

**Profitability of
energy-saving investments
in German private rental housing**

Author: Prof. Dr.rer.pol. Stefan Kofner, MCIH

TRAWOS: Institut for Transformation,
Housing and Social Spatial Development

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Abstract:

Residential buildings are responsible for a very large part of green house gas emissions in Germany. Because of the low homeownership rate the energy efficiency of the private rental housing stock is of utmost importance for the reduction of the carbon footprint. German landlords however often complain that energy-saving investment in rental housing is not profitable enough. This assertion is going to be challenged in the paper. A short overview will be given on rental laws relevant for modernisation, on the energetic state of the residential housing stock and also on the subsidies for energetic modernisation. Hereafter a set of typical energy-saving measures and bundles of such measures will be defined and initial investment costs will be attributed to each of them. The measures and attributed costs will serve as an input to various investment calculations. These calculations will take all financial effects of energetic modernisation investment into account. Investment of this kind will

- raise the value of the property in case of a future sale,
- allow for rent increases with tenants sharing in the costs, but dependent on the market situation,
- allow for a higher rent income in the future (with new tenants),
- reduce vacancy risk,
- reduce heating costs depending on future energy prices and thus allow for a higher basic rent and
- provide access to subsidies and subsidised credit.

The data input of the investment calculations will be based on assumptions for the most part. Risk and incertitude (e.g. impairment losses, future rents, interest rates and energy prices) will be taken into account however by using scenario technique and critical values. The expected result are critical values for the most important variables ensuring a minimum or satisfying rate of return on typical energy saving investment bundles. The calculations are important for the future design of the relevant subsidies. The fundamental question is if the current incentive system is adequate with respect to the governmental targets.

Keywords: Cash Flow, CO₂, CO₂-mortgage energetic modernisation, energy-efficiency, Energy Saving Act, energy-saving measures, green house gas, heating costs, Internal Rate of Return, KfW bank, local reference rent, share in the costs, thermal insulation

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1 Introduction

Within the context of EU burden-sharing the German government has set itself the ambitious target to reduce the emissions of the six greenhouse gases cited in the Kyoto Protocol by 21 per cent between 2008 and 2012.¹ Measures on the federal level are described in the National Climate Protection Programme and contain among others (Müller 2005):

- Renewable Energy Sources Act (promotes the conversion of renewable energy sources into electricity by a system of obligatory minimum prices),
- Market launch programme for renewable energy sources (benefits for the use of solar panels, biomass and rational energy use),
- Ecological tax reform 1999-2003 (gradual increase of taxes on fuels and electricity),
- Energy Saving Act for new and existing buildings (2002),
- Financial support for the energetic modernisation of buildings (since 2000),
- Expansion of combined heat and power generation (2002),
- Research and Development.

According to a McKinsey study from 2007 the biggest lever for the reduction of green house gases is increased energy-efficiency of buildings (McKinsey 2007. p. 37). The German housing stock adds up to 17,3 Mio. residential buildings with 39 Mio. dwellings. 75 per cent of these were completed before 1979. All 18,8 Mio. buildings taken together account for 40 per cent of end energy consumption.

Since 1997 however end energy consumption for heating in private households is continuously falling. Despite the growing living space total heating energy consumption has already reached the state of 1990. This is a consequence of the energy-saving modernisation of residential buildings. The energy-efficiency of the building stock has improved by 15 per cent since 1990. Residential CO₂ emissions of private households were reduced by 13 per cent (equal to 16 Mio. tons) between 1990 and 2005 (AG Energiebilanzen 2006, p. 111 and Fraunhofer-Institut / co2online 2007).

The yearly quota of fully energetically modernised buildings was 2,2 per cent in 2006 (equal to 230.000 buildings per year). The energy-saving potential in buildings completed before 1979 is still enormous however. It is estimated that less than 30 per

¹ The reduction refers to the emission values of CO₂, CH₄ and N₂O in the year 1990, and to the emission values of H-CFC, CFC and SF₆ in 1995.

cent of all possible energy-saving measures were implemented between 1989 and 2006 in this segment of the building stock (Fraunhofer-Institut / co2online 2007).

Not every technically feasible energy-saving measure is economically efficient whatsoever. The principle of economic efficiency applies for all kind of investment (Schönefeldt et al. 2008, p. 16). Even money invested to save CO₂ emissions could be wasted. Like all economic activities in a world of scarcity such investment should not be expanded beyond the point where marginal cost equals marginal utility including social marginal utility. Public subsidies should reflect social marginal utility of energy-saving investment – not more than this. In general it makes more economic sense to modernise an 11 litre house into a 7 litre house than to transform a 3 litre house into a 2 litre house. The global climate will not improve by heavy subsidies for a few “lighthouse-projects”, but rather by a measurable progress relating to the average carbon footprint of residential buildings.

Because of the low homeownership rate of only 44 per cent² and the big share of private landlords in the rental housing stock (76 per cent³) the energy efficiency of the private rental housing stock is of utmost importance for the reduction of the carbon footprint in Germany. German landlords however often complain that energy-saving investment in rental housing is not profitable enough.

This assertion is going to be challenged here. An overview will be given on rental laws relevant for modernisation (rent control system in general and rules for rent increase after modernisation) and on the subsidies relevant for energetic modernisation:

- tax incentives,
- BAFA-subsidies for investment in renewable energies and
- KfW subsidised credit programmes.

Hereafter a set of typical energy-saving bundles of measures will be defined (11-, 8,5- and 6-litre house modernisation) and initial investment costs will be attributed to each of them. The attributed costs will serve as an input to investment calculations for the three variants taking into account all financial effects of the energetic modernisation including subsidised credit.

² 49 per cent in West Germany, 55 per cent in France, around two thirds of all households in Britain and the U.S.

³ Including private persons, private housing companies, banks, property funds and insurances, but excluding public landlords, cooperatives and churches

Investment of this kind will

- raise the value of the property in case of a future sale (higher exit cap rates),
- allow for rent increases with tenants sharing in the costs, but dependent on the market situation (maximum of 11 per cent of total modernisation costs per year),
- allow for a higher rent income in the future with new tenants⁴ (higher markups on local reference rent),
- reduce vacancy risk, and
- provide access to subsidies and subsidised credit.

From the results of the calculations we will try to draw conclusions for the future design of the relevant subsidies. The question is if the current incentive system is adequate with respect to the governmental targets.

2 Relevant regulation

2.1 The German rent control system

According to article 573 of the German civil code („Bürgerliches Gesetzbuch, abbr. BGB) landlords have no general right to cancel an open-ended rental contract arbitrarily. On the other hand they have a legal right to raise the contractual rent up to the level which is regarded as “normal” in the community.

This local reference rent („ortsübliche Vergleichsmiete“ in German) is basically an empirical concept. The landlord should not demand a rent higher than the average his competitors operating in the same segment of the housing market take. The choice of factors contributing to rent price formation („Wohnwertmerkmale“ in German) is restricted however to type of dwelling, size, equipment, state and location. Furthermore only rents raised or agreed upon in the last four years are included in the local reference rent.

The artificial local reference rent will follow the local housing market, but delayed in time. Landlords will not profit from windfall gains in the short run. In bigger cities easily accessible rental tables (“Mietspiegel” in German) mapping the local rent price

⁴ Energetic modernisation reduces heating costs depending on future energy prices and thus allows for a higher basic rent.

structure will usually be available. There will be differences in their up-to-dateness and empirical validity however.

Regardless of the local rent level a landlord may not raise the rent for more than 20 per cent in three years (article 558 BGB). This additional rent cap will be a problem for the landlord whenever the contractual rent is lacking behind the market rent on a large scale, e.g. when social dwellings loose their special status after the landlord has paid back the public loans taken out.

Also the landlord will face legal sanction if the contractual rent exceeds the local reference rent for more than 20 per cent (see article 5 of German Wirtschaftsstrafgesetz). But this rent cap only applies in case of a housing shortage in the relevant segment of the local housing market. In a normal market situation or in case of a housing surplus the individual rent may be up to 50 per cent above the reference rent.⁵

For the pragmatic purposes of an investment calculation we can summarise our results as follows: When letting a dwelling landlords can demand a rent up to 50 per cent above the local reference rent – 20 per cent in case of a housing shortage. In an ongoing rental contract the local reference rent acts as a strict upper limit on the individual rent level. There is thus no possibility to raise the initial rent until the local reference rent has surpassed the contractual rent. Furthermore the individual rent might be restricted by the rent cap of 20 per cent in three years.

2.2 Rent increase after modernisation

The differentiation between maintenance / repair and modernisation has substantial financial consequences for the landlord. Only modernisation costs (including costs for energetic modernisation) qualify for a subsequent rent increase.⁶

The calculation and the procedure of the rent increase is regulated in detail in article 559-559b BGB. Costs have to be assigned to the individual dwelling wherever possible. The remaining costs have to be distributed according to the individual dwelling's share in total living space of the building. If building parts are exchanged estimated repair costs have to be deducted from modernisation costs, e.g. in cases of improved thermal insulation by replacing windows or doors.

