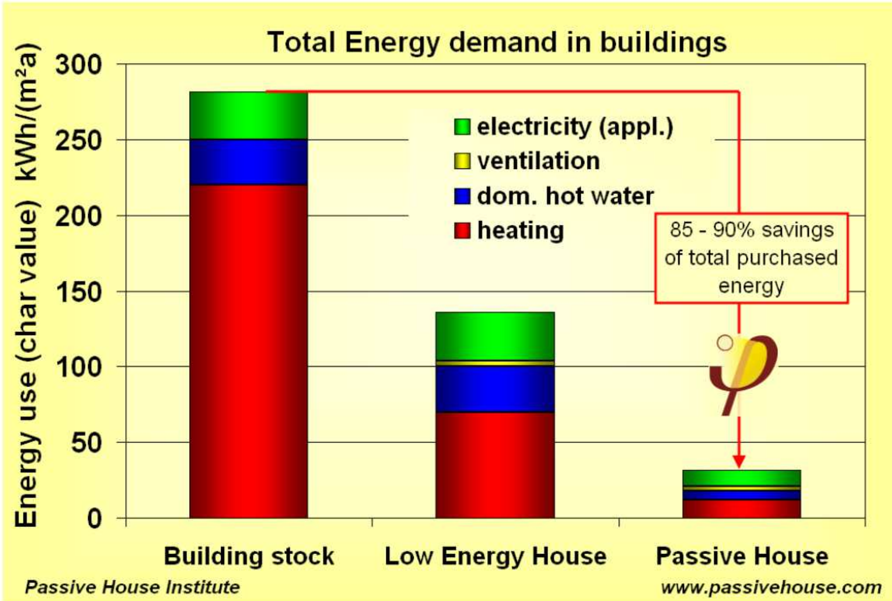
Financial workshop

Witta Ebel
PASSIVE HOUSE INSTITUTE
Darmstadt/Germany

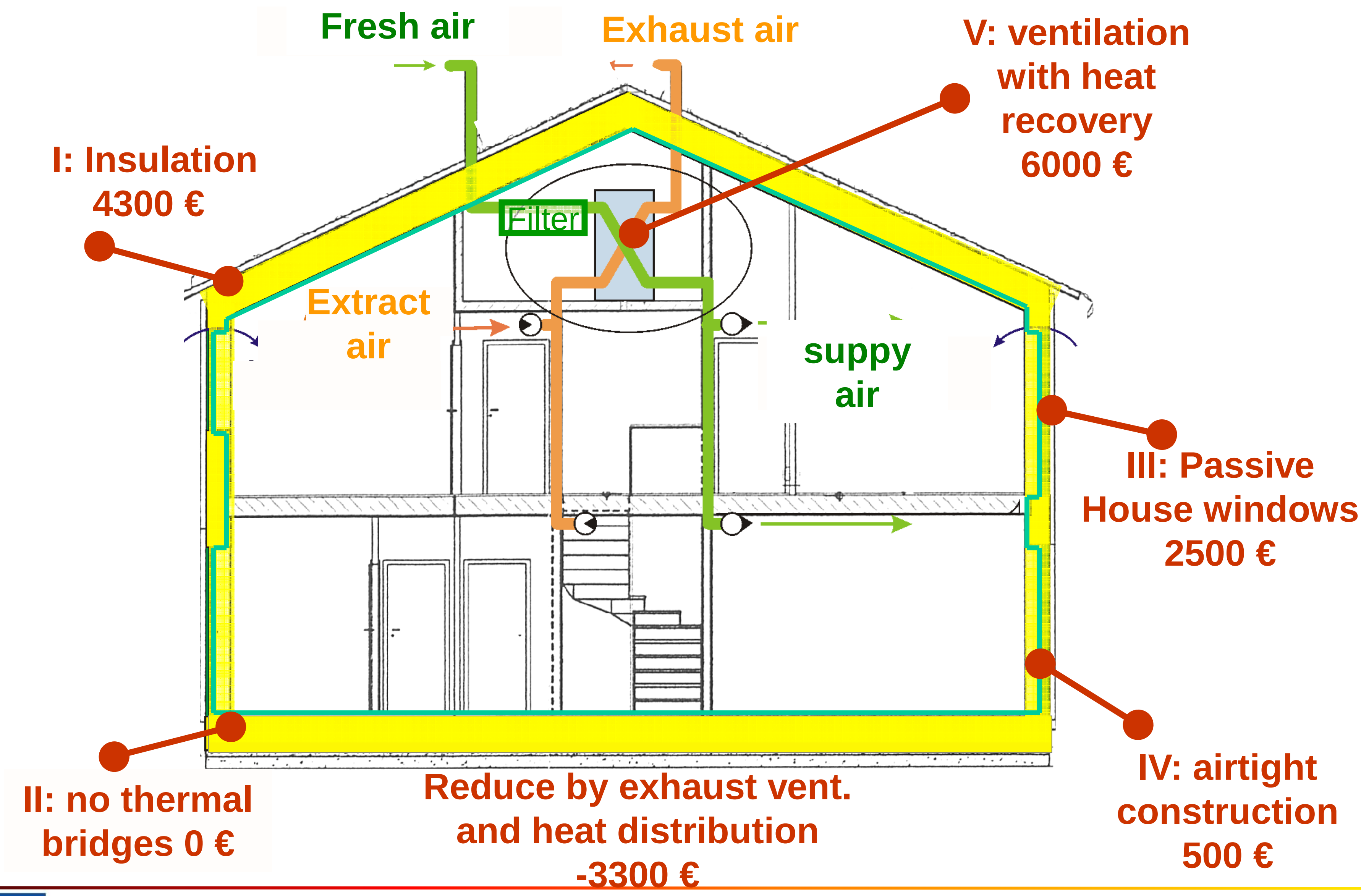
Economy of energy efficiency



Frankfurt, 18 March, 2016

www. passivehouse.com

Passive House principles and components – Sustainable Energy Becomes Affordable



Payback vs. Efficiency Life Cycle Costs

~~Payback time~~: $\dfrac{\text{Investment cost}}{\text{yearly savings of energy costs}}$

- **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

Costs

- Expenditures are made to create value or 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 can become tradable commodities, with both a market and a price
- Investments are made to achieve revenues with the comodities sold on the market. The goal of the investor is to generate profits

Economy: Life cycle costs. Present (Cash) value

How to calculate life cycle costs

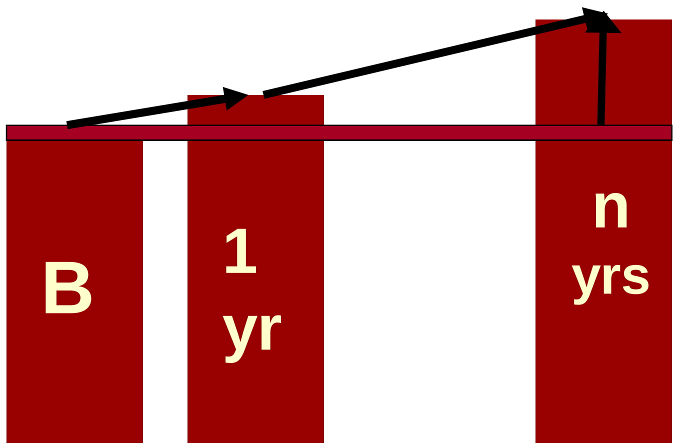
- Costs of investment
- Costs of maintenance
- Costs of energy

Cost of capital: interests (p = interest rate)

Principle of compounding:

Account now B

after n years $B^*(1+p)^n$ (final value)



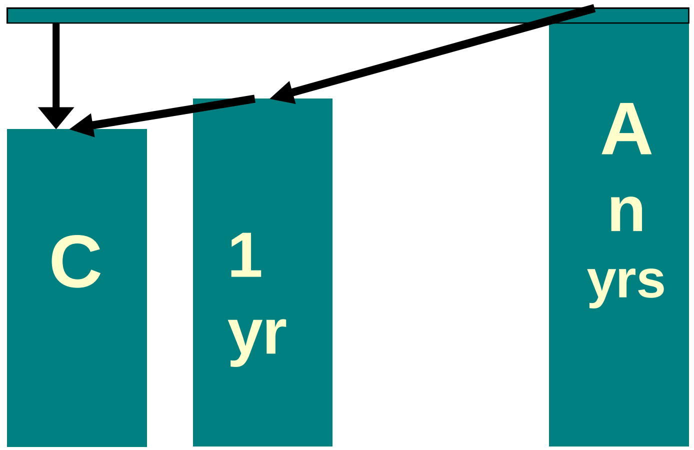
Principle of discounting:

Costs later A after n years

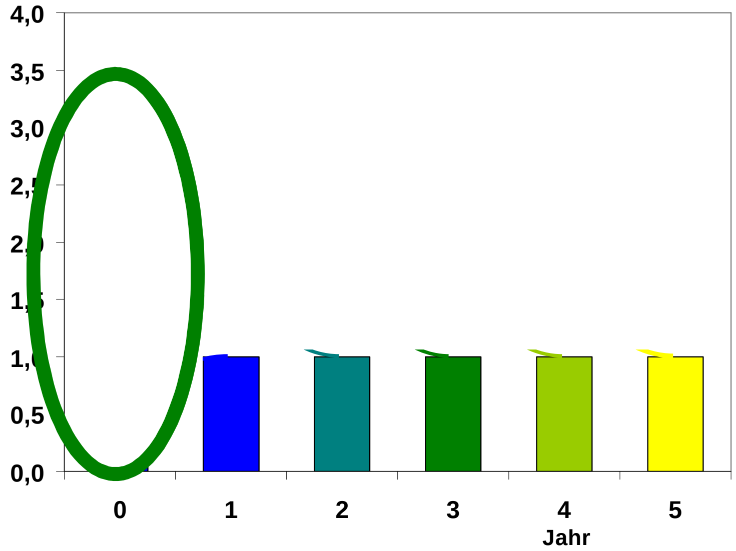
→ Cash value $C = A/(1+p)^n$

(= amount you need now to pay later using credit and interests)

Discount factor: $1/(1+p)^n$



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



Example:

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

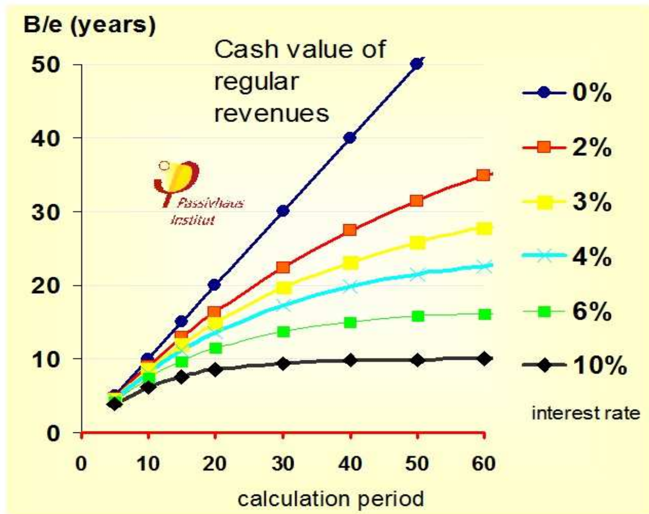
Present value = $\sum_i^n E_i/(1+p)^i$,

Present value = **Sum of discounted revenues**

Market capitalisation

Cash value factor

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

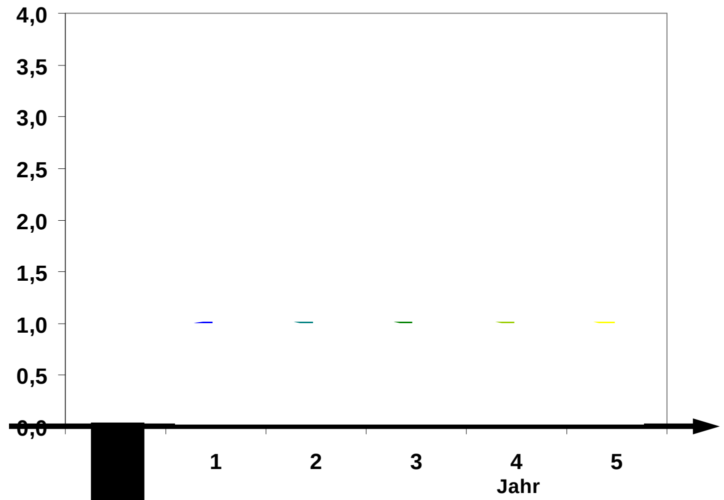


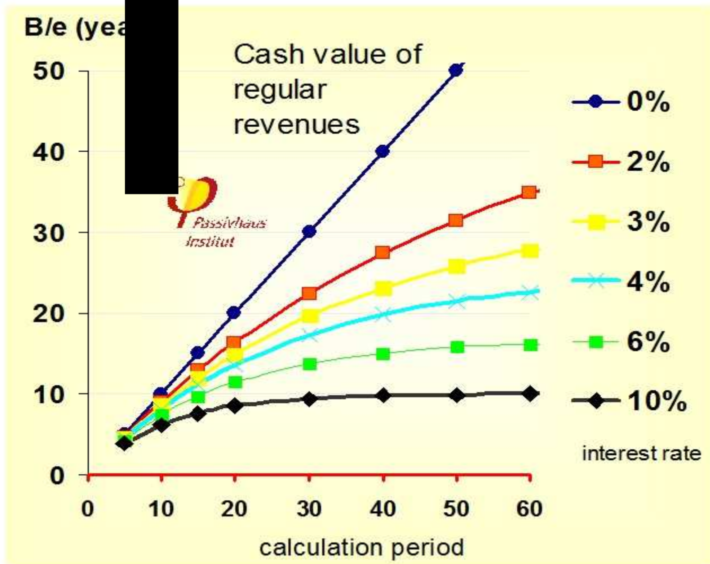
Total cost balance

Net present value (NPV)

= sum of all discounted incomes and costs

= profit (as present value)





NPV ≥ 0: investment is profitable

NPV < 0: loss!

