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New Integrated Renovation Strategy to Improve Energy Performance of Social Housing

Kompetenz im Ökologischen Bauen

Öko Zentrum NRW

Portfolio-Management and Financial Incentives

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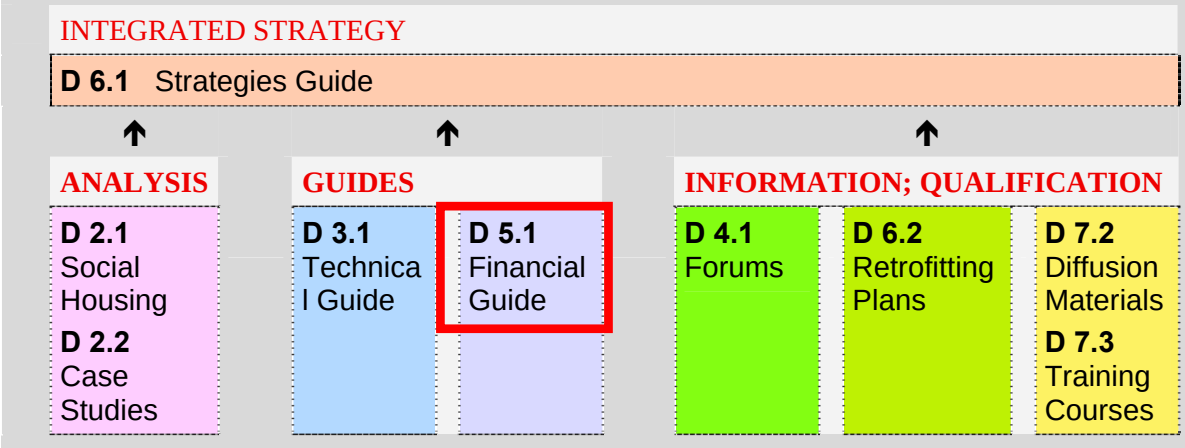

Portfolio-Management and Financial Incentives

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Content

1 Introduction

The development of financial measures and financial incentives for energy efficient retrofitting of social housings is the main interest of work package 5. Due to special demands in the sector of social housing - regarding legal limitations and limited payment requests in terms of economic rent – tailored financing schemes have to be developed.

But retrofitting of buildings is not only influenced by the financing of the retrofitting measures. The financing is only part of a large scale of influencing factors (e.g. location, current condition of the building, market situation). The portfolio-management is an approach to make fundamental decisions about the future of a building.

If a decision to retrofit a building is made different variants of retrofitting measures have to be compared on their cost-usage outcome. Economic efficiency calculation is a common check for financing measures. This report has the aim to develop a standardized calculation tool based on economic efficiency calculation methods to facilitate the financing of energy efficient retrofitting of social housings or to create incentives for further promotion of investments in energy efficient retrofitting.

Already existing financial support programmes and further incentive programmes will be introduced to gain an overview of the actual state of the promotion of energy efficient retrofitting measures. The conclusion of this work package will be proposals for the development of improved tailored incentive programmes for the energy efficient retrofitting of social housing.

2 Strategic approach in the Portfolio-Management

An analysis of a building always depends on the perspective in which it is examined. The constructional, social, economic and market factors vary from perspective to perspective. The following figure shows some possible perspectives, their connections and the facts examined in each particular perspective. For example the demographic development is a regional fact while the technical quality can only be examined on a component level.

