  - Attributed Costs – not full costs. Most profitable when anyhow measure is Residual values
  - High quality design: Avoid additional costs

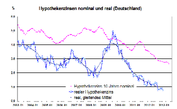


- Life cycle
  - Only life cycle costs
  - When calculation period is different, residual values must be regarded

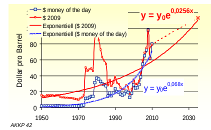


- Discount rate/required rate of return
  - High required rates of return → high capital costs (annuities)
  - → depreciate revenues
  - Alternative investments are riskless investments – low interest rates on capital market

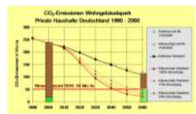




- Energy costs
  - Energy price uncertain – don‘t calulate with exponentially growing prices
  - Reliable energy performance (→ energy savings)
  - Avoid performance gaps by quality assured design and construction



- Planning for the future
  - Regard long life cycles
  - Sustainable standard ist the goal
  - Avoid „Lost opportunities“, suboptimal standards, lock-in effects:
  - When you do it, do it right!



Life cycle | *Total annual costs compared*

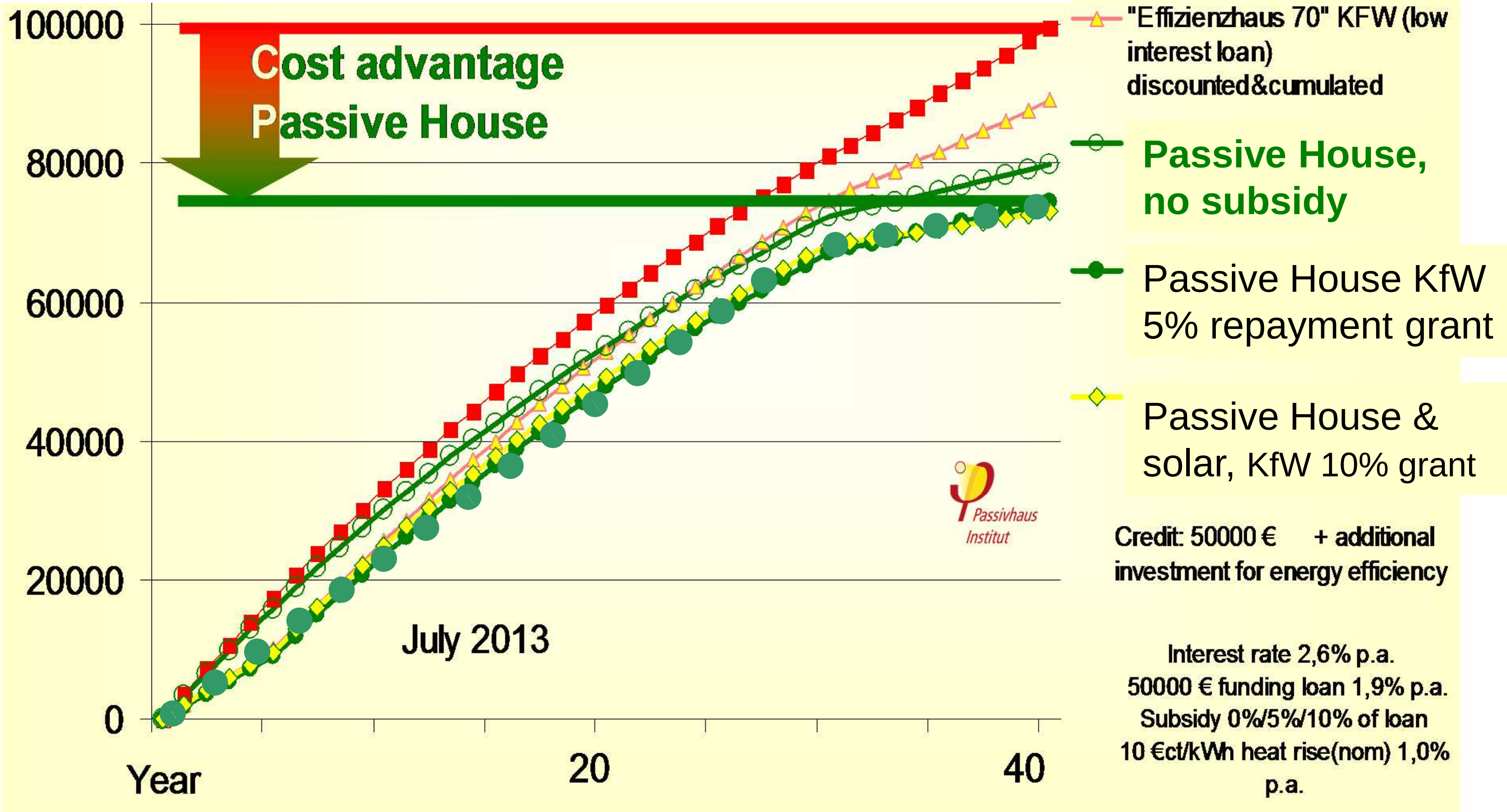
Comparison of costs for a standard new building and a Passive House over 40 years. The Passive House is subsidised by reduced rates of interest. Financial burden for debt service and energy.