Economical assessment: *always in Alternatives*

- An investment should be at least as **attractive as its alternatives** that are available on the capital market
- Dynamical methods regard price for capital
  - interest on debt
  - or equity (opportunity costs, required rate of return)
- Costs and revenues (payments) become comparable with present values
- Investments are profitable → positive /nonnegative **net present value** (= profit)
- As long as capital (incl. debt) is available, it is economically rational to make **ALL investments** up to a net present value = 0

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*

Annuity method: annual costs and revenues

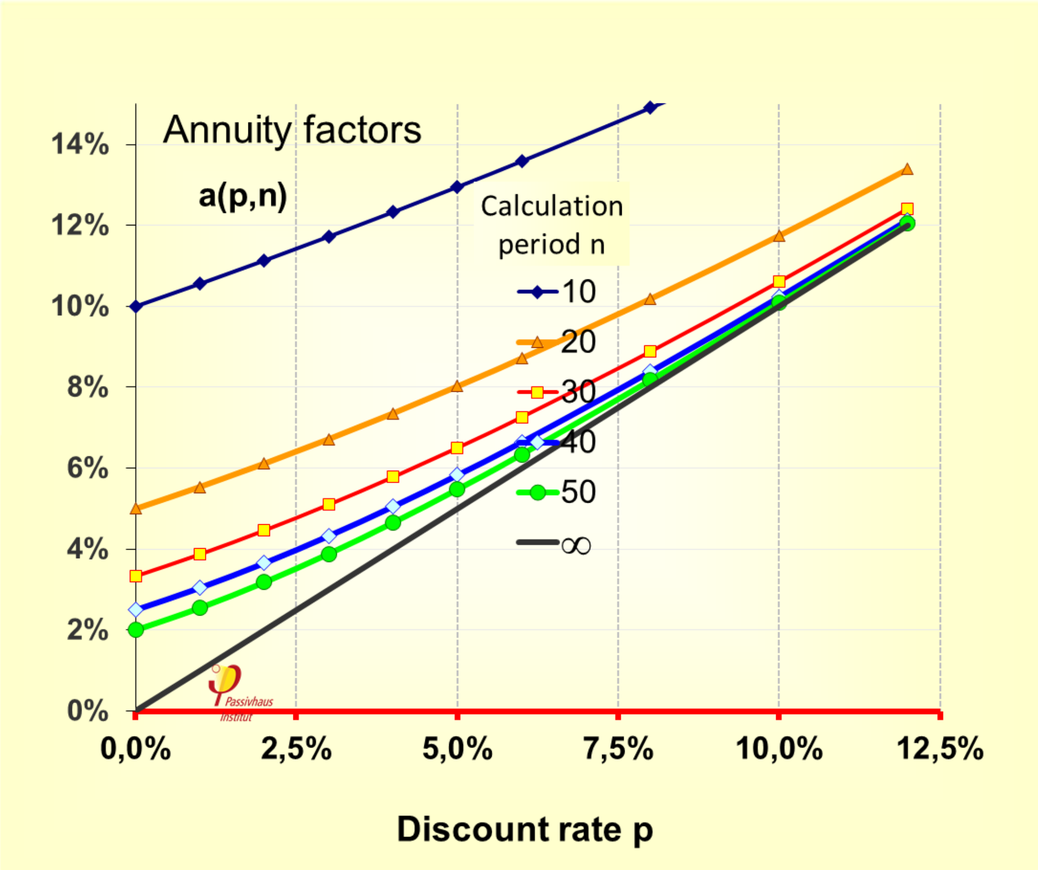
Annuity

constant yearly rates of an Investment

or

of a present value

Annuity factor $a(p,n) = \dfrac{p}{1-(1+p)^{-n}}$



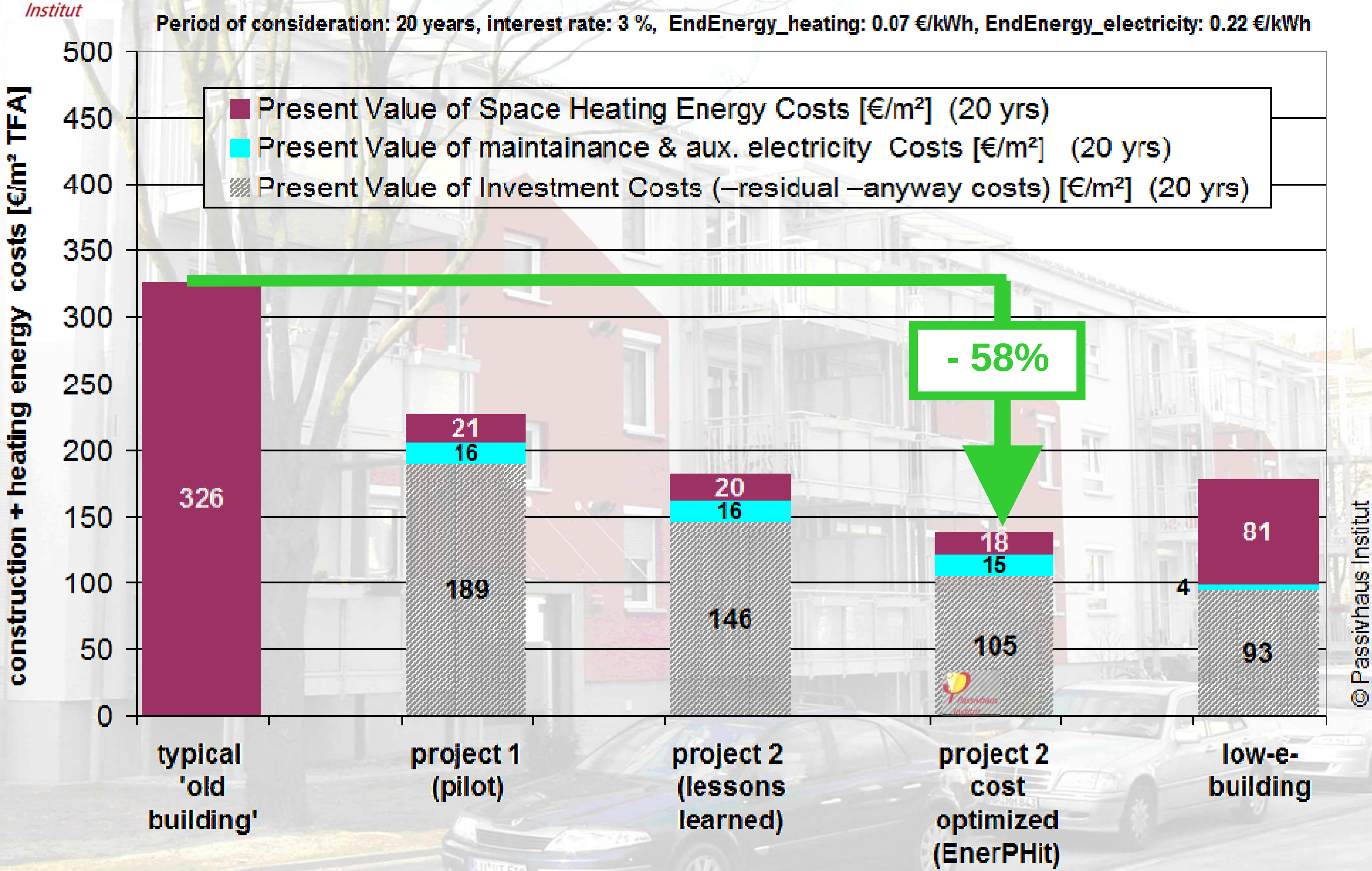
Annuity factor is

- > $1/\mathbf{n}$ limit für p = 0
static approximation)
- > **p** (limit for n→∞

approximation ~ 1/n + p/2
or 1/n + p/2 *(1+np/6)

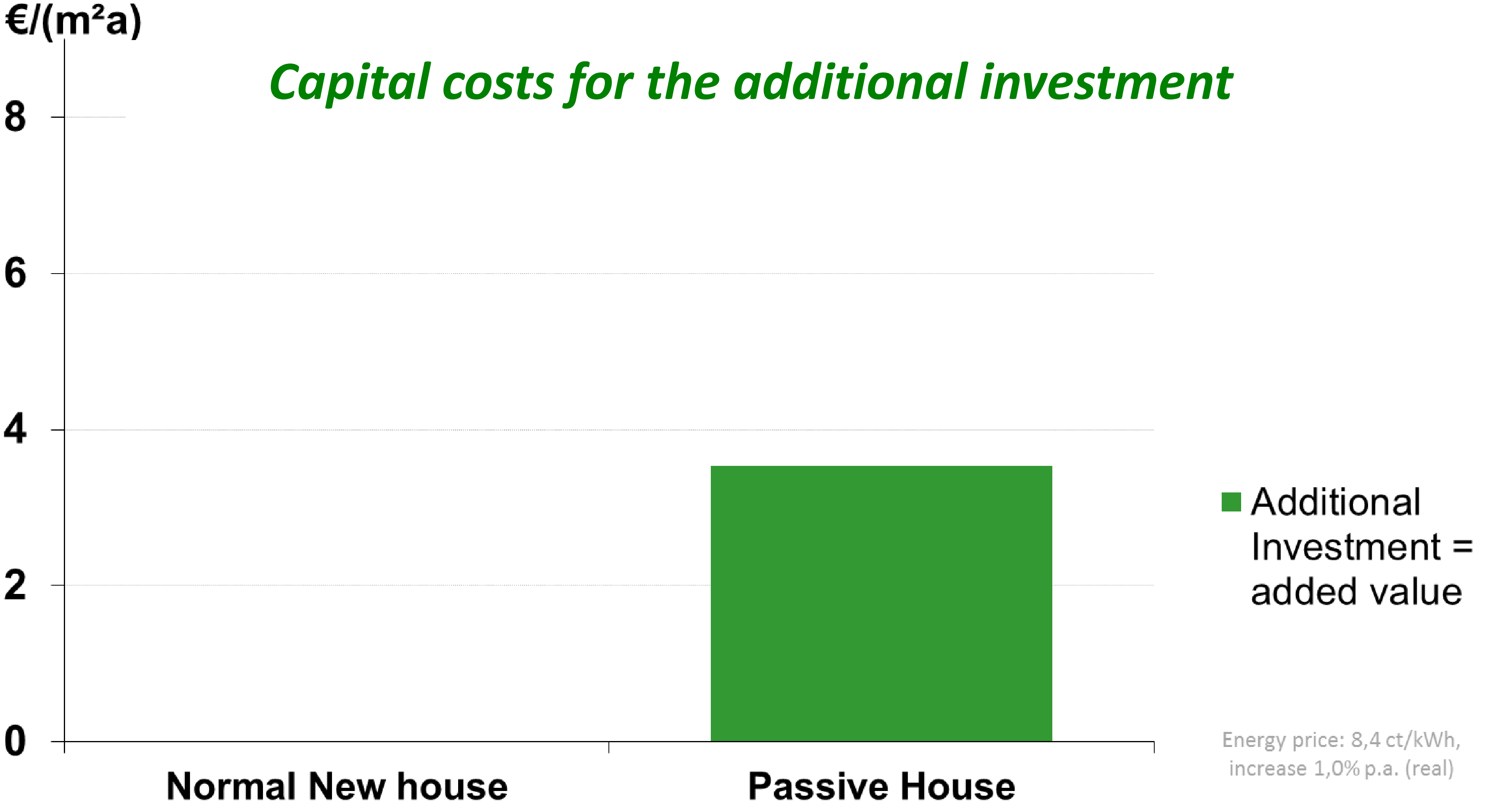

When you do it, do it right!
Ludwigshafen Schlesierstraße

When you do it, do it right!



Economy: Life cycle costs

EuroPHit



Energy price: 8,4 ct/kWh, increase 1,0% p.a. (real)

Costs over 40 years, Interest rate (real) 2,46% p.a.

Economy: Life cycle costs

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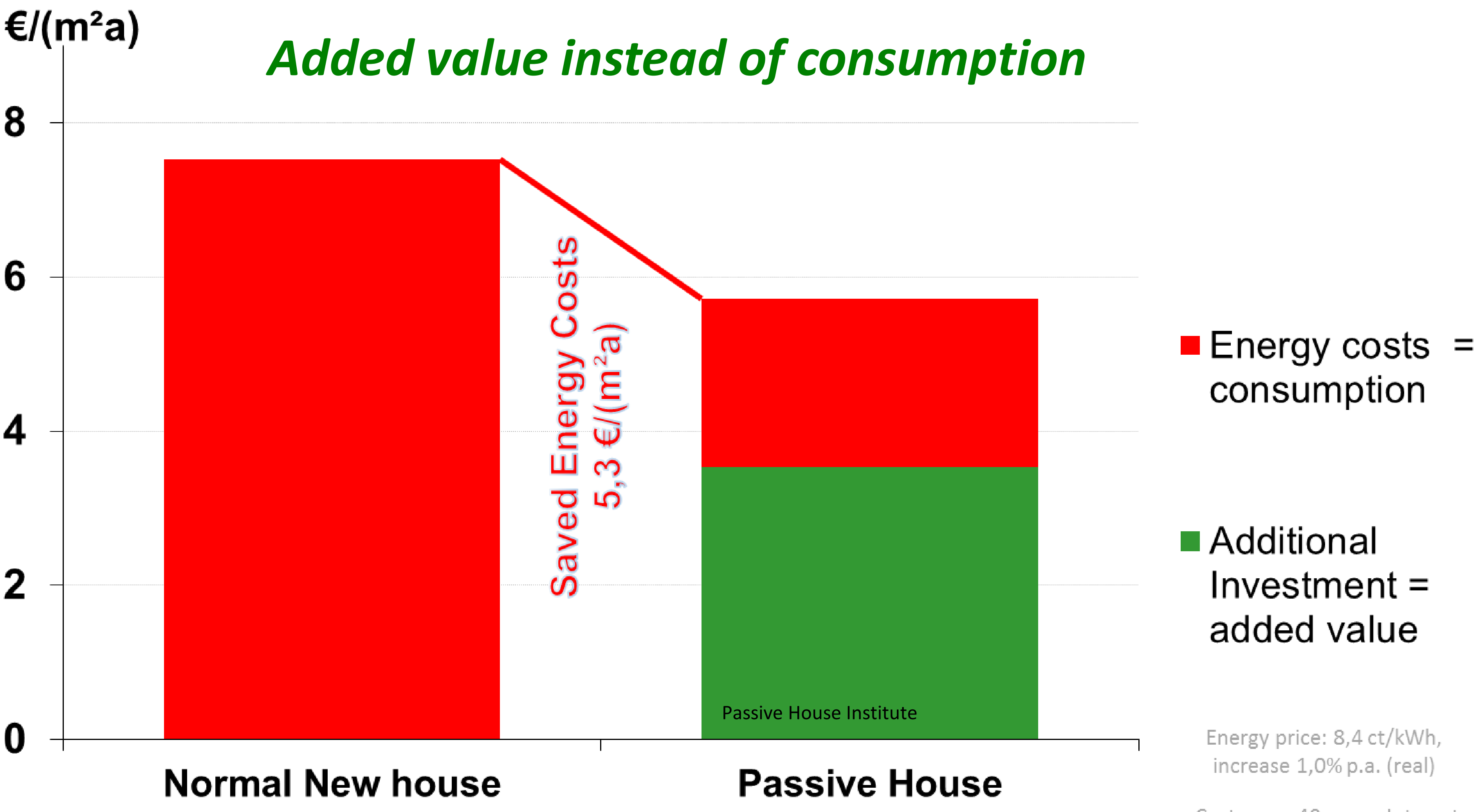


Energy price: 8,4 ct/kWh, increase 1,0% p.a. (real)

Costs over 40 years, Interest rate (real) 2,46% p.a.