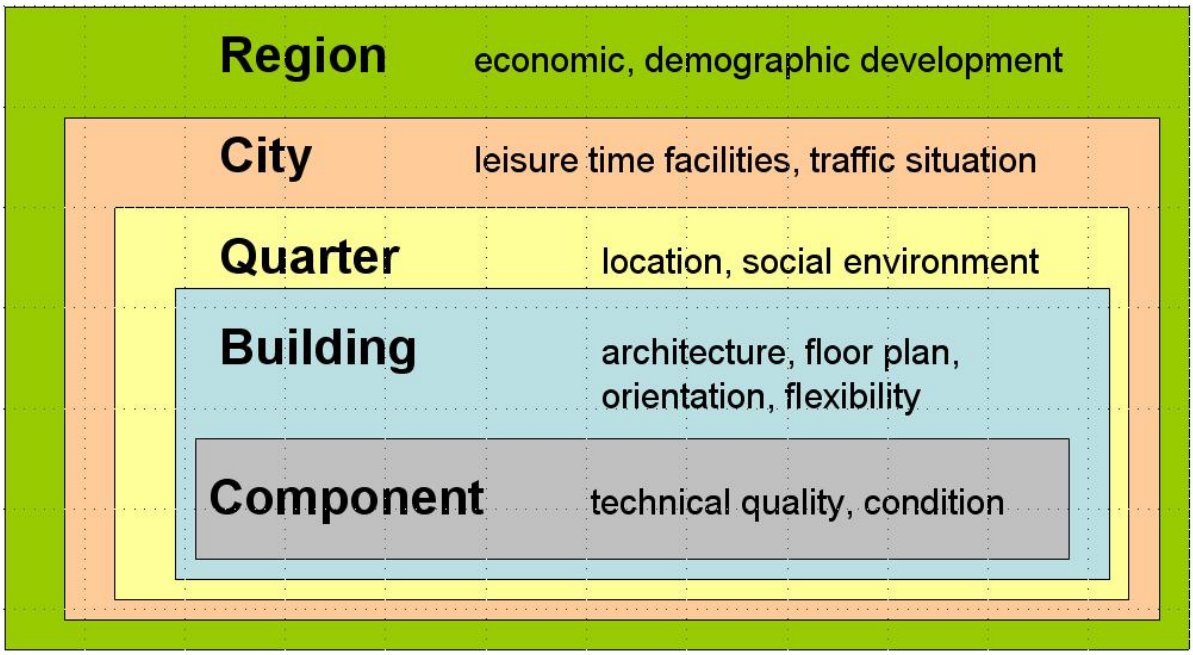

Figure 1: Perspectives for an inventory analysis

A proper analysis of the actual condition of a building or building complex can be achieved with the 7-phase-modell detailed in the next chapters.

This model consists of seven phases beginning with the early detection of a retrofitting need and ending with the postprocessing of the energy efficient retrofitting measures in form of lodger events, documentation, last removal of defects and finally the adaptation of the rents due to the modernisation measures.

	Phase 1 Early Detection	Phase 2 Inventory & Analysis	Phase 3 Aims & Options	Phase 4 Concept & Measures	Phase 5 Preparation	Phase 6 Implementation	Phase 7 Postprocessing
Ebene 1 - Housing Industry	Warning systems Strategic Orientation	Housing Industry Portfolio Analysis	Aim Definition	Concept Development	Lodger Information	Lodger Mentoring	Lodger Events
Ebene 2 - Planning Measures		Technology	Options	Standards Measures		Construction Logistics	Documentation Removal of Defects
Ebene 3 - Economic Efficiency			Decision Process	Investment appraisal Financing, Support			Adaptation of Rents

Figure 2: Structure and subdivision of the 7-phase-modell

2.1 Phase 1 – Early Detection

Early Detection

Initial point and motive for a modernisation and an investment decision are normally existing or looming constructional and/or housing industrial needs for action in housing estates. Therefore it is necessary to develop an adequate instrument to detect these needs in an early state.

Possible steps could be:

- Continuing recordal of the technical condition (recordal of damages and defects), e.g. within the running building cultivation
- Continuing controlling of the central parameters of the building cultivation (e.g. vacancy, fluctuation, operational costs)

Aims and benefit:

- Early recognition of technical and housing industrial needs of action
- Possibility of an early action instead of a afterward reaction

Strategic Orientation

Before the beginning of a modernisation process it seems to be reasonable to determine a first strategic orientation for the preparation and guidance of the following steps. Therefore future scenarios and visions of the living quarters should be developed and the target groups should be determined. These ideas can be used as foundation and orientation for the further steps.