⁵ If the landlord demands or takes more it could be an usury according to article 302a of the German penal code.

⁶ Tenants do not have to tolerate any kind of modernisation measures. Landlords have to announce the modernisation in due form and time. In case of individual hardship the tenant may not have to tolerate the measures, e.g. substantial changes of the room layout, unacceptable rent increase as a consequence of the modernisation. If there is no obligatory tolerance the rent cannot be raised subsequently (see article 554 BGB).

The calculated modernisation costs per dwelling have to be multiplied by 11 per cent and divided by 12 months in order to get the monthly share in the costs of a tenant. The tenant will have to pay his share in the costs on top of his rent before modernisation. Alternatively the landlord could raise the rent referring to the local reference rent for the modernised dwelling. In most cases it will be more remunerative for him to opt for the share in the cost model however. This model will usually bring along a large initial difference between the rent taken (basic rent plus share in the costs) and the relevant local reference rent. The landlord will thus have to wait until the local reference rent has “caught up” before he can raise the rent again (IWU 2001, p. 17).

Tenants have to pay their share in the modernisation cost only until the landlord raises the rent referring to the local reference rent next time. Also in case of termination of the tenancy, no share in the cost can be demanded from the subsequent tenant. General rental law is applicable then, i.e. local reference rent plus x per cent depending on the market situation.

3 Relevant subsidies

3.1 Tax incentives

The tax system provides only limited incentives to invest in the existing housing stock. The depreciation rate applicable to residential buildings is only 2 per cent per year, resp. 2,5 per cent for buildings finished before 1. January 1925. Buildings under monumental protection and buildings located in statutory redevelopment or preservation areas benefit from a higher depreciation scheme as stipulated in § 7h resp. 7i of the German income tax law, i.e. 9 per cent in the first eight years after purchase. For the purposes of energetic modernisation federal and state subsidies are more important however.

3.2 BAFA-subsidies for investment in renewable energies

A federal agency, the „Bundesamt für Wirtschaft und Ausfuhrkontrolle“ (BAFA) subsidises investment in renewable energies. In the year 2008 their market incentive programme is stocked with €350 Mio. The money is distributed on a first come, first served basis. The following measures can be subsidised:

- solar collectors
- biomass furnaces
- thermal heat pumps

Solar collectors for water heating only will benefit from a subsidy of 60 Euro per square meter of gross collector space, not less than 410 Euro in total however. For installations also providing heating assistance BAFA will pay out 105 Euro per square meter.

Biomass furnaces will be subsidised with 36 Euro per kilowatt of rated useful heat (“Nennwärmeleistung”). Different minimum amounts are applicable here depending on the type of furnace.

Thermal heat pumps are sponsored with 20 Euro per square meter living space. The subsidy is subject to upper limits however: 3.000 Euro per dwelling and 15 per cent of net investment costs.

On top of that bonuses will be awarded in special cases, e.g. for extra-efficient installations and certain combined investments.

3.3 KfW subsidised credit programmes

The cornerstone of the system of subsidies for the energetic modernisation of residential buildings are the different programmes offered by the German public bank KfW. The KfW bank grants cheap credits for different kinds of purposes the federal government regards worthy of support.

3.3.1 KfW residential property modernisation programme

The KfW residential *property modernisation programme* (“KfW-Wohnraummodernisierungsprogramm“) is accessible for homeowners and landlords. Different types of modernisation and repair measures can be financed within the scope of this programme, e.g. changes in the room layout, sanitary installations, additions of balconies, retrofitting of buildings with a lift, floor repair, barrier-free building modification and the replacement of heating systems.

Apart from these „standard measures“, so-called “*eco-plus measures*” are included, e.g. thermal insulation of the building envelope, or heating systems based on renewable energies. A grace period will be granted depending on the term-time of the mortgage.

Borrowers can choose between an *initial fixed rate period* of 5 or 10 years. Only in this initial period the interest rate will be below the market level. The degree of subsidisation depends on the type of measures. Interest rate will be much lower for eco-plus measures. After the initial fixed rate period rates will be adjusted to the market interest level prevailing then anyway. For standard credits – used to finance standard modernisation measures – a *disagio* of 4 per cent will be deducted from the nominal credit sum.

The KfW residential property modernisation programme funds can be combined with other subsidies as far as the total sum of credits and subsidies does not exceed total costs.

3.3.2 KfW CO₂ programme

As compared with the property modernisation programme KfW's *CO₂ programme* is subsidised more intensely and thus offers much cheaper rates to the investor. On the other hand it is much harder to fulfil the programme qualifications. In principle no single measures, but only certain bundles of measures with a remarkable effect on the carbon footprint could qualify for this programme.⁷ In 2006 the credit volume more than tripled to €3,4 Mrd. With these financial means more than 155.000 dwelling were energetically modernised (see following table).

attribute	2005	2006
Number of loan commitments	24.429	43.451
Number of dwellings modernised	70.088	155.404
Living space modernised m ²	6,4 Mio.	13,0 Mio.
Volume of loans placed Mrd. €	1,1	3,4
Average credit volume €	46.900	77.200
Number of dwellings modernised per loan	2,87	3,58
Average living space per loan placed m ²	263	298

Development of CO₂ mortgage placement,
source: Bremer Energie Institute et al. 2007, p. 69

⁷ It was estimated that the CO₂ programme has induced CO₂-reductions of 340.000 tons in the year 2005 and 700.000 tons in the year 2006 (Bremer Energie Institut et al. 2007, p. 72).

The CO₂ programme is accessible for homeowners and landlords as well. Homeowners do have the option to choose between the credit- and the cash assistance-variant of the programme, whereas landlords could only apply for the credit-variant. In the credit variant the interest rate is subsidised for an initial period of 10 years. Compared with the modernisation programme rates will be lower and no disagio will be retained.

If the modernisation brings about the energetic standard of a new building as specified in § 3 of the German Energy Saving Act (Energieeinsparverordnung EnEV) it would be qualified for “*Mortgage Principal Assistance*”, i.e. the KfW-bank will remit part of the debt (5 per cent of the initial debt after the 6th quarter). The remission will be even higher (12,5 per cent) if the yearly primary energy requirement falls below the new building standard for more than 30 per cent. In these cases the investor is free relating to the type of energy-saving measures to be taken, e.g. replacement of windows, replacement of the heating system or thermal insulation of certain building parts. He will however need a confirmation of the effectiveness of the measures in terms of primary energy saving issued by a certified energy counsellor. Also the building must have been completed before December 31st 1983.

Apart from the direct costs, counselling costs, planning costs and costs for follow-up investments (e.g. replacement of windowsills) could be financed with the CO₂-mortgage.

If the modernisation does not result in energy savings high enough to qualify for the principal assistance the landlord is confined to certain *bundles of measures* as defined in the programme leaflet and cannot profit from the mortgage principal assistance. On the other hand younger buildings (completed before December 31st 1994) are qualified for that kind of subsidy, too.

The following bundles of measures are admissible:

Bundle no. 0

- thermal insulation of outside walls, and
- thermal insulation of roof or topmost storey ceiling, and
- thermal insulation of cellar, and
- replacement of the windows.

Bundle no. 1

- replacement of the heating system, and
- thermal insulation of roof or topmost storey ceiling, and
- thermal insulation of outside walls.

Bundle no. 2

- replacement of the heating system, and
- thermal insulation of roof or topmost storey ceiling, and
- thermal insulation of cellar, and
- replacement of the windows.

Bundle no. 3

- replacement of the heating system, and
- replacement of the windows, and
- thermal insulation of outside walls.

Bundle no. 4

an individual mix recommended by a certified energy counsellor.

All single measures have to comprise all building parts falling into the respective category, e.g. all windows will have to be replaced or every outside wall will have to be insulated. Each measure demonstrably has to fulfil the standards defined in the Energy Saving Act and in the attachment of the relevant programme leaflet, e.g. admissible insulating material in terms of thickness and heat transfer coefficient. That way it is ensured that only measures with a minimum energy saving effect could profit from the financial subsidies of the programme.

It is possible to add further measures to the different bundles as far as total costs stay within the cost limit of €50.000 per dwelling. The KfW CO₂ programme funds can be combined with other subsidies as far as the total sum of credits and subsidies does not exceed total costs.

The *initial fixed rate period* is always 10 years. Only during this period the interest rate will be subsidised below market level. The investor can choose between two combinations of termtime and years of grace, i.e.

- termtime: 20 years / grace period: 1-3 years
- termtime: 30 years / grace period: 1-5 years

4 Investment analysis

4.1 Assumptions

Typical energy-saving measures refer to:

- thermal insulation of roof,
- thermal insulation of outside walls,
- thermal insulation of cellar / topmost storey ceiling,
- replacement of windows,
- replacement of the heating system or
- ventilation systems with heat recovery.