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!

Anyhow costs: Insulation of a demo project in Nuremberg

Architect/Photo: Burkhard Schulze Darup
Owner: WBG Nürnberg. Source: AKKP 24

Measures needed anyhow, regardless of renovation level

- scaffolding
- removal of old plaster
- addition of new plaster
- ~~insulation panels~~
- ~~high quality new plaster~~ saved!

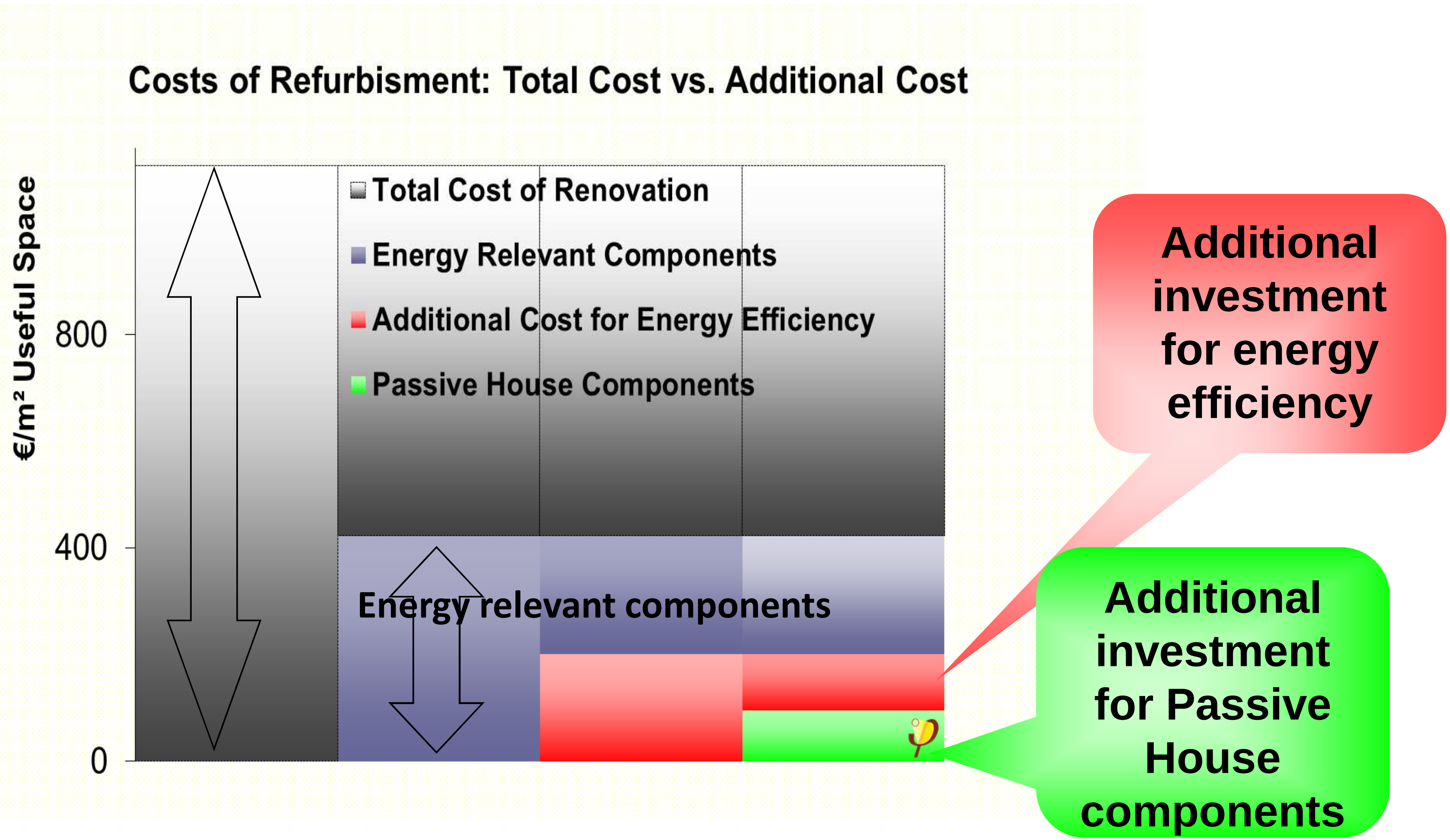
Keep the old plaster

Don't "save" money with thin insulation

Take the opportunities for efficiency technology: realise the additional benefits wherever possible.

When you do it, do it right!

What counts: *Additional* Investment



Calculation Period and Residual Values

How long will insulation last? **At least 40-50 Years!**

But: You do not obtain credits with such a long period. Typical periods: 20 a.

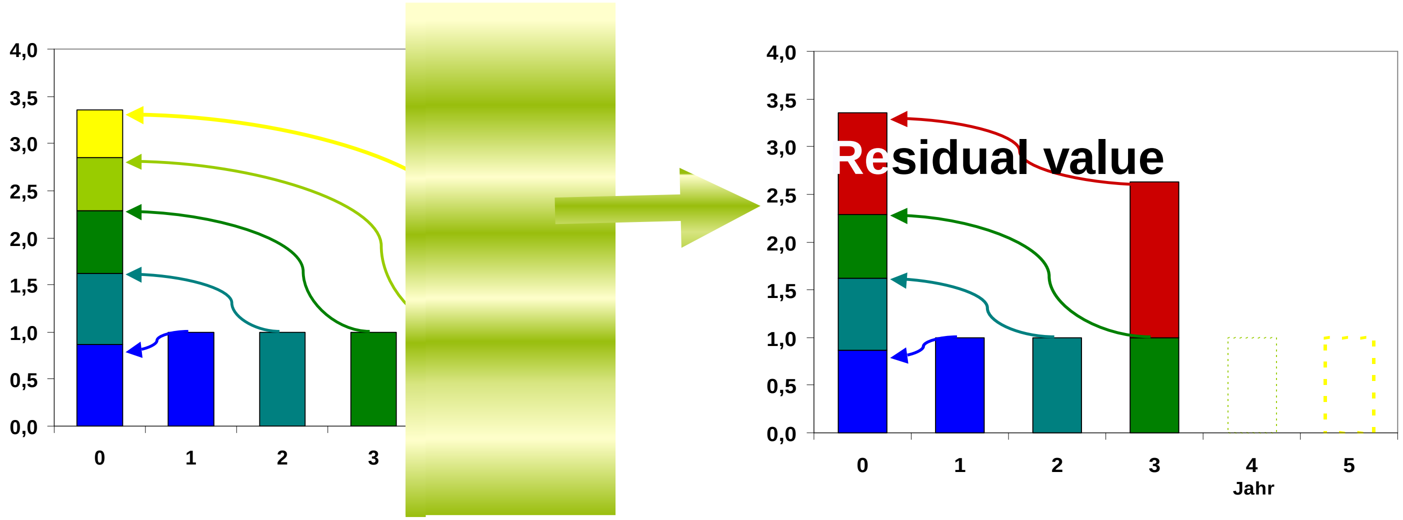
Calculation period **n** and lifecycle **N** can be different

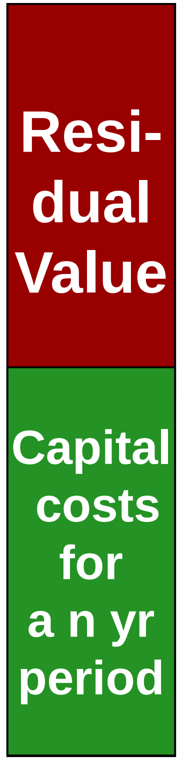
Different life cycles for partial investments (components) – STEP by STEP

Residual value is an „Income“ at the end of the calulation period n

Capital cost = depreciation during calcualtion period

= Investment – residual value

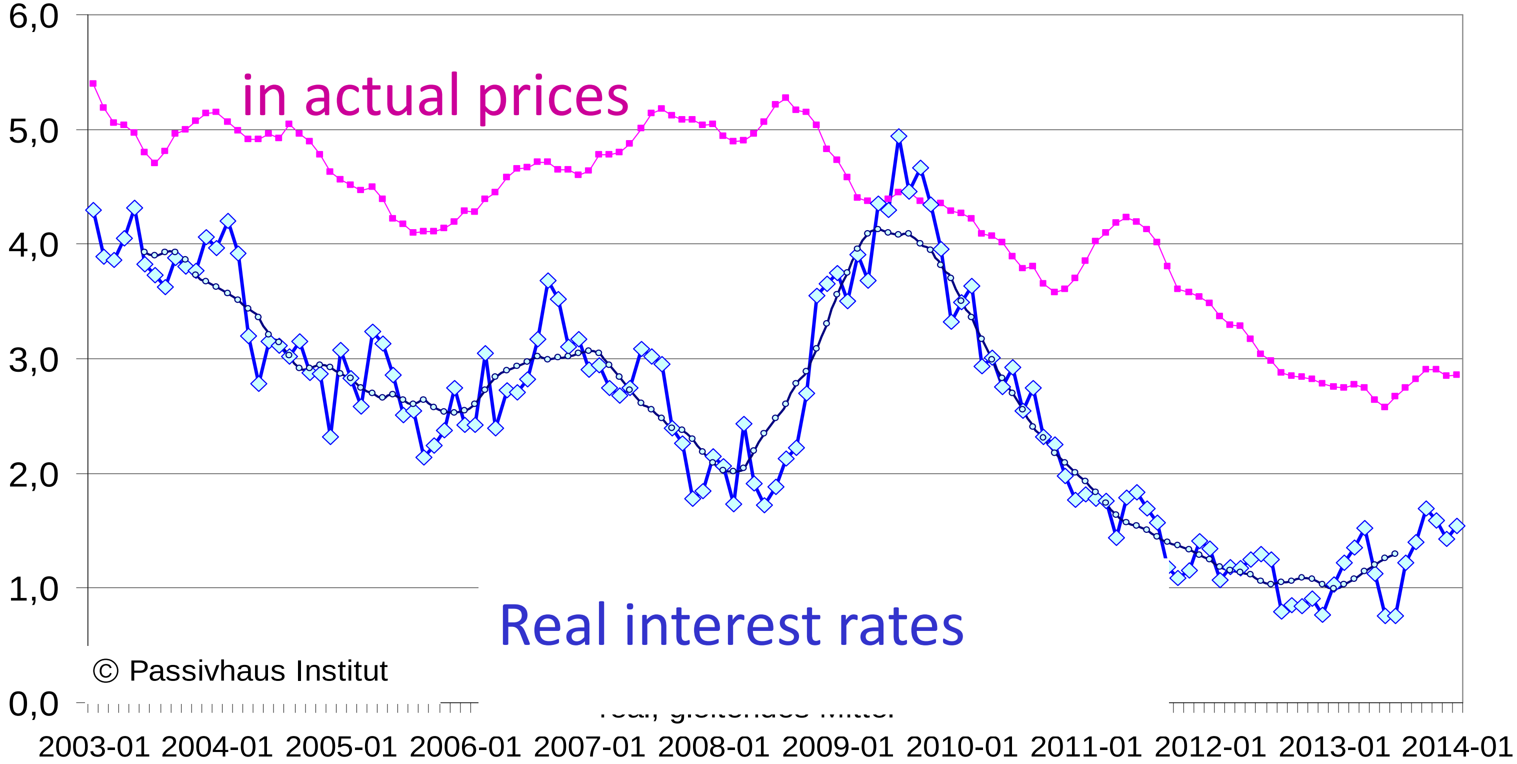




$$R = 1 - CashValueFactor_n / CashValueFactor_N$$

Paramter: Discount rate

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



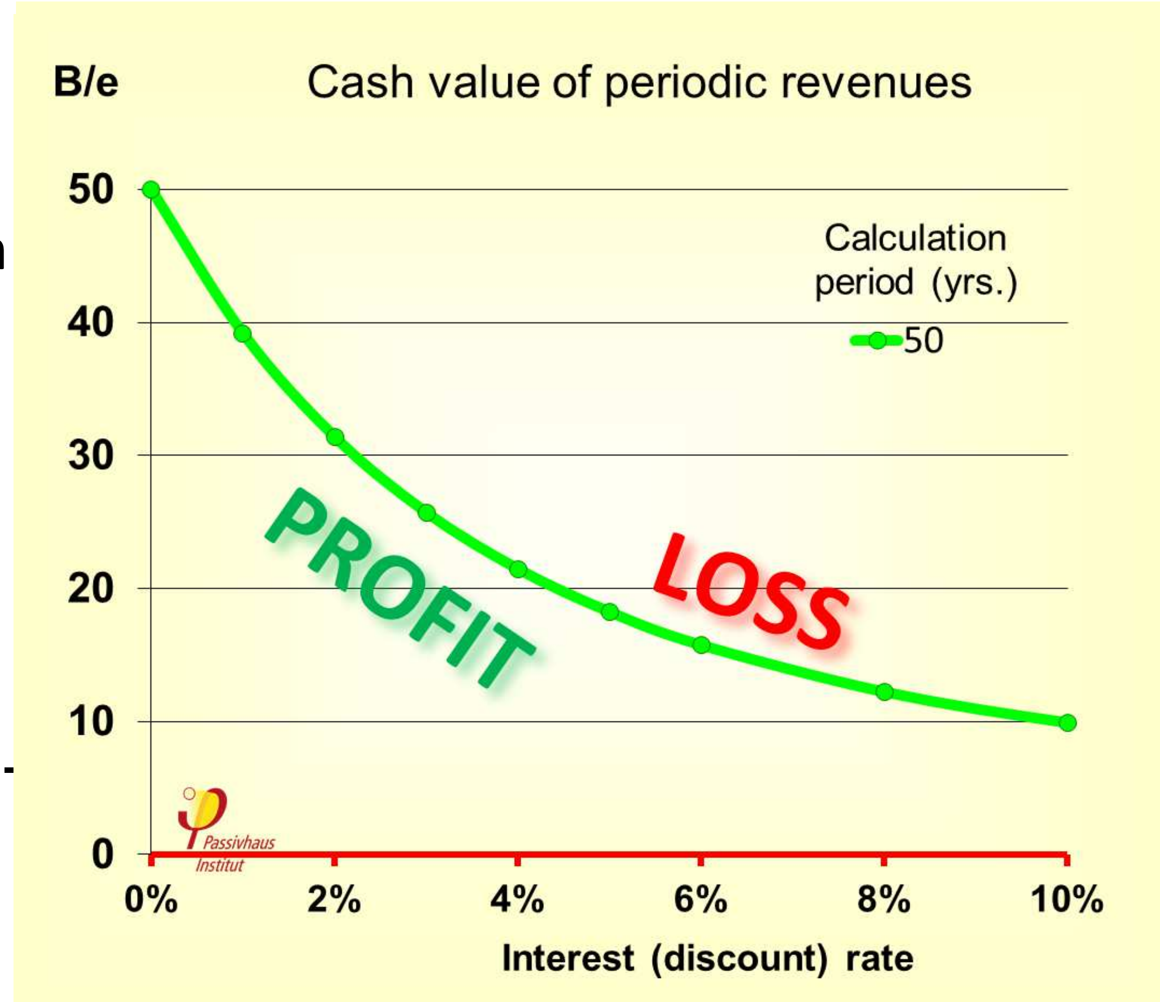
$$p_{real} = \frac{p_{nom} - i}{1 + i}$$