AUSGEBLENDET

Assumptions: … erest rate (expected rate of return; interest rates KfW (nominal) 1,90% p.a., for 10 years fixed; repayment grant: 5%, 10% respectively. Fuel price: 8.4 ct/kWh, electricity:25 ct/kWh, rise in energy prices 1,0% p.a.

Life cycle: Total annual costs

Comparison of costs for a standard new building and a Passive House over 40 years. The Passive House is subsidised by reduced rates of interest. Financial burden for debt service and energy.

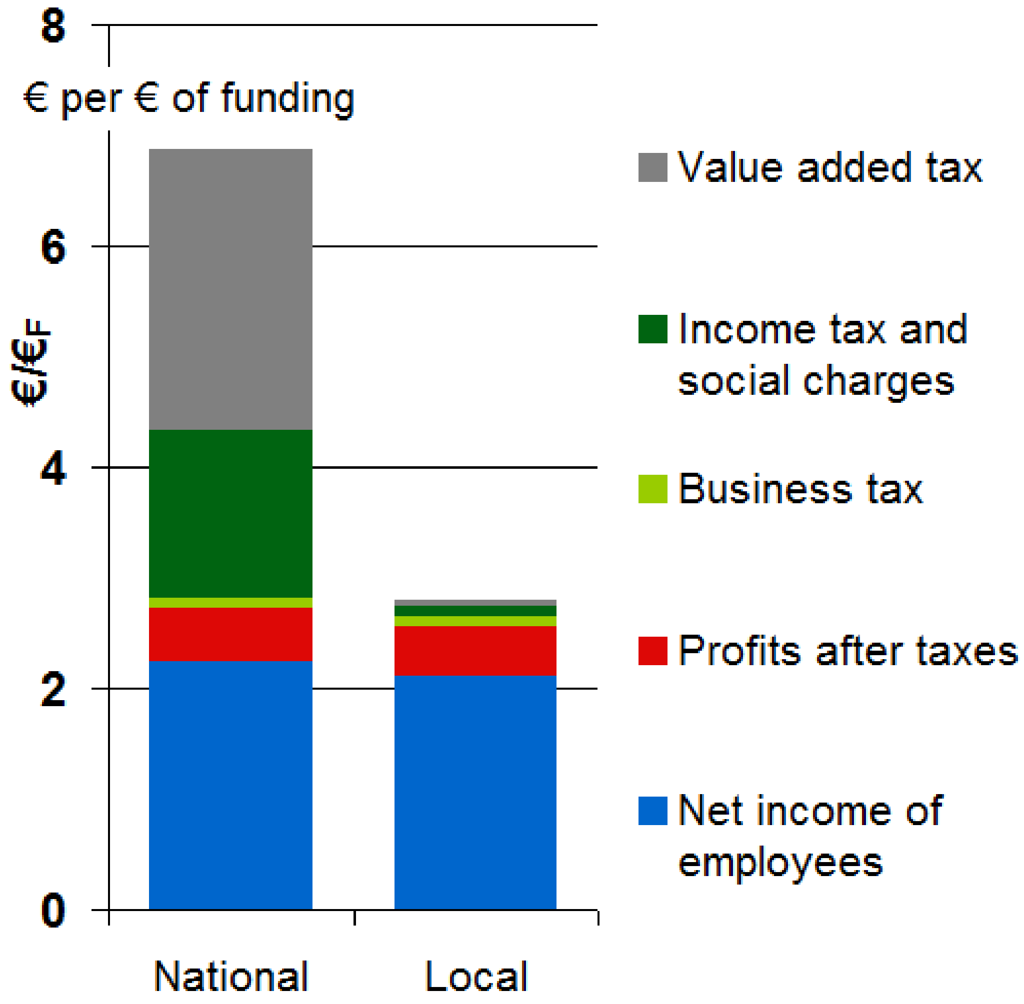


Assumptions: subsidies by KfW-loan (50 000 Euro); interest rate (mortgage) 2,60%p.a. = calculatory interest rate (expected rate of return; interest rates KfW (nominal) 1,90% p.a., for 10 years fixed; repayment grant: 5%, 10% respectively. Fuel price: 8.4 ct/kWh, electricity:25 ct/kWh, rise in energy prices 1,0% p.a.

Funding energy effciency | *Financial effects*

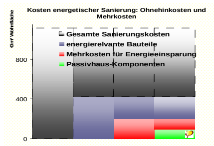
Financial aids should focus on:

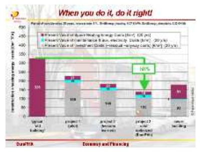
- improving liquidity and reducing
  financial burden. This can be achi
  through direct financial support,
  also special credit lines with low
  interest rates (especially in the fi
  years)
- supporting collaterals to facilitate
  access to attractive bank credits
- - binding financial support to qua
  assured design to realize the
  expected performance and guara
  damage-free construction and lo
  lifetime measures
- avoiding medium quality that hin
  the necessary reduction and caus
  "lock in" effects. Instead,
- achieving very high energy efficie
  and superior quality, because the
  next renovation will only happen
  many years.

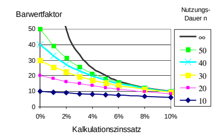


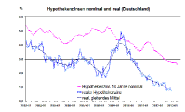
Economy of Energy Efficiency: Summary

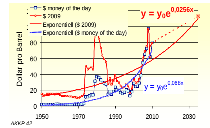
- Capital Cost
  - Attributed Costs – not full costs.
  - High quality design: Avoid additional costs
- Life cycle
  - Only life cycle costs
  - When calculation period is different, residual values must be regarded
- Discount rate/required rate of return
  - High required rates of return → high capital costs (annuities)
  - → depreciate revenues
  - Alternative investments are riskless investments
- Energy costs
  - Energy price uncertain –Reliable energy performance (→ energy savings)
- Planning for the future
  - Regard long life cycles - when you do it, do it right!