These elements will typically be combined to bundles. Following Schönefeldt et al. (2008, p. 18)⁸ we have chosen three bundles of measures with different total costs and different effects on energy needs. The “6 litre house” package will bring along the largest energy savings (about 55 per cent) but it is also the most expensive one in terms of necessary investment per square metre (290 Euro). The “11 litre house” on the other hand saves only about 25 per cent of energy costs but requires only investment on 140 Euro per square metre.

⁸ They have drawn on project experience and their so-called “Inst-Benchmark-Database”. Most of the objects included were built in the 50s and 60s.

measures	Combined heat and power district heating
	16 cm thermal insulation of topmost storey ceiling
	8 cm thermal insulation of cellar ceiling
	≥ 12 cm thermal insulation of outside walls
	Replacement of windows (U-value, $U_F \leq 1,3$ W/m ² K) in dwellings and staircases
Primary energy requirement	ca. 60 kWh/(m ² a)
Saving of energy	ca. 55 per cent
costs	290 € gross/m ² living space

Table: 6 litre house bundle of measures
source: Schönefeldt et al. 2008, p. 18

measures	<i>Combined heat and power district heating</i>
	16 cm thermal insulation of topmost storey ceiling
	8 cm thermal insulation of cellar ceiling
	Replacement of windows (U-value, $U_F \leq 1,3$ W/m ² K) in dwellings and staircases
Primary energy requirement	ca. 85 kWh/(m ² a)
Saving of energy	up to 40 per cent
costs	185 € gross/m ² living space

Table: 8,5 litre house bundle of measures
source: Schönefeldt et al. 2008, p. 18

measures	Gas central heating with condensing heating technology
	16 cm thermal insulation of topmost storey ceiling
	8 cm thermal insulation of cellar ceiling
	Replacement of windows (U-value, $U_F \leq 1,3 \text{ W/m}^2\text{K}$) in dwellings and stair-cases
Primary energy requirement	ca. 110 kWh/(m ² a)
Saving of energy	ca. 25 per cent
costs	140 € gross/m ² living space

Table: 11 litre house bundle of measures

source: Schönefeldt et al. 2008, p. 18

Relating to the distribution of the modernisation costs we assume that

- 95 per cent of the costs of the heating installation and the thermal insulation of storey and cellar ceilings,
- 70 per cent of the costs of thermal insulation of outside walls and
- 70 per cent of the costs of replacement of the windows

are apportionable. For instance the costs for new windows will be distributed as follows: 70 per cent tenants / 30 per cent landlords.

4.2 Case studies

The special problems of an investment analysis for the energetic modernisation of a residential building are illustrated in the following case studies.

A dwelling with 80 m² living space and in need of energetic modernisation is for sale. The property value / acquisition costs (including all extra costs) are estimated at €60.000.

The building is not under monumental protection and is not located in a statutory development area. As a consequence the investor cannot make use of the higher depreciation scheme stipulated in § 7h resp. 7i of the German income tax law. We assume a marginal tax rate of the investor of 35 per cent.

4.2.1 11 litre house modernisation

In case of the **11 litre house** modernisation bundle total costs of the project are made up of the following types of cost:

total costs

type of cost	amount €	€ per m ² living space
land value	11.200	140,00
value of the building substance	48.800	610,00
restoration costs	1.455	18,19
modernisation costs	9.745	121,81
total costs	71.200	890

We assume that 87 per cent of the total building costs are subject to activation. Also we leave out the interest costs during the construction period. Finally we assume the loss of rent risk not to be higher in the first year of after modernisation.

Type of measure	Costs €/ m ²	Apportionable costs €/ m ²
Gas central heating with condensing heating technology	38,70	36,77
16 cm thermal insulation of storey ceiling	40,00	38,00
8 cm thermal insulation of cellar ceiling	16,50	15,68
Replacement of windows (U-value, $U_F \leq 1,3 \text{ W/m}^2\text{K}$) in dwellings and stair-cases	44,80	31,36
Total costs €/ m²	140,00	121,81

Table: specification of costs for the 11 litre house bundle of measures

The following table exhibits the basic financial data, the financial structure and the composition of the cash flow in year 1:

I. basic data	
living space in m ²	80
number of units	1
interest rates for KfW CO ₂ -mortgage in per cent year 1-10	3,35
Reference interest rate	5,5
administration costs per unit year 1 €	370
maintenance costs per m ² year 1 €	7,00
Loss of rent, percentage of target rent year 1	3,0
II. total costs	
land value per m ² living space €	140,00
value of the existing building substance per m ² €	610,00
restoration costs per m ² living space €	18,19
modernisation costs per m ² living space €	<u>121,81</u>
total costs per m ² living space €	890,00
III. financial structure	
equity capital €	60.000
debt capital €	<u>11.200</u>
total costs €	71.200
IV. cash outflows in year 1	
A. capital costs	
annuity for the KfW CO ₂ -mortgage €	894
B. operating costs €	1.103
administration €	370
maintenance €	560
loss of rent €	173
V. rent revenue per year	5.776
previous rent per month and m ² €	4,90
share in the costs per month and m ² €	1,12
local reference rent per month and m ² €	5,25
rent after modernisation per month and m ²	6,02



All measures can be financed with a KfW CO₂-mortgage since the 11 litre house set of measures corresponds to bundle no. 2 defined in the respective leaflet. The current bank terms for this programme are listed in the following table (state: 12th June 2008):

Programme	CO2-Programme programme number 130	
max. term in years	20	30
max. years of grace	3	5
max. initial fixed rate period in years	10	10
max. nominal inter- est in per cent p.a.	3,35	3,50
max. effective inter- est in per cent p.a.	3,39	3,55

We choose a termtime of 20 years, a fixed interest rate for 10 years and a 3 years grace period without principal payment. The following table exhibits the development of the principal balance of the KfW CO₂-mortgage:

t	Principal balance €	interest €	principal €	annuity €
1	11.200	375,20	0	375,20
2	11.200	375,20	0	375,20
3	11.200	375,20	0	375,20
4	11.200	375,20	492	866,82
5	10.708	358,73	508	866,82
6	10.200	341,71	525	866,82
7	9.675	324,12	543	866,82
8	9.132	305,94	561	866,82
9	8.572	287,15	580	866,82
10	7.992	267,73	599	866,82
11	7.393	443,57	561	1.004,47
12	6.832	409,92	595	1.004,47
13	6.237	374,25	630	1.004,47
14	5.607	336,43	668	1.004,47
15	4.939	296,35	708	1.004,47

At the end of the holding period a principal balance of €4.231 remains which has to be balanced with the revenue from the sale.

KfW CO₂-mortgage: basic data

debt capital €	11.200
i t ₀ in per cent	3,35
i t ₁₀ in per cent	6,00
initial principal per cent	0,00
principal t ₄ per cent	4,39
principal t ₁₁ per cent	7,59
annuity t ₀ -t ₃ €	375,20
annuity t ₄ -t ₁₀ €	866,82
annuity t ₁₁ -t ₁₅ €	1.004,47
ref. interest per cent	5,5
reduction of interest per year €	240,80

According to § 559a of the German Civil Code (BGB) the tenant's yearly share in the costs has to be reduced by the difference between the market mortgage rate valid after the modernisation is finished and the subsidised interest rate times the initial debt, i.e. $(5,5 - 3,35) * €11.200 / 100 = €240,80$.

The tenant's gross monthly share in the costs per m² equals to the modernisation costs per m² times 11 per cent and divided by 12: $€121,81 * 11 \text{ per cent} / 12 = €1,12$. His net share in the costs per year and dwelling is €1.071,93 minus the reduction of interest (€240,80).

We assume that this difference of €831,20 (€0,87 per month and m²) is realisable at the local housing market. We remember also that the share in the modernisation cost can be charged only until the landlord raises the rent next time or until the termination of the tenancy.

The relevant local reference rent after modernisation is presumed to lack behind the sum of the previous rent and the gross share in the costs (€5,25 as opposed to €6,02). We expect the relevant local reference rent to rise by 1,8 per cent per year in the first 5 years after the energetic modernisation. For the following two 5-year intervals the growth rate is expected to fall to 1,2 and 0,6 per cent, respectively (Kofner 2008, p. 113).

An expected tenant fluctuation of 10 per cent per year means that the average residence time of a tenant will be 5 years. In a housing shortage situation the landlord could demand a rent up to 20 per cent above the relevant local reference rent from the new tenant 5 years later. Since we have only run the basic modernisation programme with limited effect on the heating bill we assume however that only a rent 15

per cent above the local reference rent is attainable then. Five years later a markup of 10 per cent is regarded as realisable.