(p interest rate, i inflation)

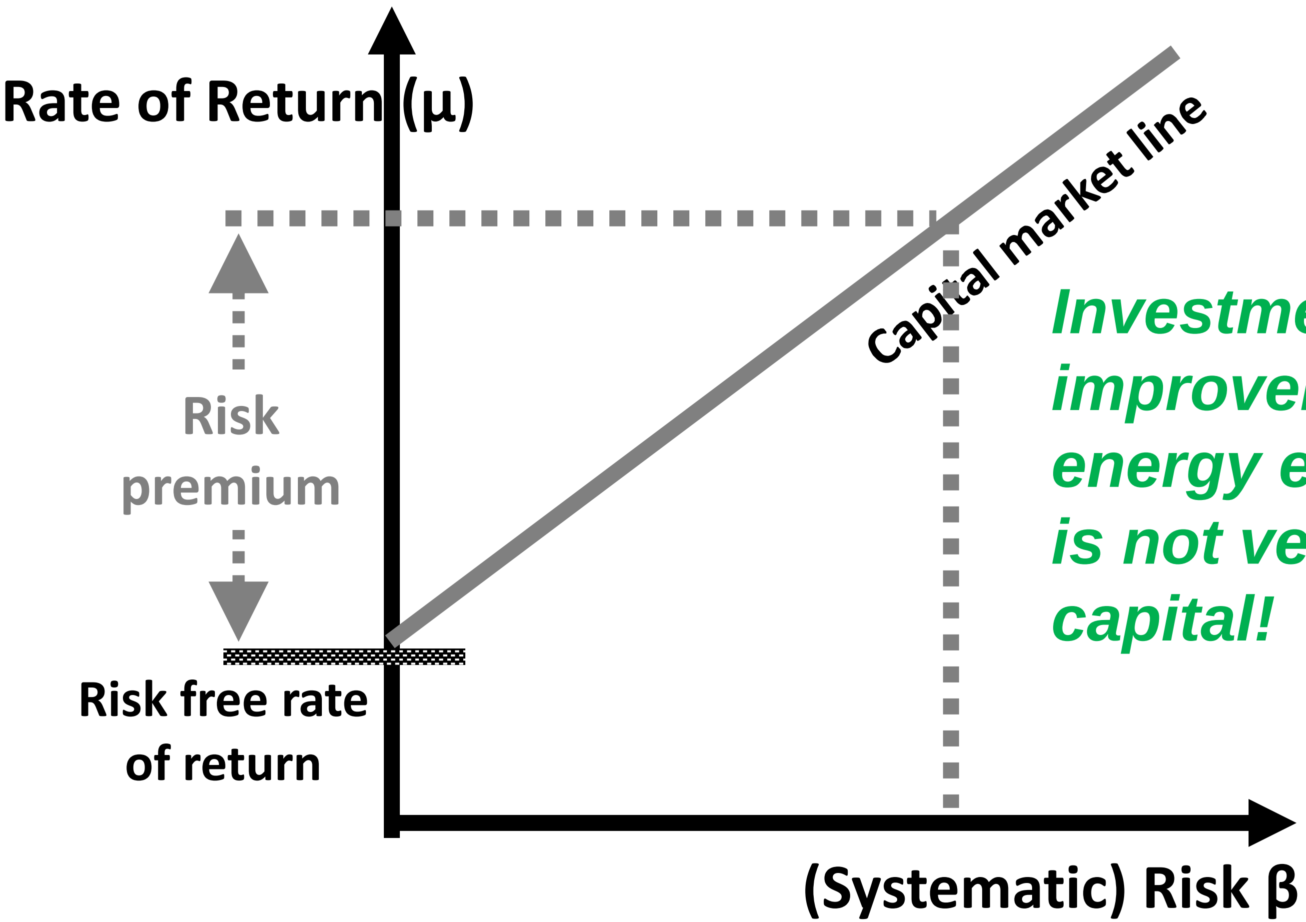
Parameter: required rate of return

EuroPHit

- Required rate of return is the discount rate
- Revenues count only with their cash values
- High required rates of return
  - Lead to high capital costs (annuity = amortisation + interest)
  - depreciate revenues
  - makes investment less profitable

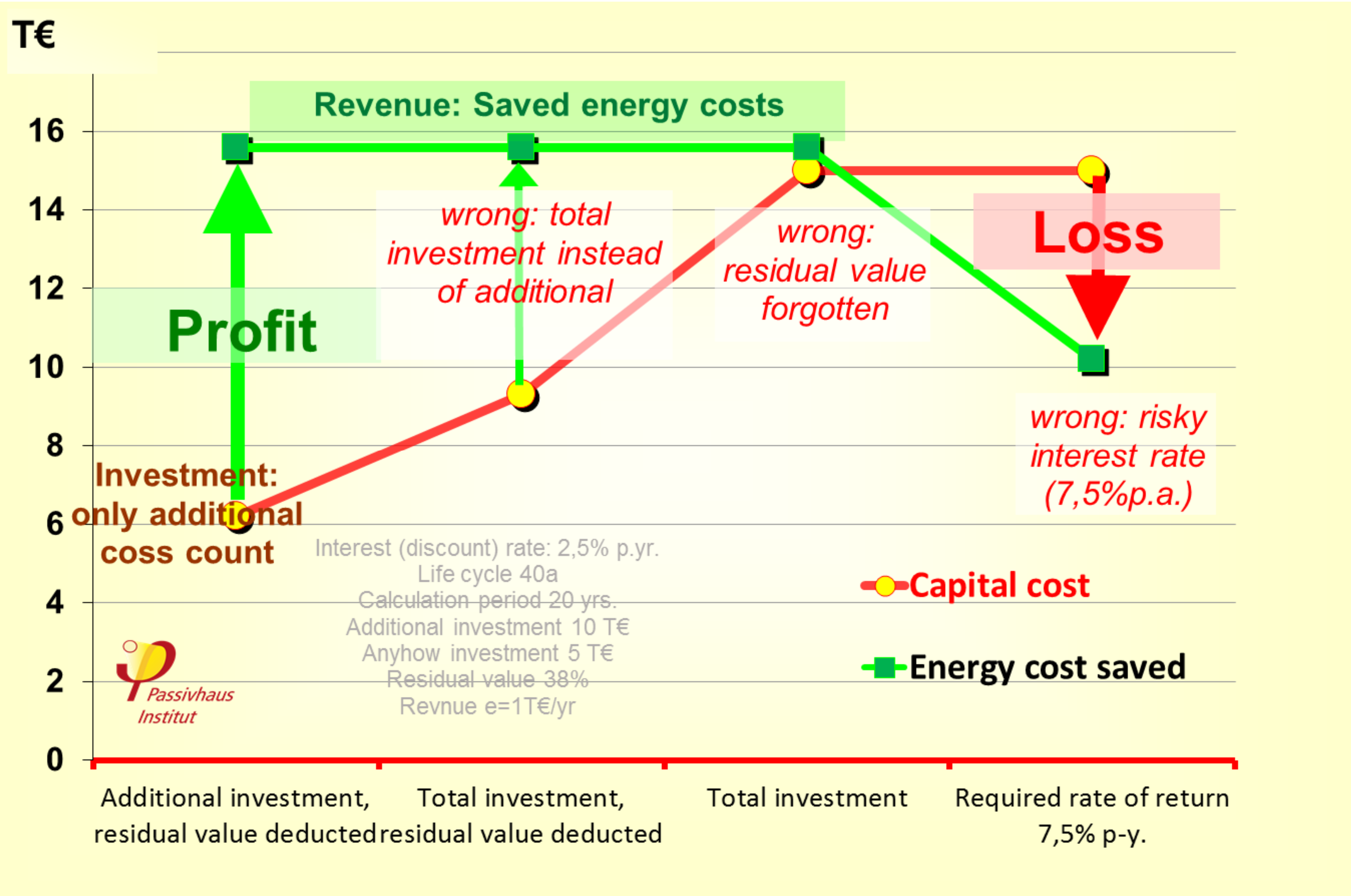


Parameter: Risk and required rate of return



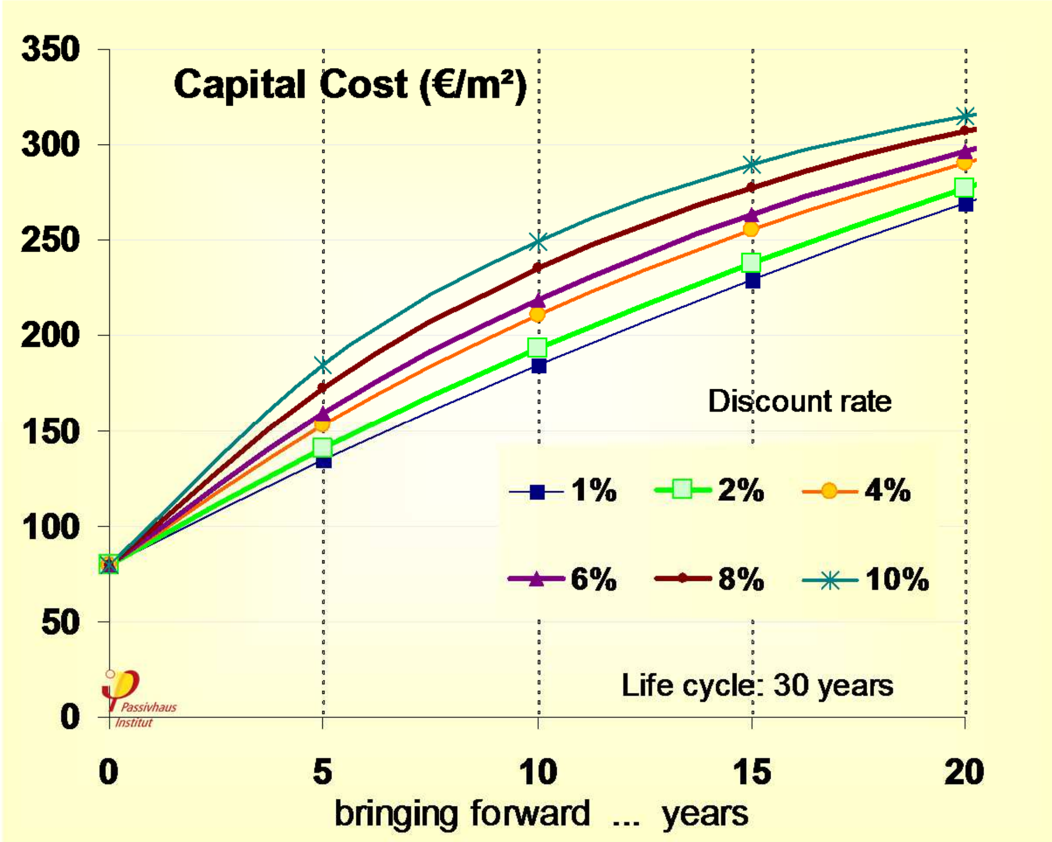
Investment in the improvement of energy efficiency is not venture capital!