Possible steps could be:

- Analysis of the technical and housing industrial data received through the early detection system
- Intra-corporate information exchange between the departments building services, building cultivation and management of the company concerning existing and looming needs of action in the living quarters
- Notice of communal development aims for the relevant quarters
- Limitation of the strategic actions. Identification of the possible scenarios and options (modernisation, demolition/new building, disposition)
- Determination of aims (e.g. target groups) and development of a first building industrial action concept

Aims and benefit:

- Early orientation and focus of the modernisation process
- First housing industrial concept
- Efficient usage of financial and personal resources

2.2 Phase 2 – Inventory & Analysis

Building Industrial Inventory

A practical housing industrial inventory include central housing industrial indicators as fluctuation, vacancy and rent outfall as well as the structure of the lodgers (e.g. size of the household, percentage of foreigners, age, job and income). The knowledge of the structure of the lodgers and their wishes is one of the most important parameters for the planning and implementation of modernisation measures. The success of a modernisation measure depends on the acceptance by the lodgers which is influenced by the structure and composition of the lodgers especially in tall connected housing estates.

Possible steps could be:

- Determination of the planned volume, the degree of detailing and the expanse of the housing industrial inventory
- The corporate-own data, the object-linked information about the inventory should be the starting point and should be collected in a database
- Completion of the internal data with central location factors and market information
- A first structuring of the inventory based on the collected data

Aims and benefit:

- Recordal of central housing industrial indicators of the existing inventory
- Detection of housing industrial needs of action
- Knowledge of the wishes and needs of the lodgers
- Hints on necessary modernisation measures

Housing market and Target Group Analysis

The retrofitting measures for the existing building inventory are increasingly oriented at the local housing market. Therefore a good knowledge of the local housing market and of other relevant markets as well as a prognosis of the future development of the housing market is essential. In a long-term observation housing trends and changes in the economic or social parameters have to be considered.

Possible steps could be:

- Analysis of the housing market
- A specific examination of the potential of the target group
- A trend analysis/prognosis

Aims and benefits:

- Quantitative and qualitative assessment of the asking of housings including the wishes of today's and future target groups
- Determination of priorities on need specific modernisation measures
- Orientation and adaptation of the modernisation measures to the actual and future askings
- Foundation for decisions to need specific modernisation measures
- Prevention of investment failures

Technical Inventory

A practical technical inventory should include the sectors dwelling, building and living environment. The inventory should be based on the first strategic orientation with its determined housing industrial aims of the development of the inventory.

Possible steps could be:

- Determination of the planned volume, the degree of detailing and the expanse of the housing industrial inventory
- The corporate-own data, the object-linked information about the inventory should be the starting point and should be collected in a database
- Completion of the internal data with central location factors and market information
- Continuous visit of the building to record the constructional condition
- Measurement and digitalisation of the object plans

Aims and benefits:

- Detection of the constructional and urbanistic qualities of the building inventory
- Detection of the constructional and urbanistic needs of action
- Evaluation of the urgency of necessary maintenance or modernisation measures
- Determination of the influencing factors of the building inventory

Portfolio-Analysis

Requirement of a need specific modernisation is a detailed housing industrial and constructional evaluation of the existing building inventory. A portfolio analysis can de used as a foundation for such an evaluation.

A portfolio analysis allows a localisation of detailed needs of action and development potentials of the inventory. The economic performance of the building inventory will be displayed. Considering risk and profit aspects superior portfolio strategies can be determined and concrete action commendations can be developed. A portfolio analysis allows the identification of the inventory which is adequate to a modernisation due to its object specific and location specific potentials.

Criteria for a market specific building evaluation can be:

- Object specific competition advantages
- Location specific market attractiveness