The following table exhibits the expected development of the rent revenue from the dwelling:

t	local ref. rent €	previous rent €	share in the costs €	reduction of interest €	target rent €
0					
1	5.040	4.704	1.072	-241	5.535
2	5.131	4.704	1.072	-241	5.535
3	5.223	4.704	1.072	-241	5.535
4	5.317	4.704	1.072	-241	5.535
5	5.413	4.704	1.072	-241	5.535
6	5.478				6.299
7	5.543				6.299
8	5.610				6.299
9	5.677				6.299
10	5.745				6.299
11	5.780				6.358
12	5.815				6.358
13	5.849				6.358
14	5.885				6.358
15	5.920				6.358

The net cash flow before taxes in year 1 is rent revenue minus operating and capital costs:

rent €	5.535
- capital costs €	375
- operating costs €	1.096
= cash flow €	€4.064

The different cash flow components shall develop as follows:

- **Holding period and conservation of value:** After the energetic modernisation the object will be rented out for 15 years and then be sold. The original state after modernisation will be maintained by adequate maintenance expenditure (no further modernisation during the holding period).
- **Rent revenue:** The initial rent revenue is given by:

$$€4.704 + €1.072 - €241 = €5.535$$
For the assumptions about its further development see above.
- **Loss of rent risk:** 3 per cent of the target rent.

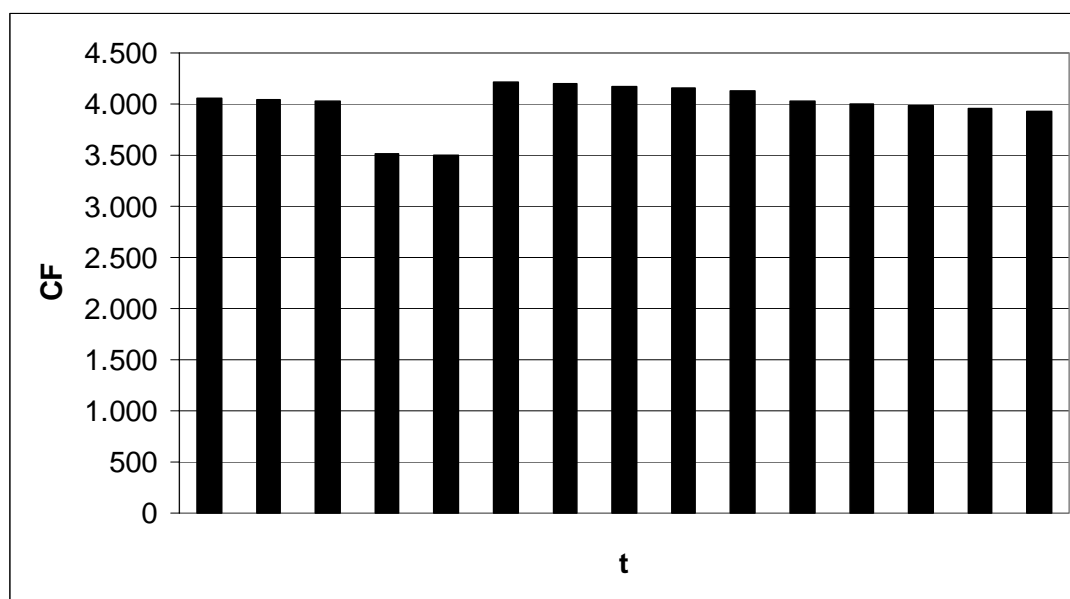
- **Capital costs:** The modernisation will be financed exclusively with debenture capital from federal KfW-bank, the purchase price however solely with equity capital. The credit needs of €11.200 per dwelling will be financed with a 10 year FRM at an interest rate of 3,35 per cent. For the prolongation period a rate of 6,0 per cent is expected. Due to the grace period granted the initial principal is 0 per cent of the initial debt. The principal rate in year 11 of 7,59 per cent makes sure that the mortgage is fully paid back after the termtime of 20 years. We assume however that the open principal balance is paid back after year 15 when the property is sold (without prepayment penalty).
- **Administration costs:** a customary in trade value of €370 per unit is assumed here.
- **Maintenance costs:** due to the modernisation just finished only €7,00 pro m². All operating costs are expected to rise with a rate of 2 per cent per year.
- **Cap rate / Exit cap rate / capital gains / value development:** The entry cap rate after modernisation is 6,23 per cent. Until the end of the holding period this rate is expected to rise to 9,64 per cent due to the age of the heating technology and the property itself, not to forget the risk of a housing market slump. With this exit cap rate we can expect a net sale revenue in year 15 of €51.264 (Cash flow in year 15 + capital costs in year 15 divided by the exit cap rate). This corresponds to a yearly decrease in value of 2,17 per cent – slightly above the depreciation rate of 2 per cent relevant for income tax purposes. After year 15 there will be no difference between the book value for taxation and the sale price. Therefore no capital gains and no capital gains taxation will accrue then.

dynamisation: assumptions 11 litre house	per cent
growth rate local ref. rent year 1-5	1,8
growth rate local ref. rent year 6-10	1,2
growth rate local ref. rent year 11-15	0,6
local ref. rent markup year 6	15,0
local ref. rent markup year 11	10,0
growth rate operating costs	2,0
loss of rent / rent revenue	3,0
entry cap rate	6,23
exit cap rate	9,64
capital gains per year	-2,17

The development of the cash flow components and of the value of the property are shown in the following table:

t	A_0/R_{15} €	rent €	capital gain €	value €	capital costs €	op. costs €	CF €
0	-60.000	0		71.200		0	0
1		5.535	-1.542	69.658	375	1.096	4.064
2		5.535	-1.509	68.149	375	1.115	4.045
3		5.535	-1.476	66.673	375	1.134	4.026
4		5.535	-1.444	65.228	867	1.153	3.515
5		5.535	-1.413	63.815	867	1.173	3.496
6		6.299	-1.382	62.433	867	1.216	4.217
7		6.299	-1.352	61.080	867	1.236	4.196
8		6.299	-1.323	59.757	867	1.257	4.175
9		6.299	-1.294	58.463	867	1.279	4.154
10		6.299	-1.266	57.196	867	1.300	4.132
11		6.358	-1.239	55.957	1.004	1.324	4.029
12		6.358	-1.212	54.745	1.004	1.347	4.006
13		6.358	-1.186	53.559	1.004	1.370	3.983
14		6.358	-1.160	52.399	1.004	1.394	3.960
15	51.264	6.358	-1.135	51.264	1.004	1.418	3.936

The IRR before taxes of this investment is 5,697668 per cent. In year 4 the CF falls because of the end of the grace period for the mortgage. Two years later the CF bounces back as a consequence of the higher rent income from the new tenants. In the following years the CF tends to decrease slightly because the rent income is more or less stagnant while operating and capital costs do rise.



CF before taxes, 11 litre house

The next step is to calculate the after tax rate of return of the investment project. The determination base for the depreciation is €71.200 (acquisition costs plus all modernisation and restoration costs).

t	A ₀ /R ₁₅ €	rent €	interest cost €	inter.- inc. €	total cap. costs €	op. costs €	CF before taxes €	IRR1	Det. base €	Depr. rate per cent	Depr. €	Taxable income €	Income tax €	CF after taxes €	IRR2
0	-60.000					0	0	-60.000						-	
1		5.535	375	0	375	1.096	4.064	4.064	71.200	2,00	1.424	2.640	-924	3.140	
2		5.535	375	232	375	1.115	4.045	4.045	69.776	2,00	1.424	2.853	-998	3.047	
3		5.535	375	475	375	1.134	4.026	4.026	68.352	2,00	1.424	3.078	-1.077	2.949	
4		5.535	375	732	867	1.153	3.515	3.515	66.928	2,00	1.424	3.315	-1.160	2.355	
5		5.535	359	974	867	1.173	3.496	3.496	65.504	2,00	1.424	3.553	-1.244	2.252	
6		6.299	342	1.228	867	1.216	4.217	4.217	64.080	2,00	1.424	4.546	-1.591	2.626	
7		6.299	324	1.539	867	1.236	4.196	4.196	62.656	2,00	1.424	4.854	-1.699	2.498	
8		6.299	306	1.865	867	1.257	4.175	4.175	61.232	2,00	1.424	5.178	-1.812	2.363	
9		6.299	287	2.210	867	1.279	4.154	4.154	59.808	2,00	1.424	5.519	-1.932	2.222	
1		6.299	268	2.572	867	1.300	4.132	4.132	58.384	2,00	1.424	5.879	-2.058	2.074	
1		6.358	444	2.954	1.004	1.324	4.029	4.029	56.960	2,00	1.424	6.120	-2.142	1.887	
1		6.358	410	3.352	1.004	1.347	4.006	4.006	55.536	2,00	1.424	6.529	-2.285	1.721	
1		6.358	374	3.771	1.004	1.370	3.983	3.983	54.112	2,00	1.424	6.961	-2.436	1.547	
1		6.358	336	4.213	1.004	1.394	3.960	3.960	52.688	2,00	1.424	7.417	-2.596	1.364	
1	51.264	6.358	296	4.679	1.004	1.418	3.936	50.969	51.264	2,00	1.424	7.898	-2.764	48.204	0,02595402

After taxes the IRR has fallen to 2,6 per cent – hardly more than long term government bonds pay. Any substantial negative changes of rent level, loss of rent or modernisation costs per m² would make the IRR after taxes almost unbearable.