Influence of parameters on economical result (NPV)



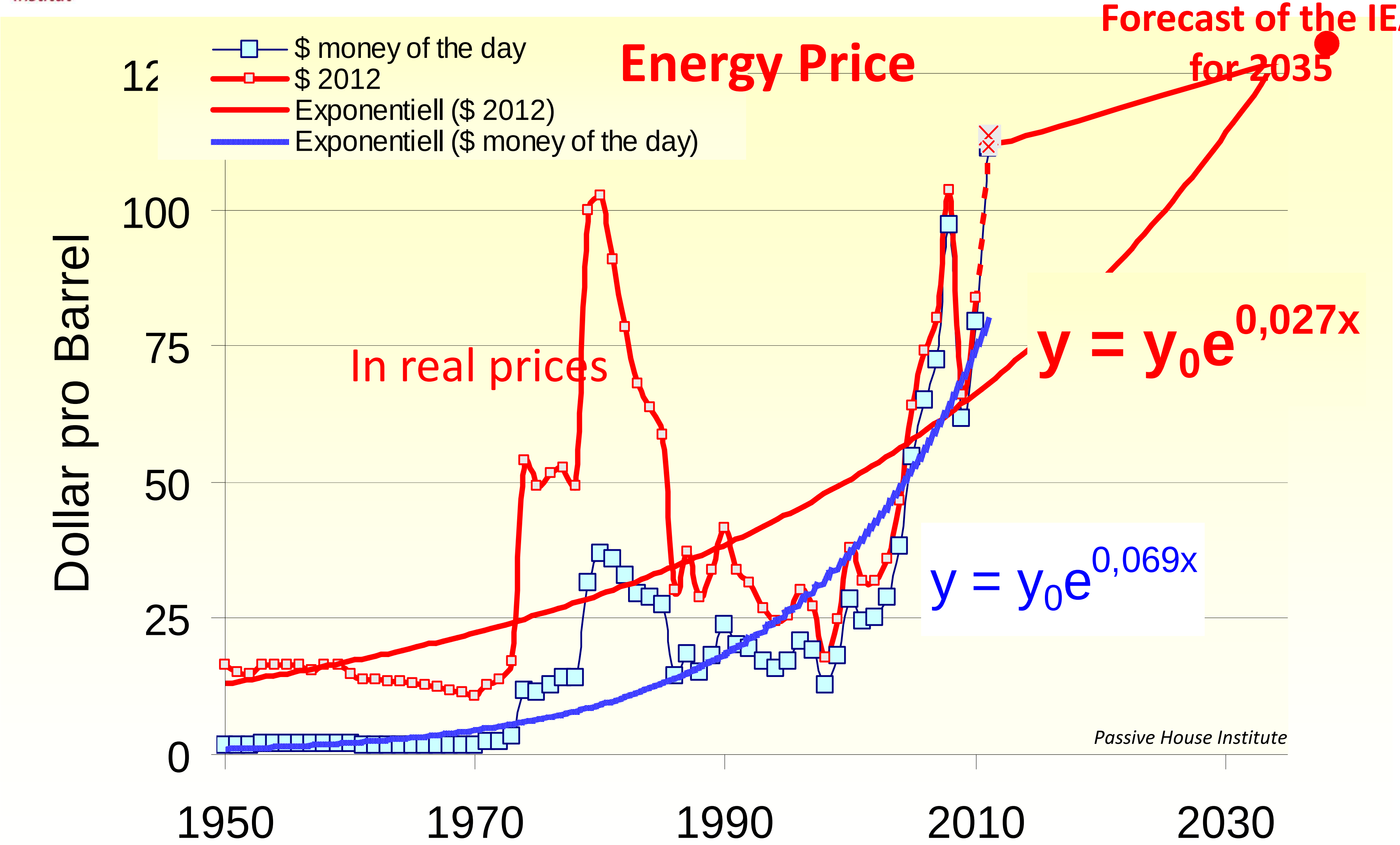
Capital Cost: The point in time – and step by step

- 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.



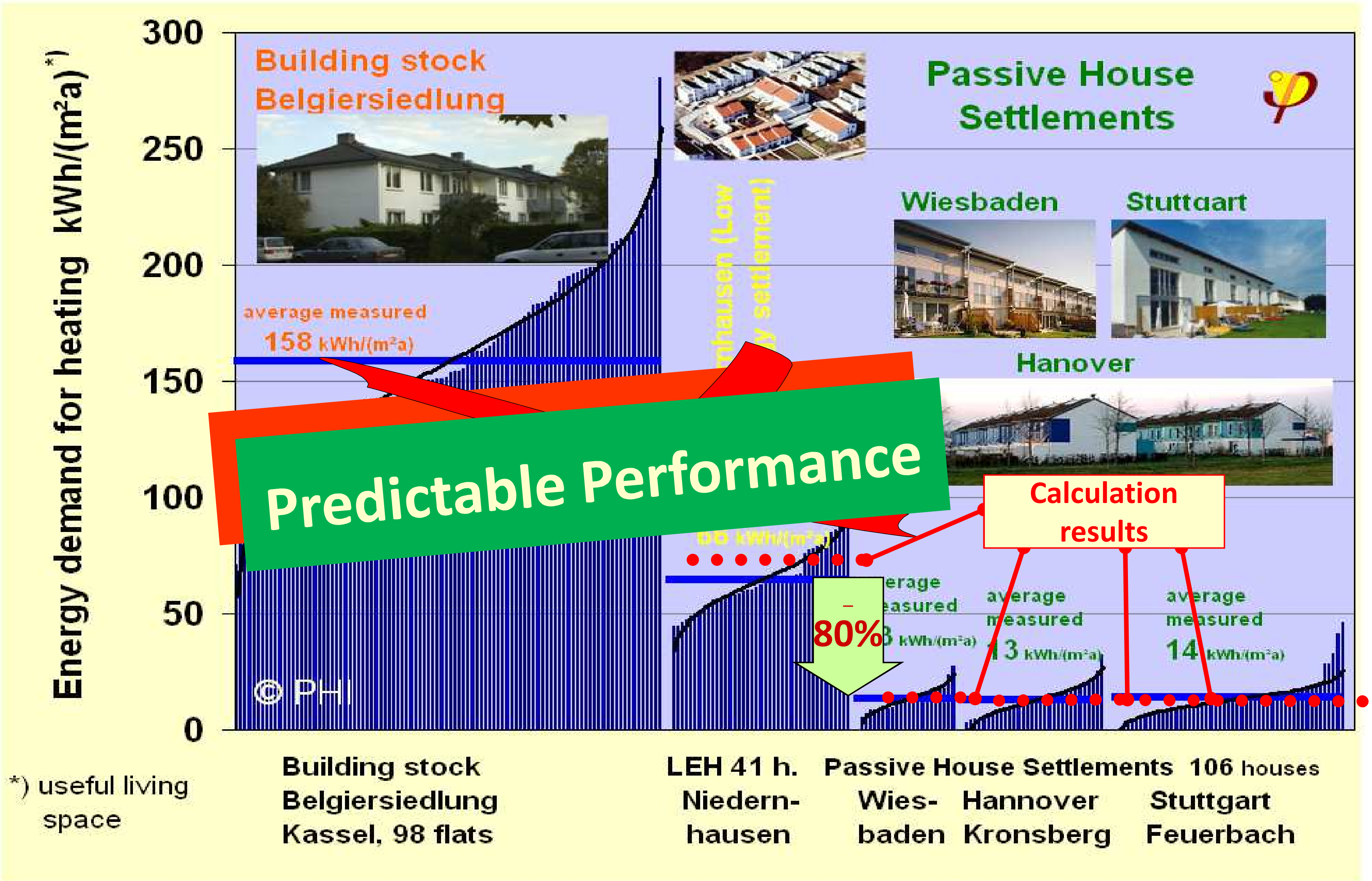
The economical effect of bringing forward the renewal of windows (2013) with Passive House windows: Additional capital cost

Boundary conditions: Energy costs savings



AKKP 42

Reliable performance: Quality is key



Well Defined Standard and Quality Assurance

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

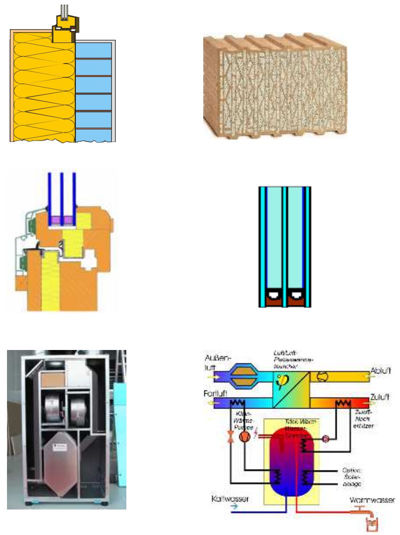
PHPP Design Tools

Certified Passive House
Passive House Institute Darmstadt

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

ZERTIFIZIERTE KOMPONENTE
Passivhaus Institut

Comp. and systems: reliable performance data



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

DESIGNER
CERTIFIED PASSIVE HOUSE DESIGNER

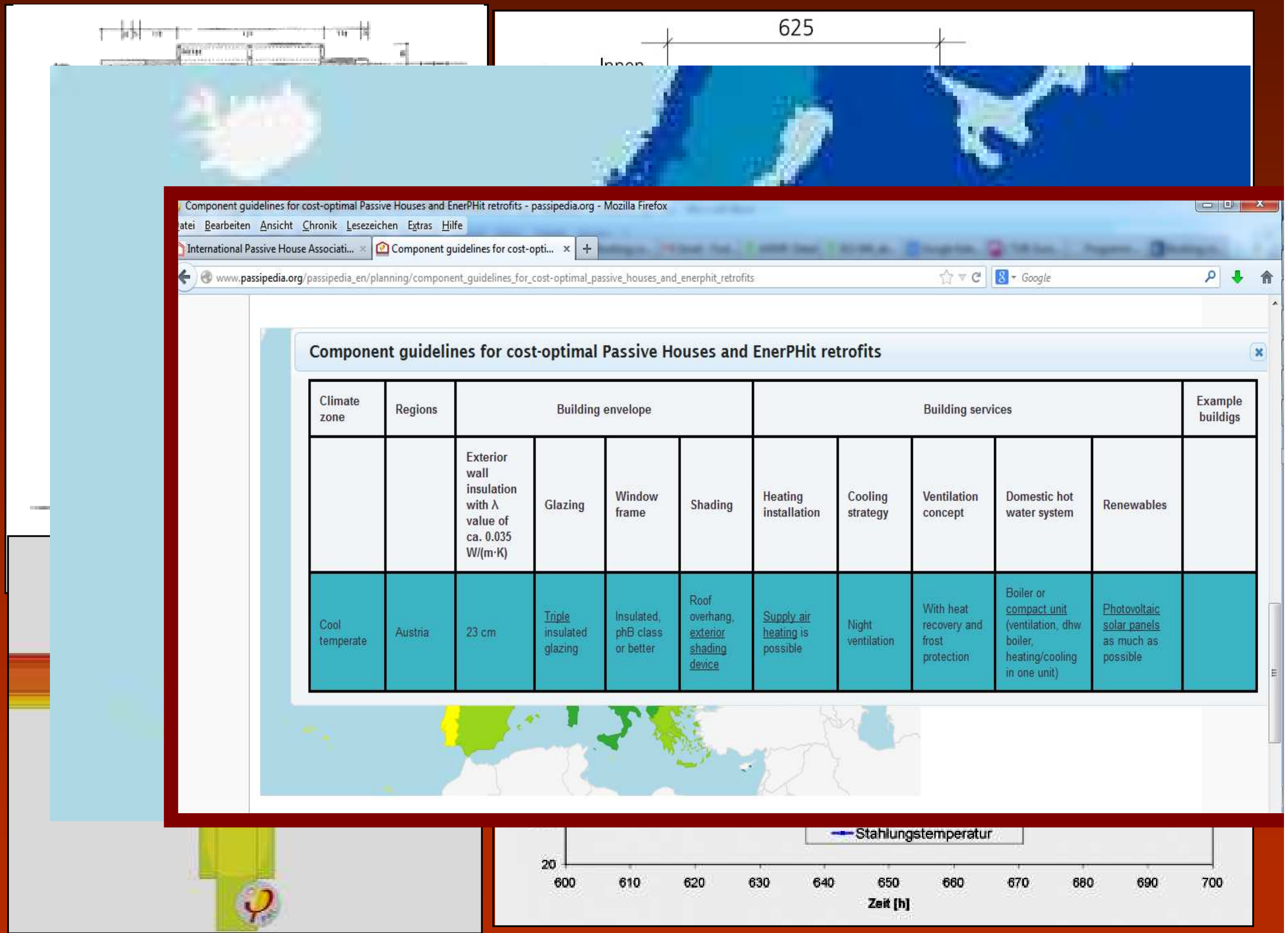
CERTIFIED PASSIVE HOUSE TRADESMAN
TRADESMAN

passipedia

Cost optimal construction | *clickable map*

Part 1: General information to the public

Part 2: Information and tools for members



Component guidelines for cost-optimal Passive Houses and EnerPHit retrofits

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	

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

cool, temperate climate
CERTIFIED COMPONENT
Passive House Institute

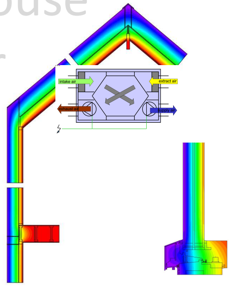
Predictable Design needs reliable Products

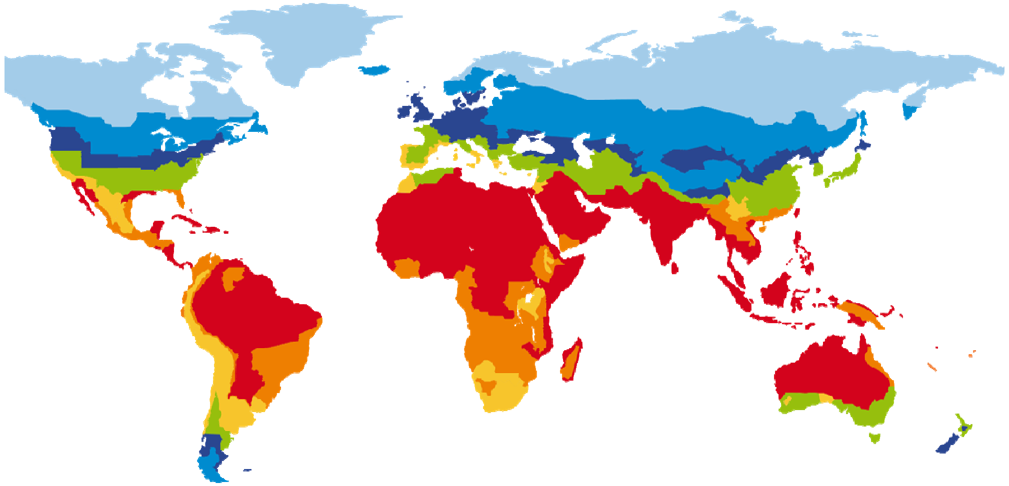
EuroPHit

Product Certification

- Values for design
- integrated in PHPP → directly availabe for energy balance - worldwide
- + component database