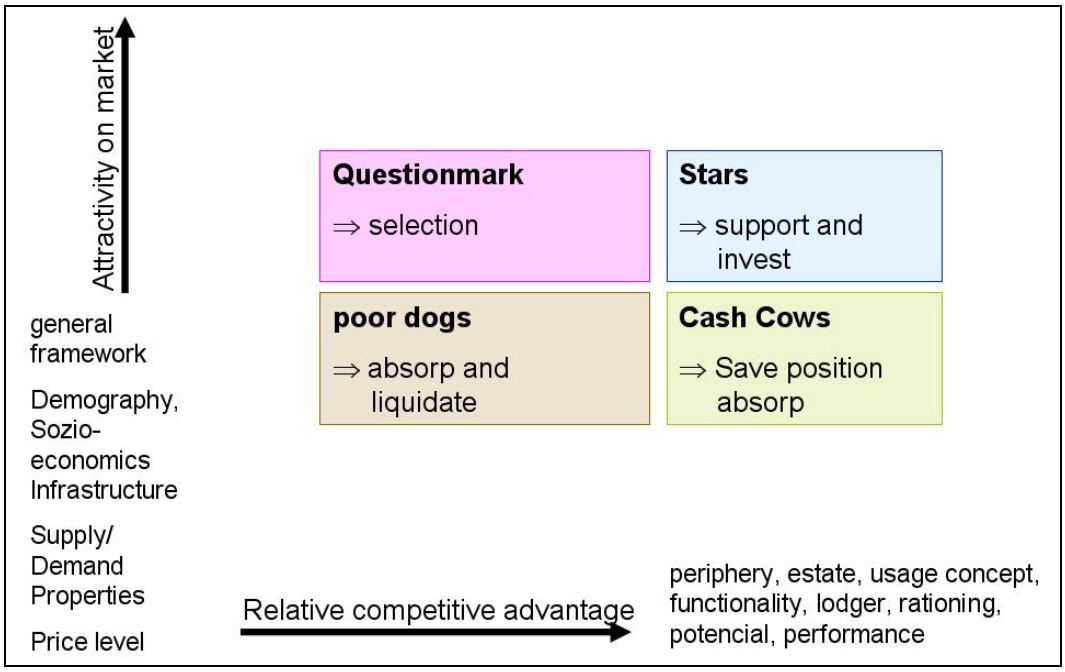

Figure 3: A possible classification of the inventory

Possible steps could be:

- A portfolio analysis with already existing and easily achievable data
- The different options and strategies have to be verified on the basis of the inventory
- A decision is not possible before a comparison of variants has shown that the implementation is technically and economically possible.

Aims and benefit:

- Creation of a standard analysis structure and of a database for the evaluation of the inventory
- Division of the inventory in specific parts based on object, location and market criteria
- Evaluation of the middle and long-term market performance
- Identification of problems of the inventory
- Determination of options and investment strategies

2.3 Phase 3 – Aims & Options

Aim definition

Starting point for the development of a need specific modernisation strategy should be the definite determination of the aims which shall be achieved with the modernisation. Requirement for a target-oriented investment decision is a vision of the future of the inventory (what and which target group will the modernisation include).

Possible steps could be:

- Determination of superior corporate aims of the modernisation
- Differentiation of the development aims inside of the building inventory
- Determination of objective, areal and temporal priorities

Aims and benefits:

- Foundation for a target-oriented investment strategy
- Target-oriented action options
- Definite determination of priorities

Options

Based on definite target settings principally possible action options can be identified and their feasibility and economic efficiency can be verified and evaluated. Future investment decisions can be made along with an accurate evaluation of the different action variants. The options should be differentiated between the various parts of the inventory.

Possible steps could be:

- Identification and Evaluation of options (perpetuation actual condition, part or complete modernisation, demolition with or without new construction, disposition)
- Development of different alternative concepts
- Technical and economic verification of the different options
- Evaluation and election of the opitions

Aims and benefits:

- Identification and evaluation of possible options
- Funded decision basis
- Economic sustainable investment decisions

Internal decision process

An integrated corporate internal decision process is an essential requirement for a need specific modernisation. The different departments should be connected so that housing industrial and technical requirements are considered and the needs of action are known as early as possible.

Possible steps could be:

- Identification of needs of action and investment needs in the departments technology, tenancy and rationing
- Creation of a list of ideas for essential investments
- Creation of a working team with members of all departments
- Short, middle and long-term investment planning with definite priorities
- Investment and modernisation decision
- Regular monitoring and adaptation of the investment planning

Aims and benefits:

- Early reaction to looming problems and needs of action
- Corporate internal coordination of the departments technology, tenancy and lodger mentoring
- Definite priorities
- Need specific investment planning
- Efficient coordination process

2.4 Phase 4 – Concept & Measures

Concept development

Is a decision towards a modernisation made a definite action concept has to be developed for the implementation of the modernisation. The concept should include the amount and the way of the modernisation. A decision between three modernisation strategies has to be made:

- A complete modernisation
- A part modernisation
- A repair-only modernisation

Possible steps could be:

- Determination of the whole extent and volume of the planned modernisation measures
- Development of an urbanistic development concept
- Areal and temporal priorities and focal points
- Definition of measure packages
- Determination of the implementation phases

Aims and benefits:

- Practical action framework for the corporate own inventory
- Coordination of the single measures

Planning requirements and standards

Following the determination of the superior modernisation concept the economic framework and the wanted technical standards have to be defined.