The case study has demonstrated a certain lack of incentives for energetic modernisation to the 11 litre house level from the landlord's point of view. The problem is that ordinary modernisation measures are subject to longer amortisation periods whereas a heating is old, worn out and inefficient compared with then available technology after 15 years. The interest rate subsidy of the CO₂-programme needs to compensate for the shorter amortisation periods.

4.2.2 8,5 litre house modernisation

In case of the **8,5 litre house** modernisation bundle total costs of the project are made up of the following types of cost:

total costs

type of cost	amount €	€ per m ² living space
land value	11.200	140,00
value of the building substance	48.800	610,00
restoration costs	1.635	20,44
modernisation costs	13.165	164,56
total costs	74.800	935,00

We assume that 89 per cent of the total building costs are subject to activation.

Type of measure	Costs €/ m ²	Apportionable costs €/ m ²
Combined heat and power district heating	83,70	79,52
16 cm thermal insulation of storey ceiling	40,00	38,00
8 cm thermal insulation of cellar ceiling	16,50	15,68
Replacement of windows (U-value, $U_F \leq 1,3 \text{ W/m}^2\text{K}$) in dwellings and stair-cases	44,80	31,36
Total costs €/ m²	185,00	164,56

Table: specification of costs for the 8,5 litre house bundle of measures

The following table exhibits the basic financial data, the financial structure and the composition of the cash flow in year 1:

I. basic data known	
II. total costs	
land value per m ² living space €	140,00
value of the existing building substance per m ² €	610,00
restoration costs per m ² living space €	20,44
modernisation costs per m ² living space €	<u>164,56</u>
total costs per m ² living space €	935,00
III. financial structure	
equity capital €	60.000
debt capital €	<u>14.800</u>
total costs €	74.800
IV. cash outflows in year 1	
A. capital costs	
annuity for the KfW CO ₂ -mortgage €	496
B. operating costs	1.115
administration €	370
maintenance €	560
loss of rent €	185
V. rent revenue per year	6.152
previous rent per month and m ² €	4,90
share in the costs per month and m ² €	1,51
local reference rent per month and m ² €	5,45
rent after modernisation per month and m ²	6,41

As in the 11 litre house case all modernisation measures will be financed exclusively with a KfW CO₂-mortgage, the purchase price however solely with equity capital. The credit needs of €14.800 per dwelling will be financed with a 10 year FRM at an interest rate of 3,35 per cent. For the prolongation period a rate of 6,0 per cent is expected. Due to the grace period granted the initial principal is 0 per cent of the initial debt. The principal rate in year 11 of 7,59 per cent makes sure that the mortgage is fully paid back after the termtime of 20 years. We assume however that the open principal balance is paid back when the property is sold.

t	Principal balance €	interest €	principal €	annuity €
1	14.800	495,80	0	495,80
2	14.800	495,80	0	495,80
3	14.800	495,80	0	495,80
4	14.800	495,80	650	1.145,44
5	14.150	474,04	671	1.145,44
6	13.479	451,55	694	1.145,44
7	12.785	428,30	717	1.145,44
8	12.068	404,28	741	1.145,44
9	11.327	379,45	766	1.145,44
10	10.561	353,79	792	1.145,44
11	9.769	586,15	741	1.327,33
12	9.028	541,68	786	1.327,33
13	8.242	494,54	833	1.327,33
14	7.410	444,57	883	1.327,33
15	6.527	391,60	936	1.327,33

At the end of the holding period a principal balance of €5.591 remains which has to be balanced with the expected revenue from the sale.

KfW CO₂-mortgage: basic data

debt capital €	14.800
i t ₀ in per cent	3,35
i t ₁₀ in per cent	6,00
initial principal per cent	0,00
principal t ₄ per cent	4,39
principal t ₁₁ per cent	7,59
annuity t ₀ -t ₃ €	495,90
annuity t ₄ -t ₁₀ €	1.145,44
annuity t ₁₁ -t ₁₅ €	1.327,33
ref. interest per cent	5,5
reduction of interest per year €	318,20

The tenant's yearly share in the costs has to be reduced by the difference between the market and the subsidised interest rate times the initial debt, i.e. $(5,5 - 3,35) * € 14.800 / 100 = €318,20$.

The tenant's gross monthly share in the costs per m² equals to the modernisation costs per m² times 11 per cent and divided by 12: $€164,56 * 11 \text{ per cent} / 12 = € 1,51$. Per year and dwelling our tenant will have to pay €1.448 more – minus the reduction of interest (€318,20). We assume that the difference of €1.129,80 is realisable at the local housing market.

The relevant local reference rent after modernisation is presumed to lack behind the sum of the previous rent and the gross share in the costs (€ 5,45 as opposed to € 6,41). We expect the relevant local reference rent to rise by 1,8 per cent per year in the first 5 years after the energetic modernisation. For the following two 5-year intervals the growth rate is expected to fall to 1,2 and 0,6 per cent, respectively.

An expected tenant fluctuation of 10 per cent per year means that the average residence time of a tenant will be 5 years. In a housing shortage situation the landlord could demand a rent up to 20 per cent above the relevant local reference rent from the new tenant 5 years later. We assume that this span will be attainable then. Five years later an additional markup of 15 per cent is regarded as realisable.

The following table exhibits the expected development of the rent revenue from the dwelling:

t	local ref. rent €	previous rent €	share in the costs €	reduction of interest €	target rent €
0					
1	5.232	4.704	1.448	-318	5.834
2	5.326	4.704	1.448	-318	5.834
3	5.422	4.704	1.448	-318	5.834
4	5.520	4.704	1.448	-318	5.834
5	5.619	4.704	1.448	-318	5.834
6	5.686				6.824
7	5.755				6.824
8	5.824				6.824
9	5.894				6.824
10	5.964				6.824
11	6.000				6.900
12	6.036				6.900
13	6.072				6.900
14	6.109				6.900
15	6.145				6.900

The net cash flow before taxes in year 1 is rent revenue minus operating and capital costs:

rent €	5.834
- capital costs €	496
- operating costs €	1.105
= cash flow €	€4.233

The entry cap rate after modernisation is 6,32 per cent (6,23 per cent in the 11 litre house case). The exit cap rate at the end of the holding period is expected to be slightly lower than in the 11 litre house case (9,44 versus 9,64 per cent) since the heating technology is more energy-efficient. With this exit cap rate we can expect a net sale revenue in year 15 of €57.903 (€51.264 in the 11 litre house case). This corresponds to a yearly decrease in value of 1,69 per cent (as opposed to 2,17 per cent for the 11 litre house). After year 15 there will be a positive difference between the sale price and the book value for taxation. This accounting profit of €4.047 is not taxable however if the object is held as private property and not commercially traded.

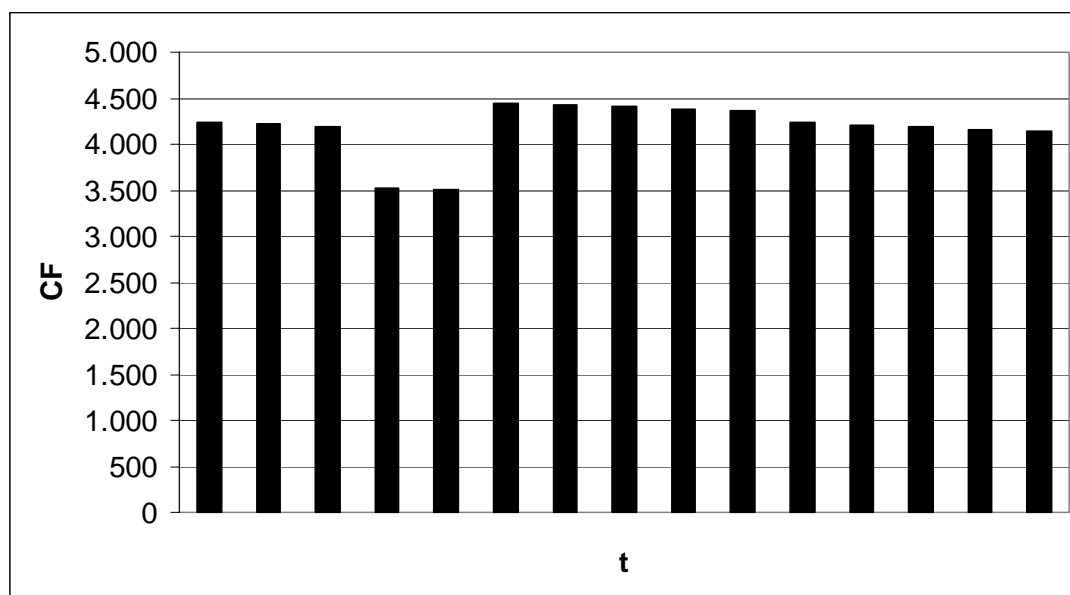
Failing that and alleged the property would be a business asset the capital gain could be tax-efficiently transferred to a substitute property. As a result immediate taxation would be circumvented, but the scheduled depreciation on the substitute property would be somewhat lower. The landlord would thus save on income tax. If the property were a private asset however the capital gain would be fully taxable in the year of the sale.