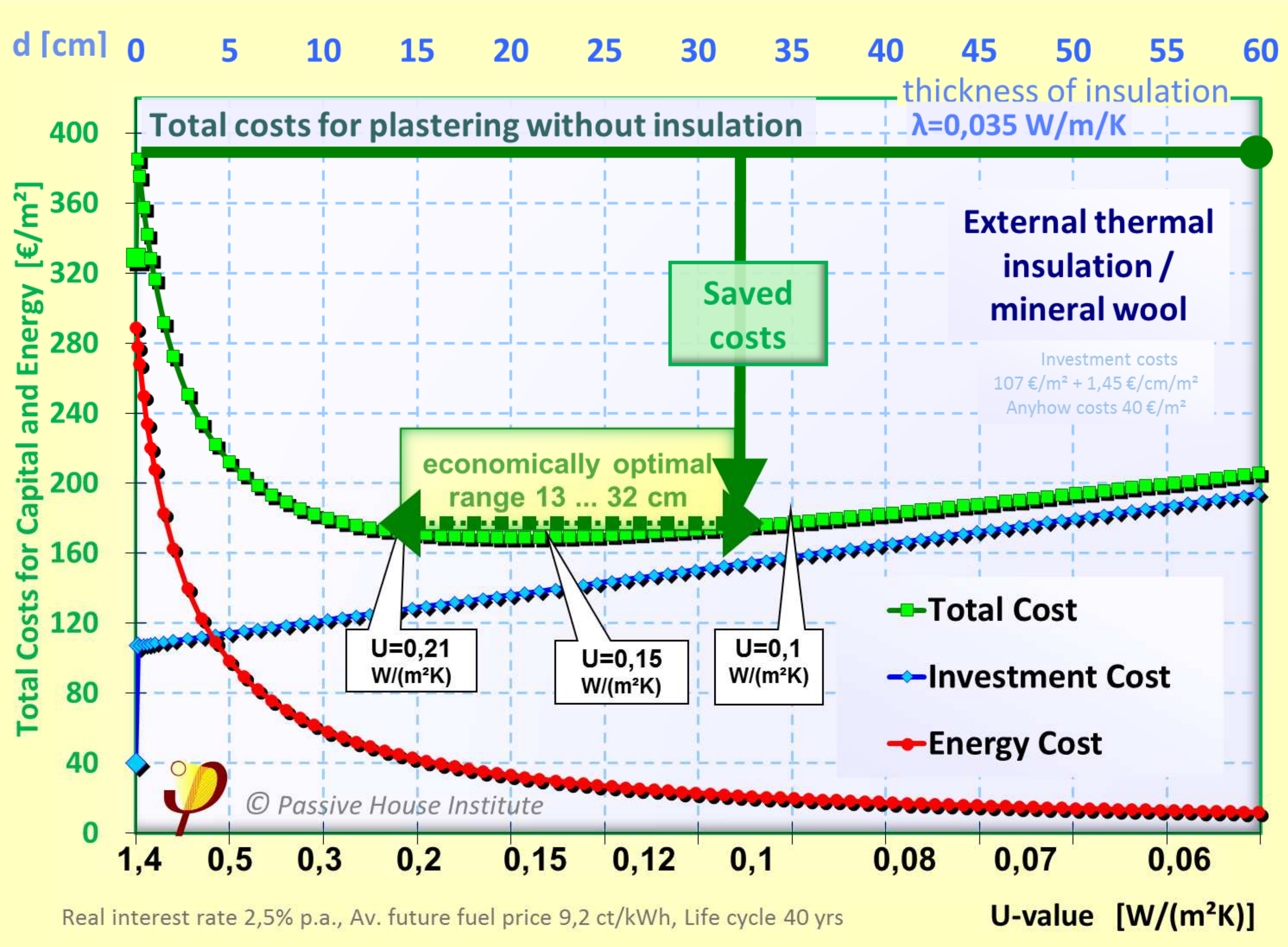
Passive House quality for indiviual buildings PHPP