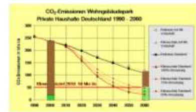




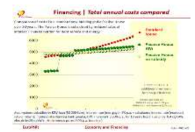


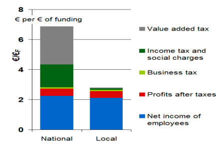






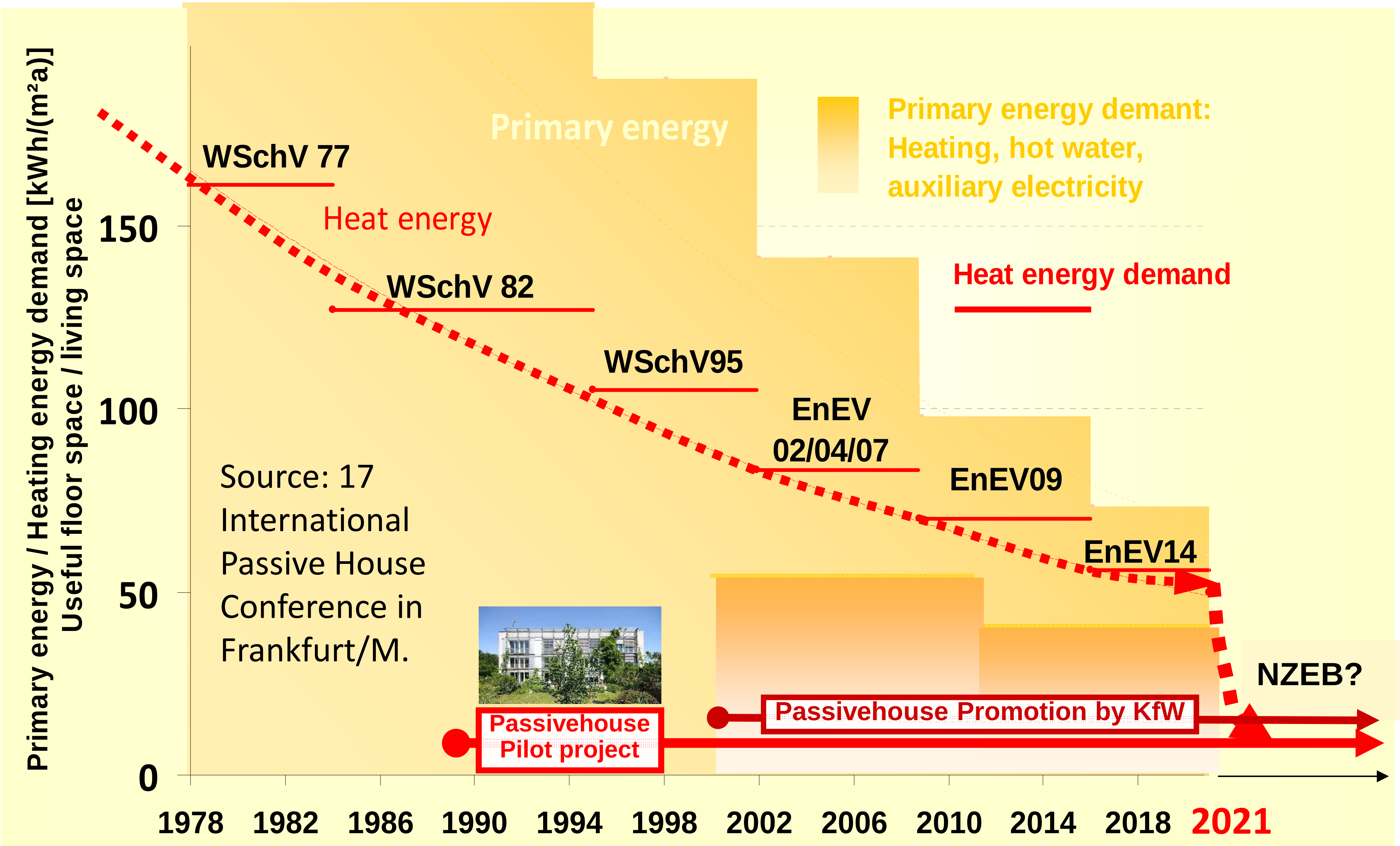
- Adequate financing and funding
  - Financing models should reflect low risk and lower the initial financial burdens
  - Funding always linked to high quality und high performance
  - Avoid lock in effects
  - Create added value and win win situations
  - Use funding to create awareness!