dynamisation: assumptions 8,5 litre house	per cent
growth rate local ref. rent year 1-5	1,8
growth rate local ref. rent year 6-10	1,2
growth rate local ref. rent year 11-15	0,6
local ref. rent markup year 6	20,0
local ref. rent markup year 11	15,0
growth rate operating costs	2,0
loss of rent / rent revenue	3,0
entry cap rate	6,32
exit cap rate	9,44
capital gains per year	-1,69

The development of the cash flow components and of the value of the property are shown in the following table:

t	A_0/R_{15} €	rent €	capital gain €	value €	capital costs €	op. costs €	CF €
0	-60.000			74.800		0	0
1		5.834	-1.266	73.534	496	1.105	4.233
2		5.834	-1.245	72.289	496	1.124	4.215
3		5.834	-1.223	71.066	496	1.143	4.196
4		5.834	-1.203	69.863	1.145	1.162	3.527
5		5.834	-1.182	68.681	1.145	1.182	3.507
6		6.824	-1.162	67.518	1.145	1.232	4.447
7		6.824	-1.143	66.376	1.145	1.252	4.426
8		6.824	-1.123	65.252	1.145	1.273	4.405
9		6.824	-1.104	64.148	1.145	1.294	4.384
10		6.824	-1.086	63.062	1.145	1.316	4.362
11		6.900	-1.067	61.995	1.327	1.341	4.232
12		6.900	-1.049	60.945	1.327	1.363	4.209
13		6.900	-1.032	59.914	1.327	1.386	4.186
14		6.900	-1.014	58.900	1.327	1.410	4.163
15	51.264	6.900	-997	57.903	1.327	1.434	4.139

The IRR before taxes of this investment is 6,398211 per cent, a remarkable gain compared with the 11 litre house's IRR of 5,697668 per cent.



CF before taxes, 8,5 litre house

The next step is to calculate the after tax rate of return of the investment project. The determination base for the depreciation is €74.800 (acquisition costs plus all modernisation and restoration costs).

t	A ₀ /R ₁₅ €	rent €	interest cost €	interest- income €	total capital costs €	op. costs €	CF before taxes €	IRR1	Det. base €	Depr. rate per cent	Depr. €	Taxable income €	Income tax €	CF after taxes €	IRR2
0	-60.000					0	0	-60.000						-	
1		5.834	496	0	496	1.105	4.233	4.233	74.800	2,00	1.496	2.737	-958	3.275	
2		5.834	496	271	496	1.124	4.215	4.215	73.304	2,00	1.496	2.989	-1.046	3.168	
3		5.834	496	558	496	1.143	4.196	4.196	71.808	2,00	1.496	3.257	-1.140	3.055	
4		5.834	496	862	1.145	1.162	3.527	3.527	70.312	2,00	1.496	3.542	-1.240	2.287	
5		5.834	474	1.143	1.145	1.182	3.507	3.507	68.816	2,00	1.496	3.825	-1.339	2.168	
6		6.824	452	1.440	1.145	1.232	4.447	4.447	67.320	2,00	1.496	5.085	-1.780	2.667	
7		6.824	428	1.817	1.145	1.252	4.426	4.426	65.824	2,00	1.496	5.464	-1.912	2.514	
8		6.824	404	2.216	1.145	1.273	4.405	4.405	64.328	2,00	1.496	5.867	-2.053	2.352	
9		6.824	379	2.640	1.145	1.294	4.384	4.384	62.832	2,00	1.496	6.294	-2.203	2.181	
10		6.824	354	3.089	1.145	1.316	4.362	4.362	61.336	2,00	1.496	6.747	-2.362	2.001	
11		6.900	586	3.566	1.327	1.341	4.232	4.232	59.840	2,00	1.496	7.043	-2.465	1.767	
12		6.900	542	4.065	1.327	1.363	4.209	4.209	58.344	2,00	1.496	7.564	-2.647	1.562	
13		6.900	495	4.595	1.327	1.386	4.186	4.186	56.848	2,00	1.496	8.118	-2.841	1.345	
14		6.900	445	5.156	1.327	1.410	4.163	4.163	55.352	2,00	1.496	8.706	-3.047	1.116	
15	51.264	6.900	392	5.753	1.327	1.434	4.139	56.450	53.856	2,00	1.496	9.331	-3.266	53.184	0,03049638

After taxes the IRR is now 3,05 per cent – a considerable increase of 0,45 per cent compared to the 11 litre house variant. The result is still vulnerable against substantial negative changes of rent level, loss of rent or modernisation costs per m².

4.2.3 6 litre house modernisation

In case of the **6 litre house** modernisation bundle total costs of the project are made up of the following types of cost:

total costs

type of cost	amount €	€ per m ² living space
land value	11.200	140,00
value of the building substance	48.800	610,00
restoration costs	4.155	51,94
modernisation costs	19.045	238,06
total costs	83.200	1.040,00

82,1 per cent of the total building costs are subject to activation this time.

Type of measure	Costs €/ m ²	Apportionable costs €/ m ²
Combined heat and power district heating	83,70	79,52
16 cm thermal insulation of storey ceiling	40,00	38,00
8 cm thermal insulation of cellar ceiling	16,50	15,68
≥ 12 cm thermal insulation of outside walls	105,00	73,50
Replacement of windows (U-value, U _F ≤1,3 W/m ² K) in dwellings and stair-cases	44,80	31,36
Total costs €/ m²	290,00	238,06

Table: specification of costs for the 6 litre house bundle of measures

The following table exhibits the basic financial data, the financial structure and the composition of the cash flow in year 1:

I. basic data known	
II. total costs land value per m ² living space € value of the existing building substance per m ² € restoration costs per m ² living space € modernisation costs per m ² living space € total costs per m ² living space €	 140,00 610,00 51,94 <u>238,06</u> 1.040,00
III. financial structure equity capital € debt capital € total costs €	 60.000 <u>23.200</u> 83.200
IV. cash outflows in year 1 A. capital costs annuity for the KfW CO ₂ -mortgage € B. operating costs administration € maintenance € loss of rent €	 777 1.134 370 560 204
V. rent revenue per year previous rent per month and m ² € share in the costs per month and m ² € local reference rent per month and m ² € rent after modernisation per month and m ²	 6.799 4,90 2,18 5,65 7,08

As in the other cases all modernisation measures will be financed exclusively with a KfW CO₂-mortgage, the purchase price however solely with equity capital. The credit needs of €23.200 per dwelling will be financed with a 10 year FRM at an interest rate of 3,35 per cent. Since a 7 litre house normally would already reach the energetic standard of a new building as specified in § 3 of the German Energy Saving Act (Energieeinsparverordnung EnEV), we can assume that our 6 litre house qualifies for the “Mortgage Principal Assistance” granted by the KfW for that kind of extra-efficient energetic modernisation. The principal balance of the KfW mortgage will thus be lowered by 5 per cent after the 6th quarter. The landlord will save € 1.160 on principal this way.

For the prolongation period a rate of 6,0 per cent is expected. Due to the grace period granted the initial principal is 0 per cent of the initial debt. The principal rate in year 11 of 7,59 per cent makes sure that the mortgage is fully paid back after the termtime of 20 years. We assume however that the open principal balance is paid back when the property is sold.

t	Principal balance €	interest €	principal €	annuity €
1	23.200	777,20	0	777,20
2	22.620	757,77	0	757,77
3	22.040	738,34	0	738,34
4	22.040	738,34	967	1.705,77
5	21.073	705,93	1.000	1.705,77
6	20.073	672,44	1.033	1.705,77
7	19.039	637,82	1.068	1.705,77
8	17.971	602,04	1.104	1.705,77
9	16.868	565,07	1.141	1.705,77
10	15.727	526,85	1.179	1.705,77
11	14.548	872,89	1.104	1.976,65
12	13.444	806,66	1.170	1.976,65
13	12.274	736,46	1.240	1.976,65
14	11.034	662,05	1.315	1.976,65
15	9.720	583,17	1.393	1.976,65

At the end of the holding period a principal balance of €8.326 remains which has to be balanced with the expected revenue from the sale.

KfW CO₂-mortgage: basic data

debt capital €	23.200
mortgage principal assistance €	1.160
i _{eff} in per cent	2,74
i _{t₀} in per cent	3,35
i _{t₁₀} in per cent	6,00
initial principal per cent	0,00
principal t ₄ per cent	4,39
principal t ₁₁ per cent	7,59
annuity t ₀ -t ₃ €	777,20
annuity t ₄ -t ₁₀ €	1.705,77
annuity t ₁₁ -t ₁₅ €	1.967,65
ref. interest per cent	5,5
reduction of interest per year €	640,32

The tenant's yearly share in the costs has to be reduced by the difference between the market and the subsidised (effective) interest rate⁹ times the initial debt, i.e. $(5,5 - 2,74) * €23.200 / 100 = €640,32$.