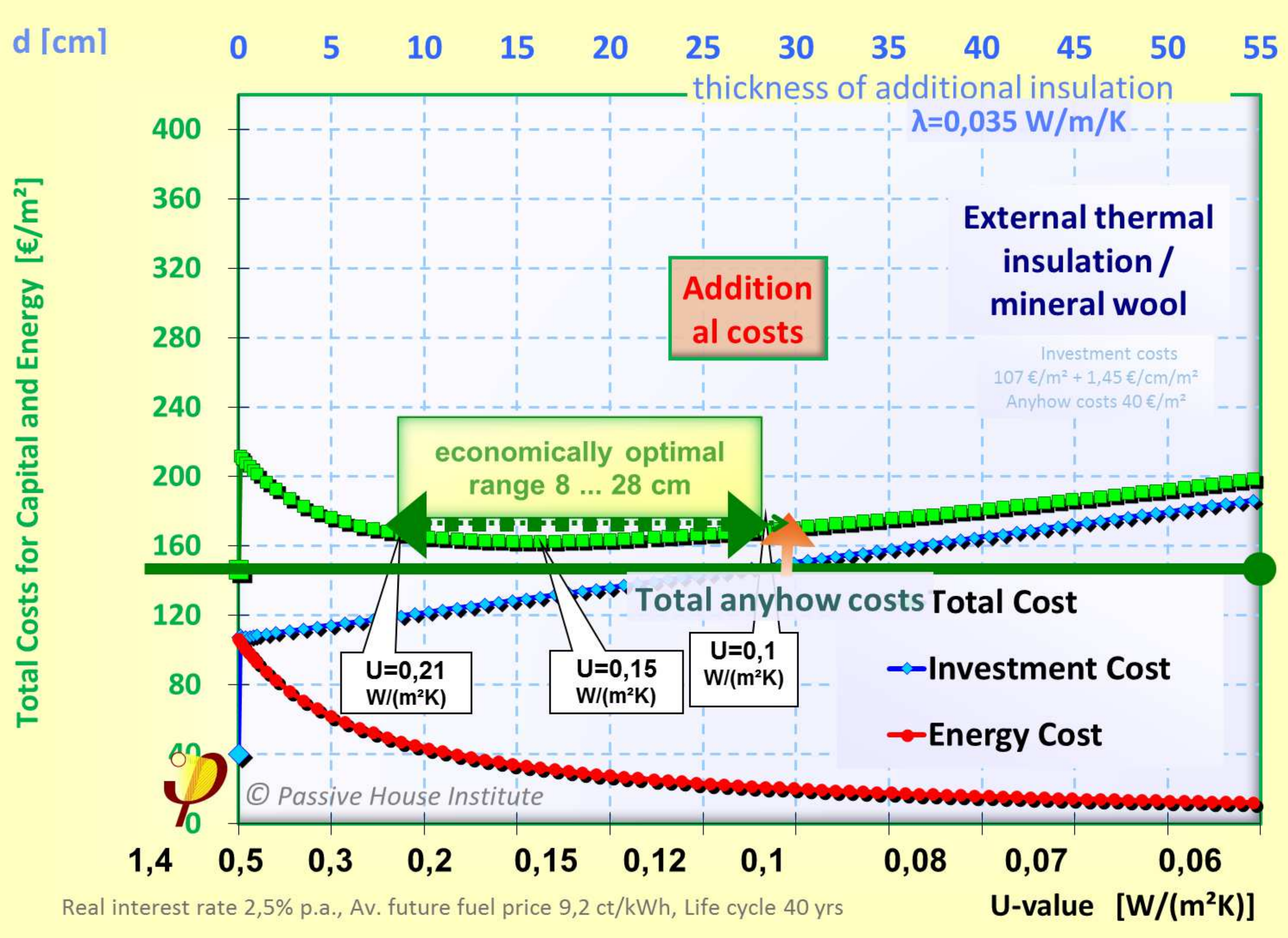


Make it Simple , Efficient , Cost effective

Life cycle costs: optimization



Life cycle costs: optimization



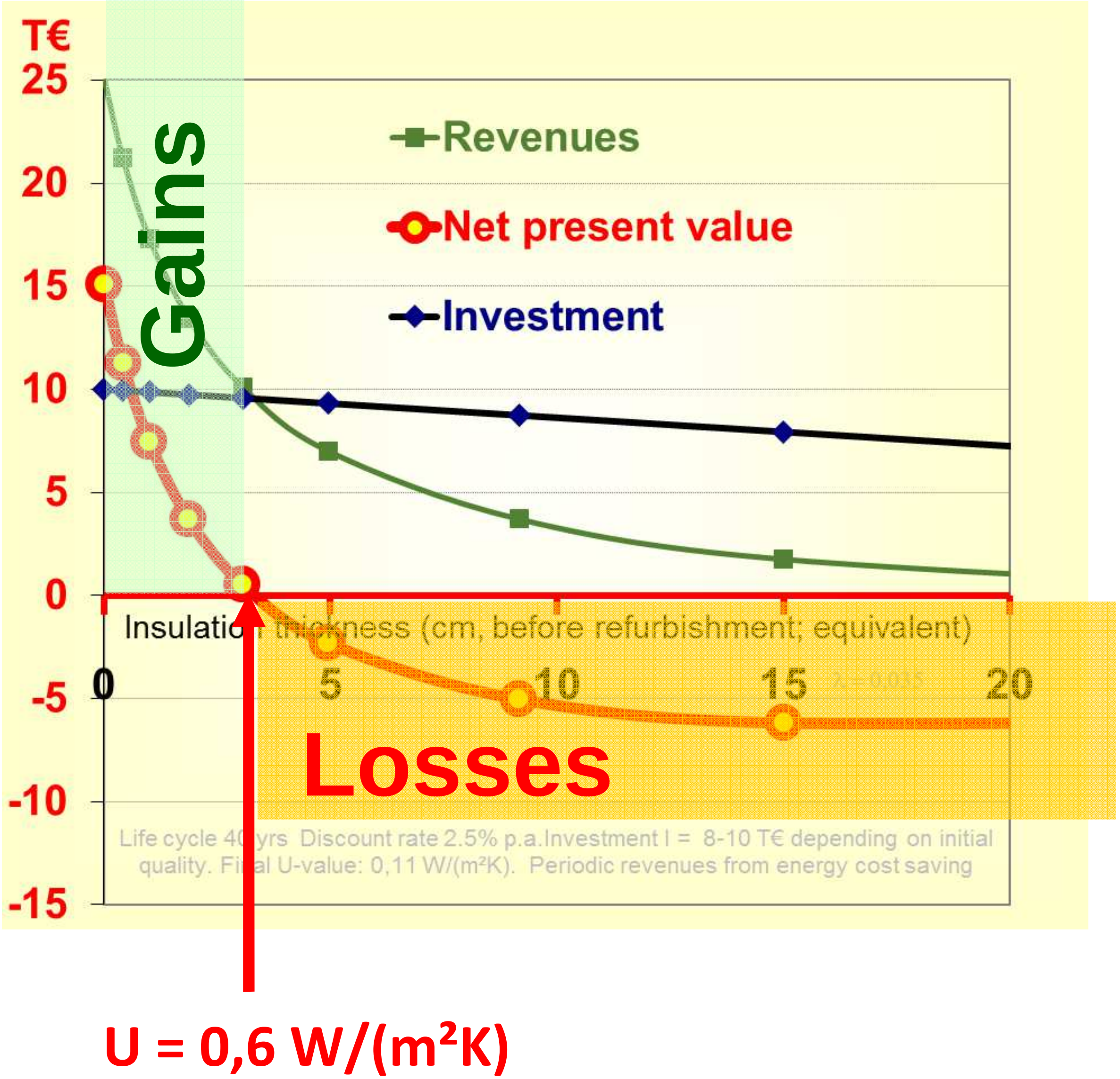
Parameter: Influence of starting point

EuroPHit

Passivhaus Institut

- The existing 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

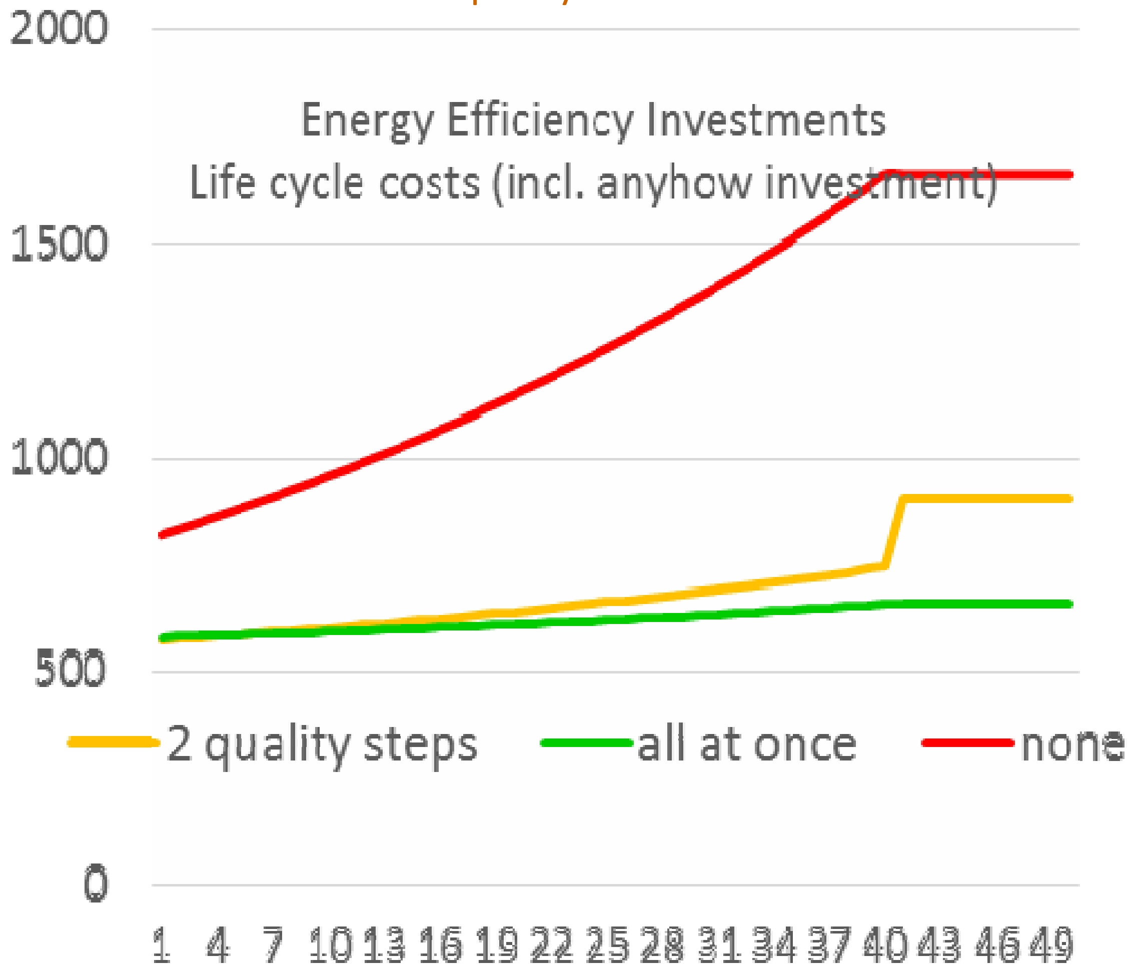
„When you do it, do it right“

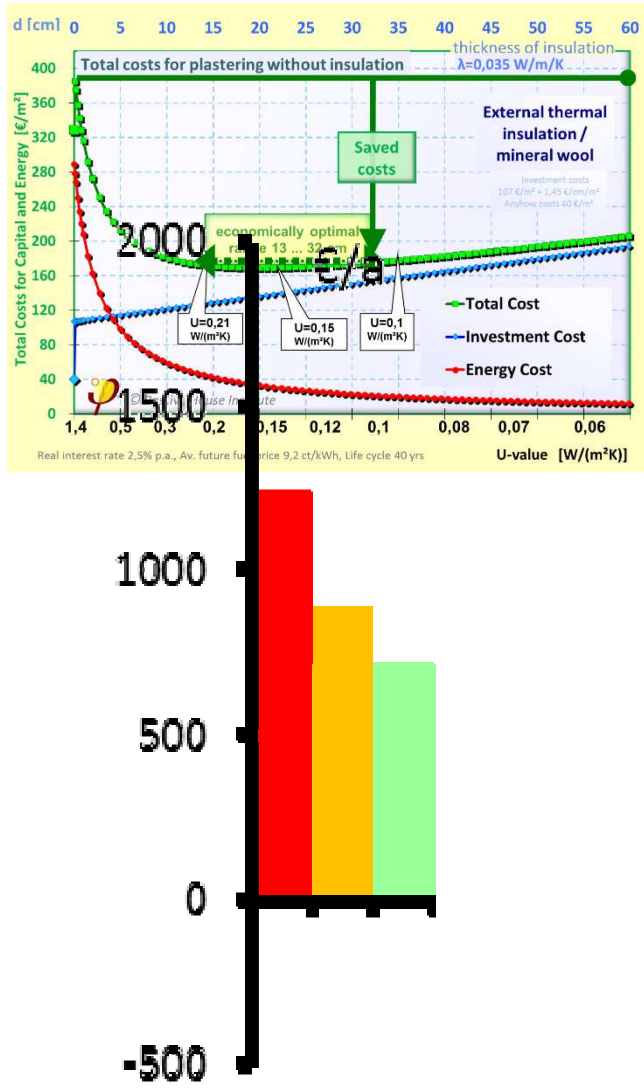


Lock-in effects through moderate quality

3 variants:

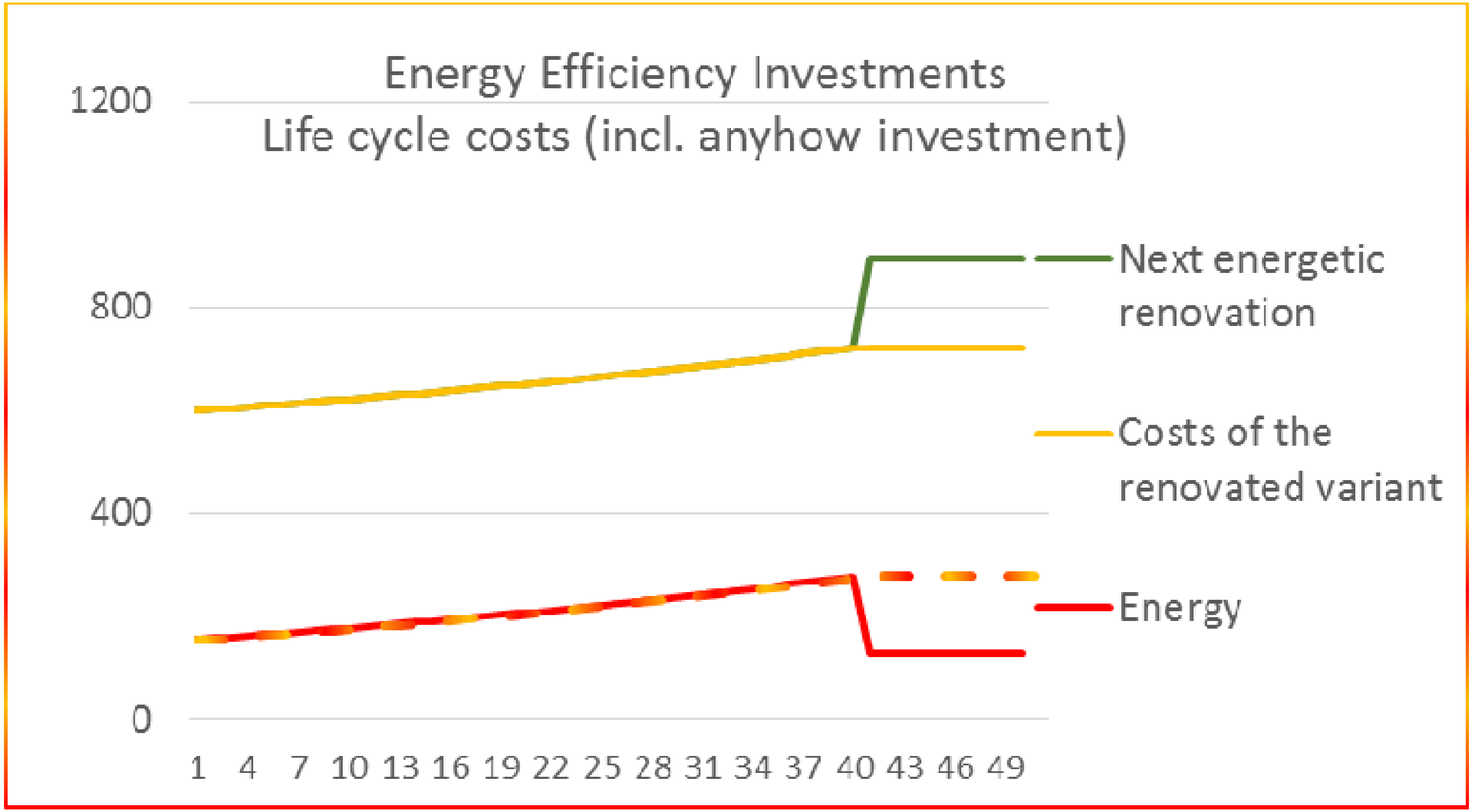
- without energy effeiciency
- deep renovation
- medium quality





Lock In Effects

Variant „Medium quality“: Next cycle causes higher costs

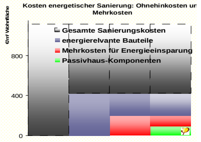


Economy of Energy Efficiency: Summary

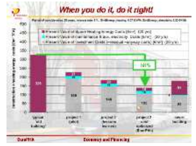
EuroPHit

Passivhaus Institut

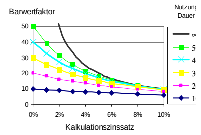
- Capital Cost
  - Attributed Costs – not full costs. Most profitable when anyhow measure is Residual values
  - High quality design: Avoid additional costs

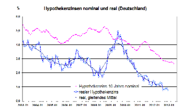


- Life cycle
  - Only life cycle costs
  - When calculation period is different, residual values must be regarded

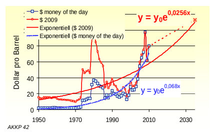


- Discount rate/required rate of return
  - High required rates of return → high capital costs (annuities)
  - → depreciate revenues
  - Alternative investments are riskless investments – low interest rates on capital market

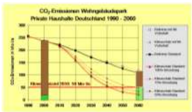




- Energy costs
  - Energy price uncertain – don‘t calulate with exponentially growing prices
  - Reliable energy performance (→ energy savings)
  - Avoid performance gaps by quality assured design and construction



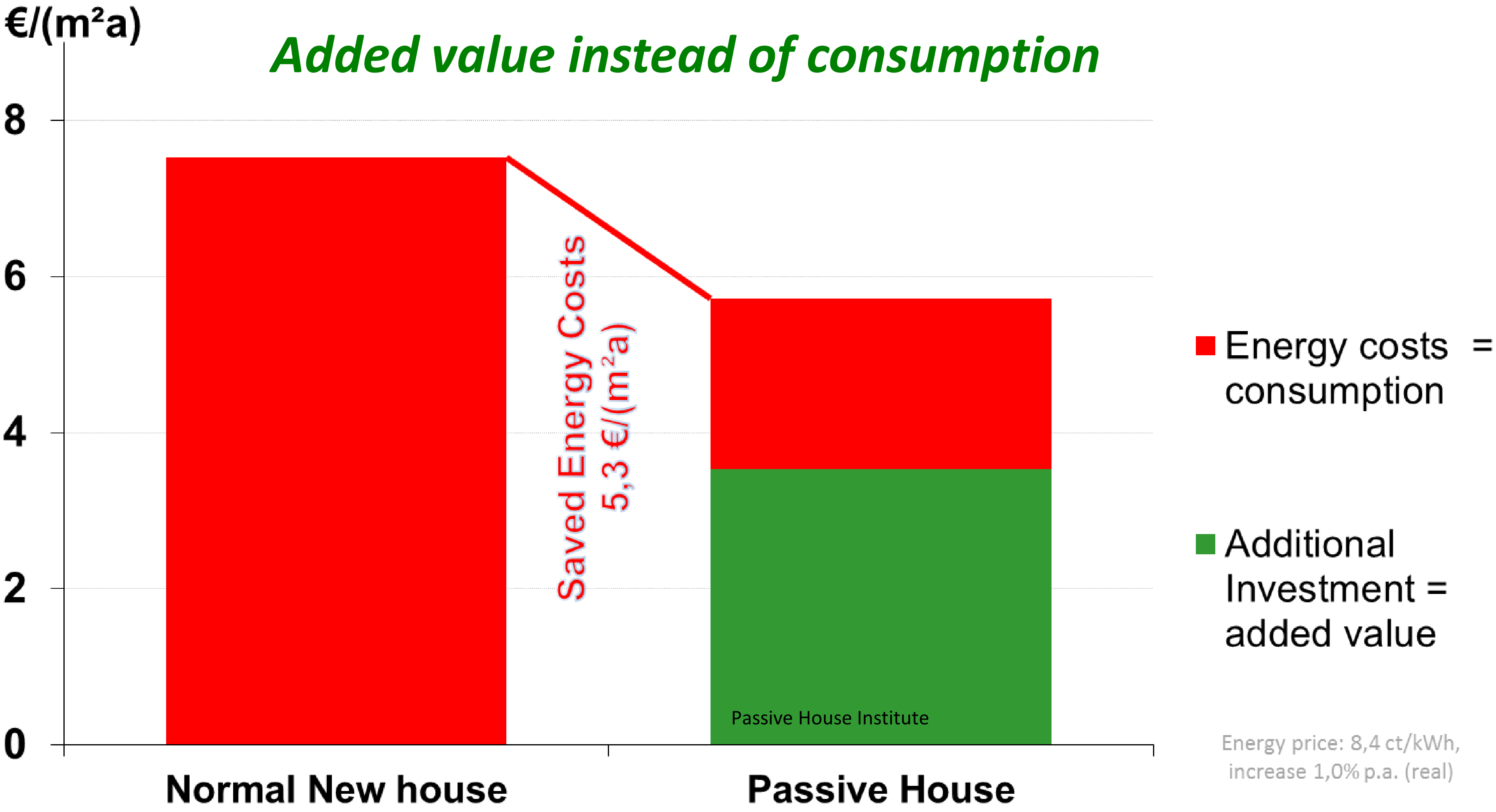
- Planning for the future
  - Regard long life cycles
  - Sustainable standard ist the goal
  - Avoid „Lost opportunities“, suboptimal standards, lock-in effects:
  - When you do it, do it right!



FINANCING and FUNDING

Economy: Life cycle costs

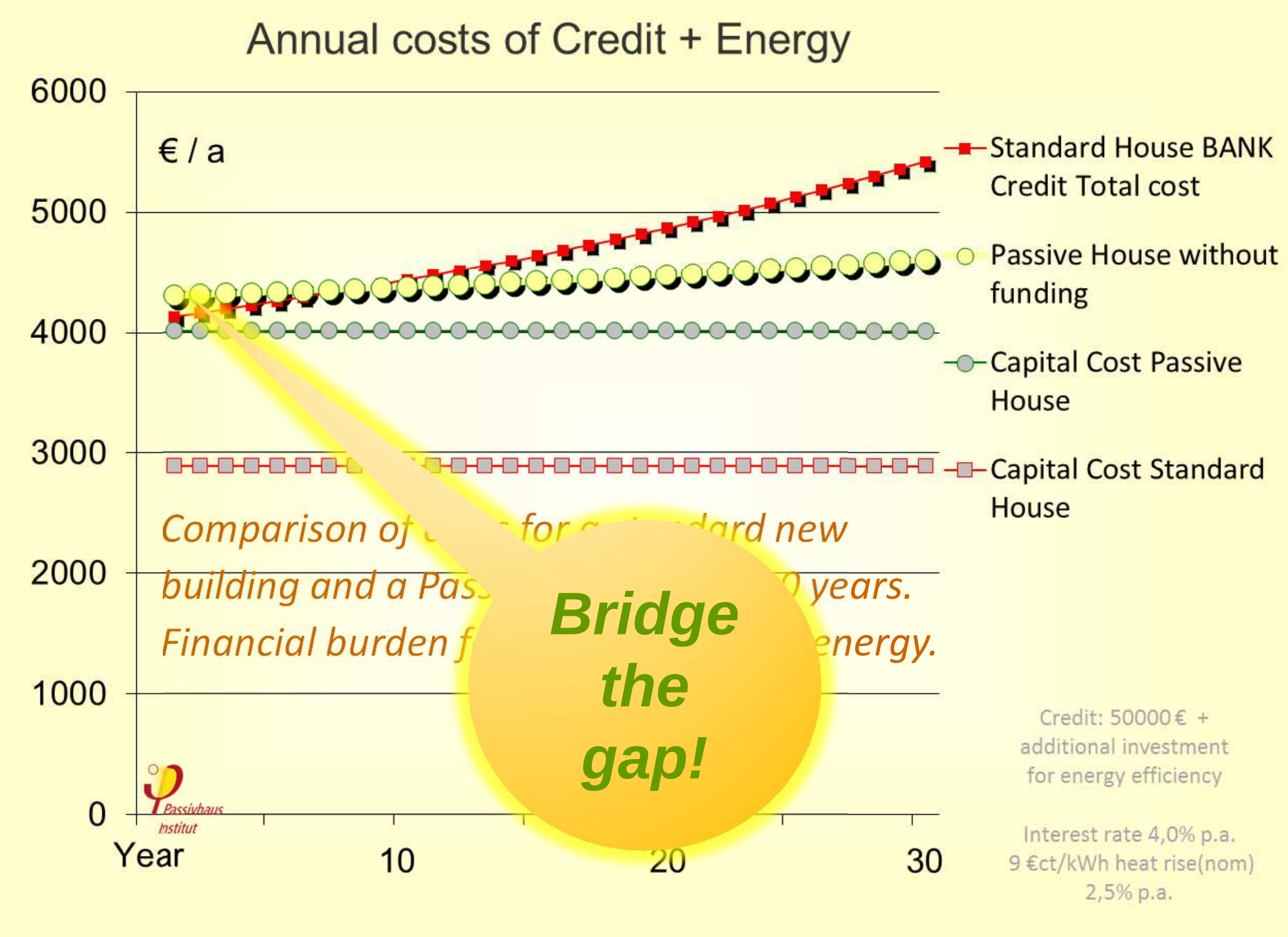
EuroPHit



Energy price: 8,4 ct/kWh, increase 1,0% p.a. (real)