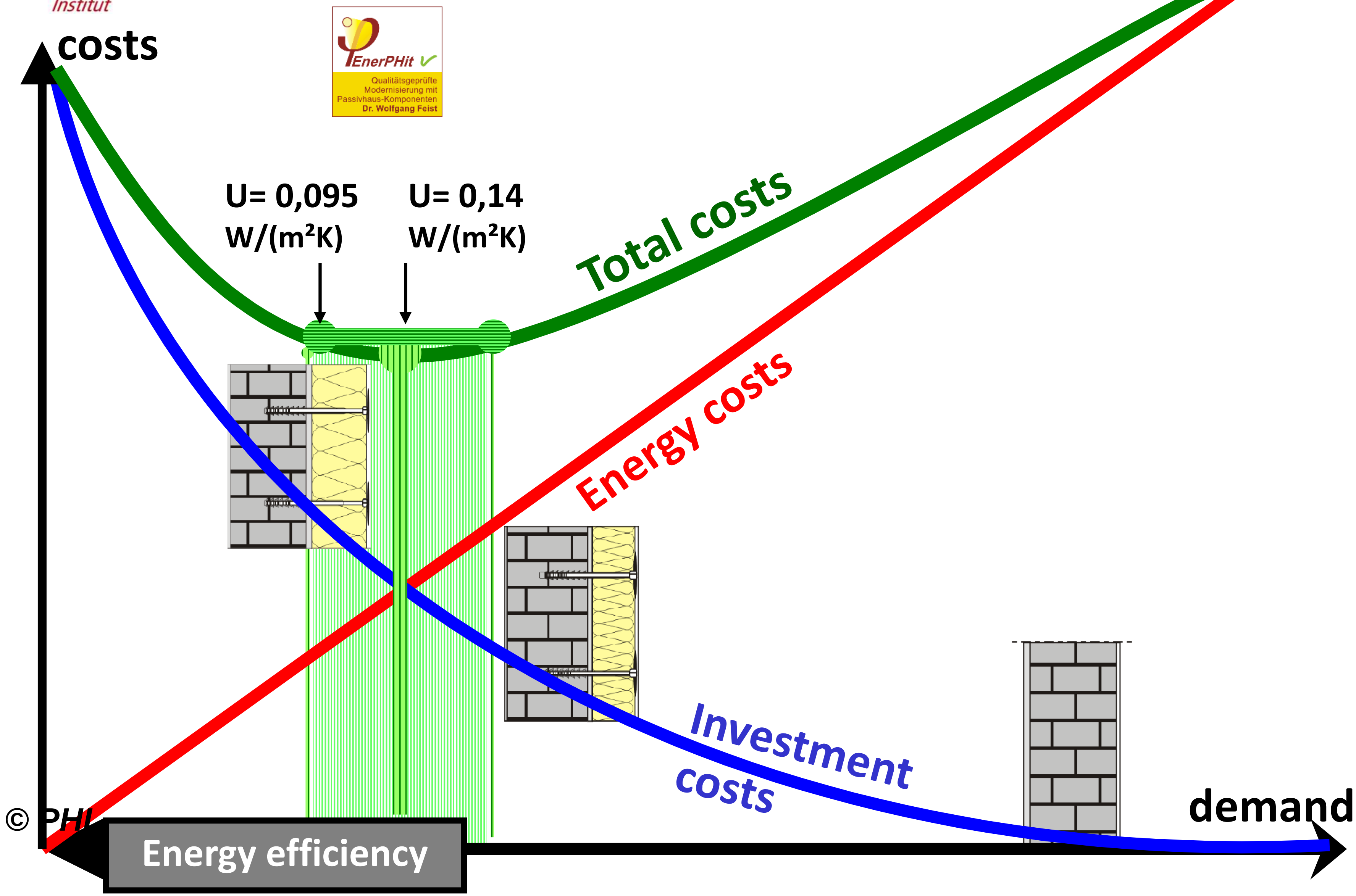


www.passivehouse.com
Passive House Institute

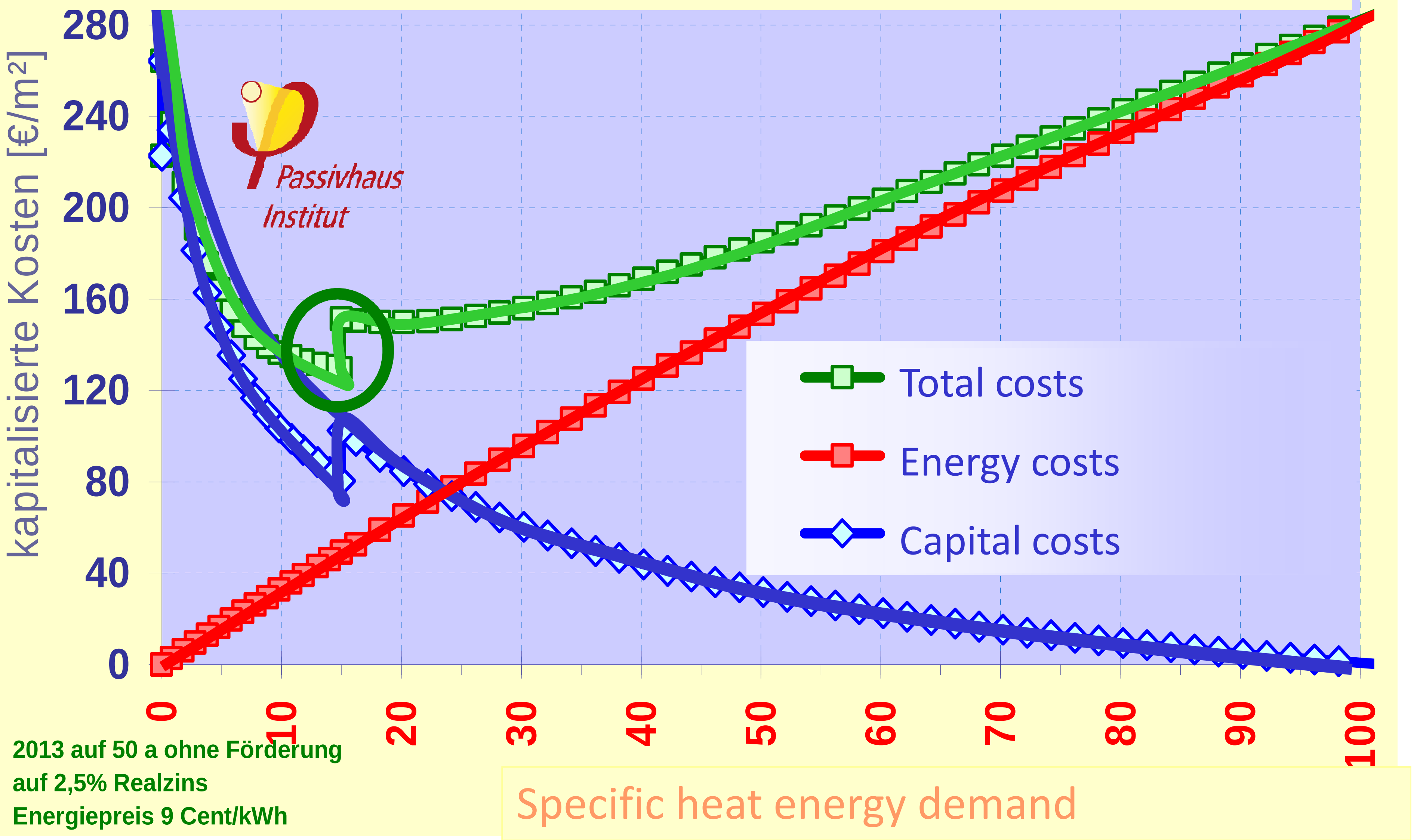
Germany | *Building Energy Performance Standards*



Life cycle costs | *cost optimal level*



PH: cost-optimal balance between the investments and energy costs



2013 auf 50 a ohne Förderung
auf 2,5% Realzins
Energiepreis 9 Cent/kWh

EuroPHit

Thank you for your attention

www.europhit.eu

The sole responsibility for the content of this presentation lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EACI nor the European Commission are responsible for any use that may be made of the information contained therein.

Partners:

Passive House Institute

Passivhus.dk

Supporters:

NÆSTVED

SAINT-GOBAIN

KfW Bankengruppe