⁹ Taking into account the mortgage principal assistance.

The tenant's gross monthly share in the costs per m² equals to the modernisation costs per m² times 11 per cent and divided by 12: €238,06 * 11 per cent / 12 = €2,18. Per year and dwelling our tenant will have to pay €2.095 more – minus the reduction of interest (€640,32). We assume that this difference of €1.454,68 is realisable at the local housing market.

The relevant local reference rent after modernisation is presumed to lack behind the sum of the previous rent and gross share in the costs (€5,65 as opposed to €7,08). We expect the relevant local reference rent to rise by 1,8 per cent per year in the first 5 years after the energetic modernisation. For the following two 5-year intervals the growth rate is expected to fall to 1,2 and 0,6 per cent, respectively.

We assume that markupa of 20 per cent upon the relevant local reference rent will be attainable 5 and 10 years later. The following table exhibits the expected development of the rent revenue from the dwelling:

t	local ref. rent €	previous rent €	share in the costs €	reduction of interest €	target rent €
0					
1	5.424	4.704	2.095	-640	6.159
2	5.522	4.704	2.095	-640	6.159
3	5.621	4.704	2.095	-640	6.159
4	5.722	4.704	2.095	-640	6.159
5	5.825	4.704	2.095	-640	6.159
6	5.895				7.074
7	5.966				7.074
8	6.037				7.074
9	6.110				7.074
10	6.183				7.074
11	6.220				7.464
12	6.258				7.464
13	6.295				7.464
14	6.333				7.464
15	6.371				7.464

The net cash flow before taxes in year 1 is rent revenue minus operating and capital costs:

rent €	6.159
- capital costs €	777
- operating costs €	1.115
= cash flow €	€4.267

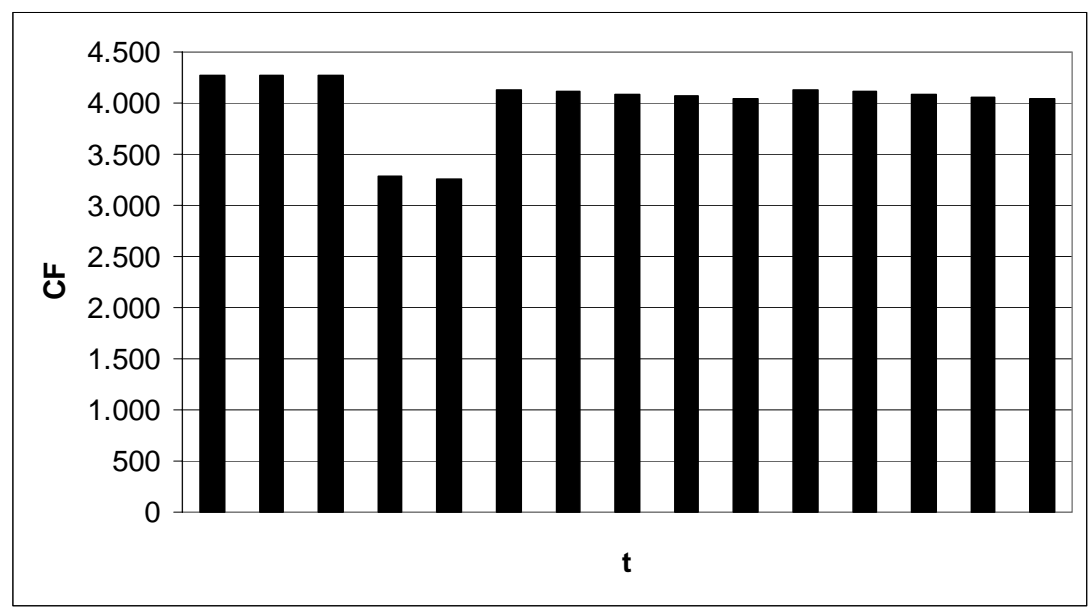
The entry cap rate after modernisation is 6,06 per cent. The exit cap rate at the end of the holding period is expected to be considerably lower than in the 8,5 litre house case (8,44 versus 9,44 per cent) since the thermal insulation of the walls is a measure with a long amortisation period and a remarkable effect on heating costs. With this exit cap rate we can expect a net sale revenue in year 15 of €71.248 (€57.903 in the 8,5 litre house case). This corresponds to a yearly decrease in value of 1,03 per cent (as opposed to 1,69 per cent for the 11 litre house). After year 15 there will be a positive difference between the sale price and the book value for taxation (accounting profit of €11.344).

dynamisation: assumptions 6 litre house	per cent
growth rate local ref. rent year 1-5	1,8
growth rate local ref. rent year 6-10	1,2
growth rate local ref. rent year 11-15	0,6
local ref. rent markup year 6	20,0
local ref. rent markup year 11	20,0
growth rate operating costs	2,0
loss of rent / rent revenue	3,0
entry cap rate	6,06
exit cap rate	8,44
capital gains per year	-1,03

The development of the cash flow components and of the value of the property is shown in the following table:

t	A_0/R_{15} €	rent €	capital gain €	value €	capital costs €	op. costs €	CF €
0	-60.000			83.200		0	0
1		6.159	-856	82.344	777	1.115	4.267
2		6.159	-847	81.497	758	1.133	4.267
3		6.159	-838	80.659	738	1.152	4.268
4		6.159	-830	79.830	1.706	1.172	3.281
5		6.159	-821	79.009	1.706	1.191	3.261
6		7.074	-813	78.196	1.706	1.239	4.129
7		7.074	-804	77.392	1.706	1.260	4.109
8		7.074	-796	76.596	1.706	1.281	4.088
9		7.074	-788	75.808	1.706	1.302	4.066
10		7.074	-780	75.028	1.706	1.324	4.045
11		7.464	-772	74.257	1.977	1.358	4.130
12		7.464	-764	73.493	1.977	1.380	4.107
13		7.464	-756	72.737	1.977	1.403	4.084
14		7.464	-748	71.989	1.977	1.427	4.061
15	71.248	7.464	-740	71.248	1.977	1.451	4.037

The IRR before taxes of this investment is 6,875515 per cent, a remarkable gain compared with the 11 litre house's IRR of 5,697668 per cent and the 6,398211 per cent we calculated for the 8,5 litre house.



CF before taxes, 6 litre house

The next step is to calculate the after tax rate of return of the investment project. The determination base for the depreciation is €83.200 (acquisition costs plus all modernisation and restoration costs).

t	A ₀ /R ₁₅ €	rent €	interest cost €	interest- income €	total capital costs €	op. costs €	CF before taxes €	IRR1	Det. base €	Depr. rate per cent	Depr. €	Taxable income €	Income tax €	CF after taxes €	IRR2
0	-60.000					0	0	-60.000						-60.000	
1		6.159	777	0	777	1.115	4.267	4.267	83.200	2,00	1.664	2.603	-911	3.356	
2		6.159	758	293	758	1.133	4.267	4.267	81.536	2,00	1.664	2.897	-1.014	3.254	
3		6.159	738	607	738	1.152	4.268	4.268	79.872	2,00	1.664	3.211	-1.124	3.144	
4		6.159	738	942	1.706	1.172	3.281	3.281	78.208	2,00	1.664	3.527	-1.234	2.047	
5		6.159	706	1.232	1.706	1.191	3.261	3.261	76.544	2,00	1.664	3.830	-1.340	1.921	
6		7.074	672	1.541	1.706	1.239	4.129	4.129	74.880	2,00	1.664	5.040	-1.764	2.365	
7		7.074	638	1.931	1.706	1.260	4.109	4.109	73.216	2,00	1.664	5.444	-1.905	2.203	
8		7.074	602	2.347	1.706	1.281	4.088	4.088	71.552	2,00	1.664	5.874	-2.056	2.032	
9		7.074	565	2.789	1.706	1.302	4.066	4.066	69.888	2,00	1.664	6.332	-2.216	1.850	
10		7.074	527	3.260	1.706	1.324	4.045	4.045	68.224	2,00	1.664	6.820	-2.387	1.658	
11		7.464	873	3.763	1.977	1.358	4.130	4.130	66.560	2,00	1.664	7.333	-2.566	1.564	
12		7.464	807	4.305	1.977	1.380	4.107	4.107	64.896	2,00	1.664	7.919	-2.772	1.336	
13		7.464	736	4.884	1.977	1.403	4.084	4.084	63.232	2,00	1.664	8.544	-2.990	1.094	
14		7.464	662	5.500	1.977	1.427	4.061	4.061	61.568	2,00	1.664	9.212	-3.224	837	
15	71.248	7.464	583	6.158	1.977	1.451	4.037	66.958	59.904	2,00	1.664	9.924	-3.473	63.485	0,03608556

After taxes the IRR has risen to 3,61 per cent – a considerable increase of 0,56 per cent compared to the 8,5 litre house variant (1,01 per cent compared to the 11 litre house).