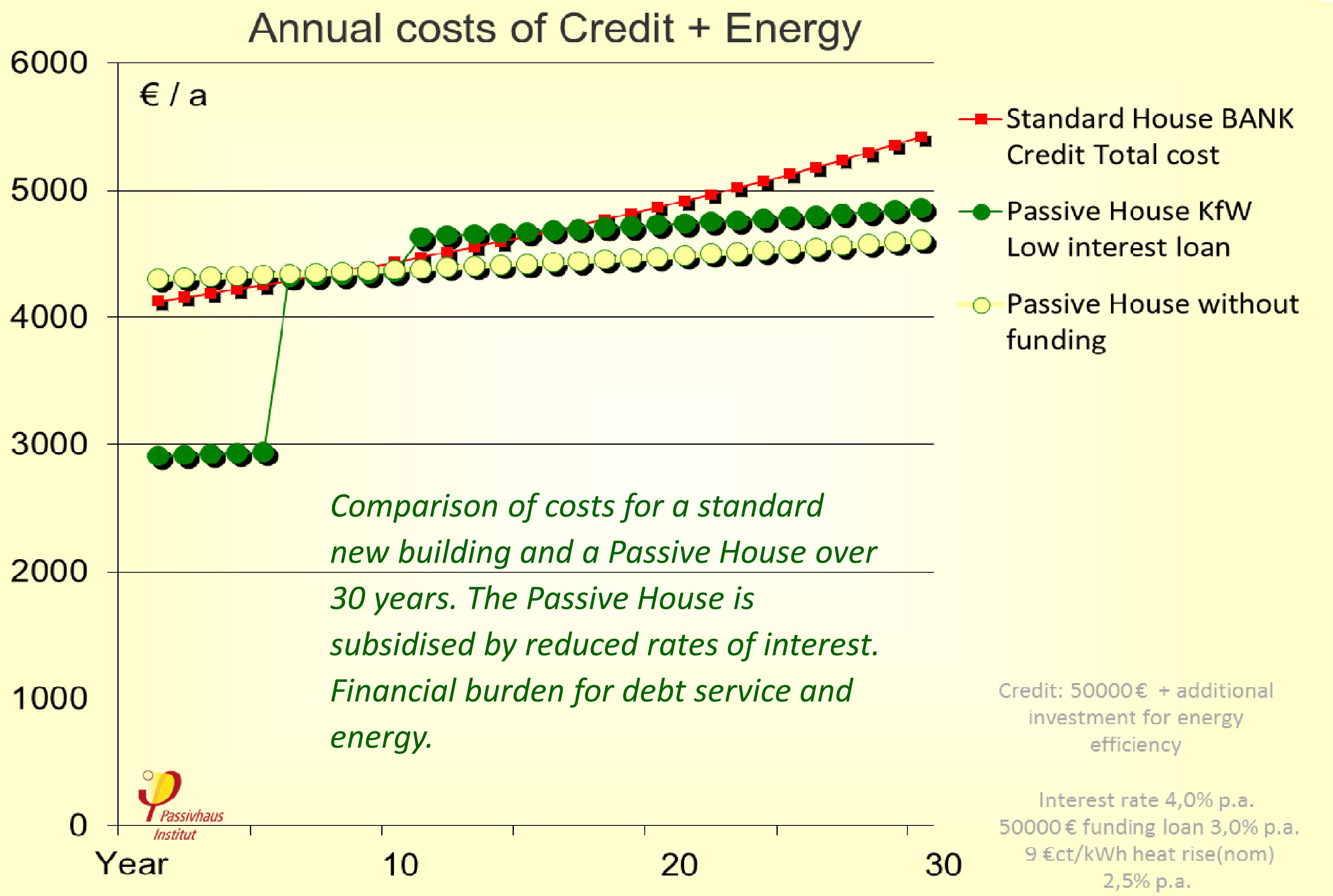
Costs over 40 years, Interest rate (real) 2,46% p.a.

Financing | *Total annual costs compared*



Financing through low-interest loans

EuroPHit



Assumptions: subsidies by KfW-loan (50 000 Euro); interest rate (mortgage) 4% p.a. = calculatory interest rate (expected rate of return); interest rates funding bank (analog KfW) (nominal) 2,50% p.a., for 10 years fixed; Fuel price: 8.4 ct/kWh, electricity:25 ct/kWh, rise in energy prices 1% p.a. (real).

Investment costs: Learning curve

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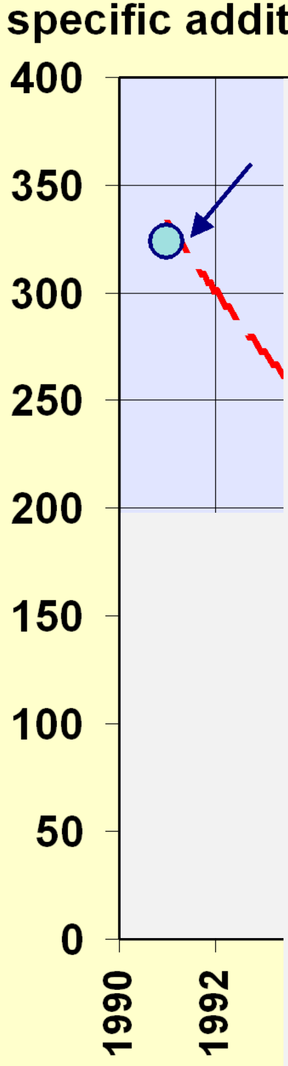
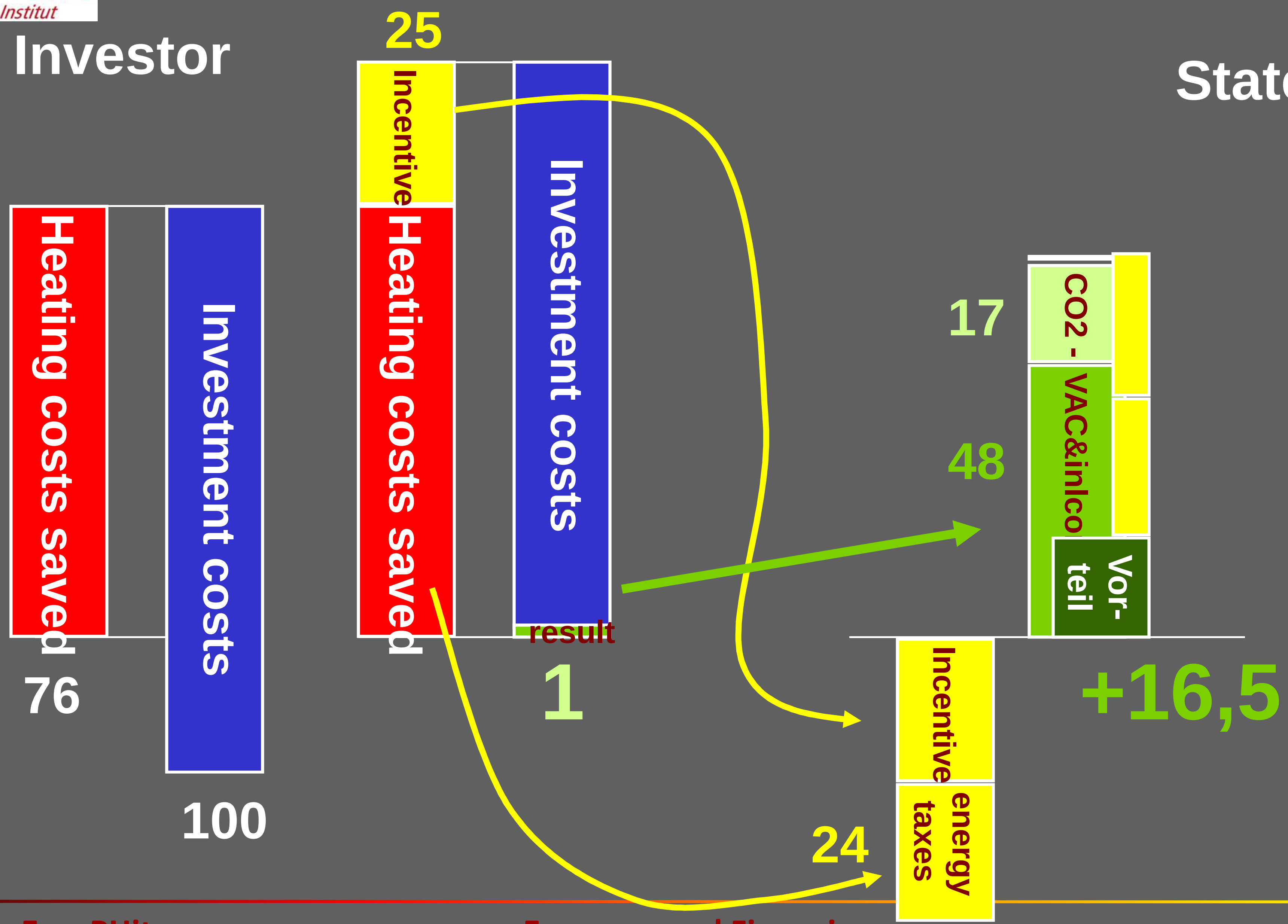


Why incentives?

- new solutions are more expensive in the beginning
- industry has to change production lines
- planners need training and experience

- Energy costs do not reflect full costs, additional external costs can be avoided
- incentives for economy for the production of useful goods reduce social costs

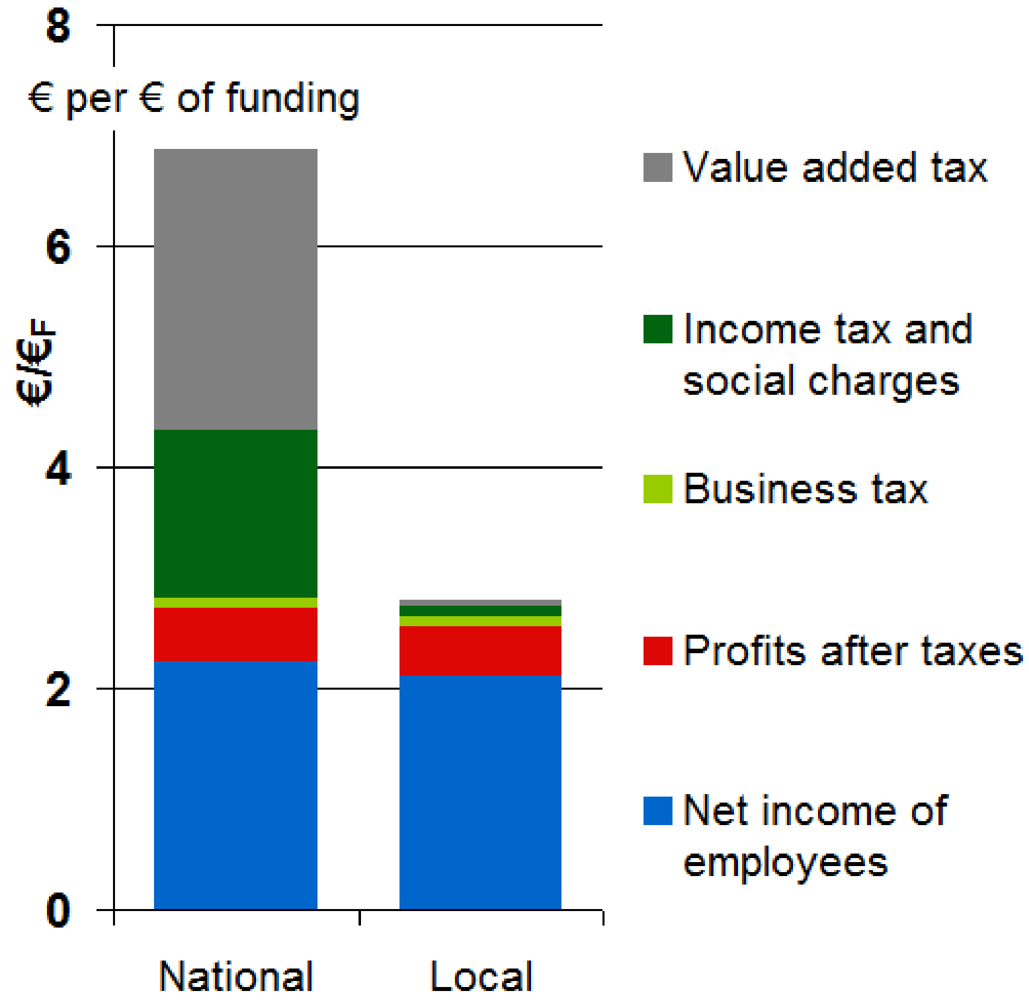
Added Value: Macroeconomic perspective.



Local result of funding EE in buildings

Every Euro of incentive

- generates a total investment of 16 €,
- while the additional investment for additional efficiency is only 2 € (but double the value of the incentive)
- creates added value of 7 €
- generates a local labour equivalent to 3 €.



Funding energy effciency | *Financial effects*

Financial aids should focus on:

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