4.3 Review of findings and comparison with non-subsidised investment

We have analysed different bundles of energy-saving measures for a dwelling of 80 m² worth €60.000 before modernisation. All measures were financed with mortgages from the KfW-bank's CO₂-Programme. This programme brings down the interest rate for the mortgage taken noticeably during the first ten years of the holding period. Compared to current market rates investors save more than 2 percentage points on interest, i.e. 3,35 versus 5,5 per cent. An overview of the results of our investment analysis is given in the following table:

Bundle	11 litre	8,5 litre	6 litre
costs per m ² €	140,00	185,00	290,00
tenant's gross share in the costs per year and dwelling € / per month and m ² €	1.071,93 / 1,12	1.448,13 / 1,51	2.094,93 / 2,19
reduction of interest per year € / per month and m ² €	240,80 / 0,25	318,20 / 0,33	640,32 / 0,67
tenant's net share in the costs per year and dwelling € / per month and m ² €	831,13 / 0,87	1.129,93 / 1,18	1.454,61 / 1,52
rent markup upon local reference rent after years 5 / 10 per cent	15 / 10	20 / 15	20 / 20
entry / exit cap rate per cent	6,23 / 9,64	6,32 / 9,44	6,06 / 8,44
decrease in value , per cent per year	2,17	1,69	1,03
sale price after year 15 €	51.264	57.903	71.248
IRR before / after tax per cent	5,70 / 2,60	6,40 / 3,05	6,88 / 3,70

The influence of the bundle chosen on the entry cap rate is only minor. All bundles will raise interest costs and rent income at the same time. Although the entry cap rate is noticeably

higher than the subsidised interest rate for the debt capital, *the effect of the choice of a more costly bundle of measures on the IRR is only limited* (no “green leverage”). That is because the more expensive the modernisation package is, the higher the amount of interest to be deducted from the gross share in the costs will be. The differences in the internal rates of return before and after taxes are largely attributable to the assumption about future rent markups and liquidation revenues. If these assumptions are valid, it makes sense to opt for the 6 litre house anyway.

The interest rate reduction stipulated in the German civil code brings down the rates of return of each type of investment. The following table compares the rates already calculated with the respective hypothetical IRRs if there were no interest rate reduction.

Bundle	11 litre	8,5 litre	6 litre
IRR before / after tax per cent	5,70 / 2,60	6,40 / 3,05	6,88 / 3,70
hypothetical IRR without interest rate reduction before / after tax per cent	5,88 / 2,61	6,64 / 3,05	7,34 / 3,69

If we neglect the interest rate reduction the rent income will rise in the first 5 years, but afterwards the CF flow will be unaltered. The effect on the pre-tax IRR depends on the volume of the investment. *After tax the IRR will not rise at all.* This is a puzzling result for sure. Part of the explanation is that 35 per cent of the additional rent income will be taxed away. On top of this we have to take into account the positive effect of the additional rent income on interest income in succeeding periods. The resulting additional taxable income and higher tax payments just compensate for the extra rent income in time.

We could not defend the thesis that the interest rate reduction hampers the incentives to invest, thus.

How about the effect of the interest rate subsidy on the incentive to choose a CO₂-mortgage to finance the investment? We found, that compared with an ordinary mortgage with an effective interest rate of 5,5 per cent *the positive effect of the subsidised credit on the IRR is rather limited* – especially from an after tax perspective.

Bundle	11 litre	8,5 litre	6 litre
IRR before / after tax per cent	5,70 / 2,60	6,40 / 3,05	6,88 / 3,70
IRR without subsidised credit before / after tax per cent	5,58 / 2,59	6,24 / 3,05	6,59 / 3,60

A year by year comparison of relevant CF-components of the 6 litre variant with and without subsidised credit is shown in the next table:

t	Rent subs. €	Rent unsub. €	capital costs subs. €	capital costs unsub. €	op. costs subs. €	op. costs unsub. €	CF subs. €	CF unsub. €
1	6.159	6.799	777	1.920	1.115	1.134	4.267	3.745
2	6.159	6.799	758	1.920	1.133	1.153	4.267	3.726
3	6.159	6.799	738	1.920	1.152	1.172	4.268	3.708
4	6.159	6.799	1.706	1.920	1.172	1.191	3.281	3.688
5	6.159	6.799	1.706	1.920	1.191	1.211	3.261	3.668
6	7.074	7.074	1.706	1.920	1.239	1.239	4.129	3.915
7	7.074	7.074	1.706	1.920	1.260	1.260	4.109	3.895
8	7.074	7.074	1.706	1.920	1.281	1.281	4.088	3.874
9	7.074	7.074	1.706	1.920	1.302	1.302	4.066	3.852
10	7.074	7.074	1.706	1.920	1.324	1.324	4.045	3.831
11	7.464	7.464	1.977	2.026	1.358	1.358	4.130	4.081
12	7.464	7.464	1.977	2.026	1.380	1.380	4.107	4.058
13	7.464	7.464	1.977	2.026	1.403	1.403	4.084	4.035
14	7.464	7.464	1.977	2.026	1.427	1.427	4.061	4.012
15	7.464	7.464	1.977	2.026	1.451	1.451	4.037	3.988

In the last five year interval the difference between the subsidised and the unsubsidised variant is almost negligible because market interest rates will be taken for both credits and rent income will be exactly the same in both variants during this period. This is also the case in the second 5 year-interval. Between year 6 and 10 of the holding period the subsidised investment profits from the lower interest rate however. In the first interval the difference between the sum of the cash flows is rather narrow, the unsubsidised CF for the five years being only € 809 lower. The interest rate reduction eats up most of the interest rate subsidy here.¹⁰

As we have shown the interest rate reduction from 5,5 to 3,35 per cent during the first 10 years of the holding period does not have an effect upon the IRR after tax. The following ta-

¹⁰ Also in the unsubsidised variant it would be plausible to expect a residence time shorter than the 5 years assumed in the subsidised variant because of the higher rent level. In this case the unsubsidised investment could even outperform the subsidised one in terms of the IRR.

ble exhibits the correlation between interest rate and IRR for different rate levels (8,5 litre variant).

subsidised interest rate per cent	5,5	5,0	4,0	3,35	3,0	2,0	1,0	0,0
IRR before tax per cent	6,26	6,29	6,36	6,40	6,42	6,47	6,52	6,56
IRR after tax per cent	2,96	2,98	3,03	3,05	3,06	3,10	3,13	3,16
yearly rent after modernisation €	6.152	6.078	5.930	5.834	5.782	5.634	5.486	5.338
monthly rent per m² after mod. €	6,41	6,33	6,18	6,08	6,02	5,87	5,71	5,56

sensitivity of IRR relating to changes in the subsidised interest rate, 8,5 litre house

The sensitivity of the IRR on interest rate changes is obviously very low. It is in fact so low, that one can question the whole approach of interest rate subsidies as a means to influence investment behaviour relating to energetic building modernisation. Even subsidising the rate down to zero per cent raises the IRR before taxes only by 0,32 per cent (0,11 per cent after taxes). *The real profiteers are the tenants.* The difference between the non-subsidised variant and a zero interest rate modernisation credit is €814 (13,25 per cent) in terms of the periodic rent burden during residence time – whereas the difference for the landlord is only €120 per year. These results do not take into account the possible effect of the rent burden on the residence time however. One should expect that on average tenants stay longer in their dwelling if the rent is lower. Now if we take that into consideration it seems probable that a cheaper credit will in fact lower the IRR of energetic investments.

Another surprise was the low sensitivity of the IRR on changes in the modernisation cost multiplier. If we lift the multiplier from 11 to 14 per cent the after tax IRR remains almost unchanged. Even if we let it drop to zero the computational effect on the IRR is not large. On the other hand we should expect that the lower the rent level falls the longer the average residence time will be and vice versa.

It cannot be denied that from a landlord's point of view the incentive effect of the KfW-CO₂-programme is rather limited all in all. The final recipients of the programme-inherent subsidies are in fact the tenants. But the conclusion is not straightforward. It will not help the landlords much if we lowered the interest rates even more, if we raised the cost multiplier or if we cancelled the interest rate reduction stipulated in the civil code. With these levers we would

only raise the tenant's energetic burden without doing much good for the landlords. There is thus no easy trade-off here.

Since cheap credit does not make much difference from the landlord's perspective, the best recommendation is to switch to other policy instruments for promoting energy-saving investment. An obvious choice would be tax incentives. We should allow for higher depreciation rates in case of buildings that fall below the 7 litre house standard as defined in the energy saving act. It is the only way to make a sweeping effect on after tax rates of return. We should allow for a depreciation rate of 5 per cent in the first ten years for conforming buildings. Extra-efficient buildings should profit from even higher depreciation rates.

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