Possible steps could be:

- Definition of technical standards and cost limits for each maintenance group
- Differentiation of the quality standards depending on location an target group
- Election of the furniture standard by the lodgers

Aims and benefits:

- Precisely definite technical standards and cost limits
- Quality assurance

Measures

In a modernisation concept definite measures or measure packages and their temporal succession have to be determined. The coordination of measure packages is necessary to achieve a preferably efficient implementation.

Investment calculation

Phase 4 is the time point when different variants will be compared by their cost-benefit-proportion. The foundation for the evaluation of the measures is the investment calculation. In this chapter only the steps and the aims and benefits of an investment calculation will be described. The static and dynamic methods of an investment calculation or economic efficiency calculation will be explained in chapter 3.

Possible steps could be:

- Election of a fitting calculation method
- Collection of the necessary data
- Implementation of the investment calculation
- Summary and evaluation of the calculation results

Aims and benefits:

- Verification of the economic efficiency of the planned modernisation measures
- Comparison of different investment variants
- Founded basis for an investment decision

Financing and support

In the context of the financing of the modernisation measures it has to be searched for fitting support programmes. Besides own capital public support programmes can be used to finance the energy efficient modernisation of social housing. The already existing programmes will be described in chapter 4.

Possible steps could be:

- Triage of different support programmes
- Check of the linked requirements and frameworks
- Consideration if support programmes linked to bonds shall be called on

Aims and benefits:

- Securing the financing needs
- Usage of the existing support programmes
- Securing the corporate action possibilities

2.5 Phase 5 – Preparation

The preparation phase includes the information and the participation of the lodgers in the modernisation process. –Modernisation measures are often linked to grave disturbances of the lodgers. To achieve the acceptance of the measures anyhow an intensive and systematic information and participation of the lodgers is essential. The possibility for lodgers to influence the modernisation process or to choose between various single measures can strengthen the acceptance of the lodgers towards the modernisation process.

The extent and the content of the public relations depend on the planned measures and their linked disturbances as well as the lodger structure. A pyramid-formed lodger information starting with common

information for all lodgers and ending with the individual consultation of single lodgers seems to be a fitting method to prepare the modernisation process.

Possible steps could be:

- A prematurely as possible information of the lodgers about the planned modernisation
- A statutory announcement of the modernisation measures three months before the beginning of the work
- Invitation to an information event about the modernisation measures
- Implementation of lodger assemblies
- Additional consultation-hours for the lodgers and visits to the lodgers
- Construction of a dwelling example
- Lodger interviews concerning their wishes

Aims and benefits:

- Early information and participation of the lodgers
- High acceptance of the modernisation measures
- Prevention of objections and claims concerning the reduction of the rent by the lodgers
- Long-term improvement of the living satisfaction

2.6 Phase 6 – Implementation

Lodger mentoring

A need specific modernisation requires a systematic and intensive mentoring of the lodgers during the implementation of the modernisation measures. Two cases have to be differentiated: the modernisation in an inhabited condition and the modernisation in a vacant condition.

Possible steps in an inhabited condition could be:

- Allocation of staff members for a continuing mentoring of the lodgers in the corporation and at the site
- Definite nomination of contact persons for the lodgers
- Early date agreement with the lodgers
- Allocation of toilet and washing containers for the inhabitants
- Additional mentoring offers and services
- Financial equation of the lodgers for the disturbances during the modernisation process

Possible steps in a vacant condition could be:

- Allocation of relocation management for the coordination of the moves of the lodgers and to support the lodgers
- Vacant dwellings should be kept free in an early state so that they can be used as ersatz dwellings
- Building or block-wise vacancy of the dwellings
- Removal of the lodgers in the modernised dwellings

Aims and benefits:

- Presence of the corporation on-site
- Minimisation of the stress and disturbances for the lodgers
- High acceptance of the modernisation measures
- Improvement of the communication between the corporation and the lodgers as well as the strengthening of the neighbourhood feeling

Construction and logistics

The implementation of modernisation measures especially in an inhabited condition demands high requirements from the corporation and from the implementing companies. The way of the implementation highly influences the acceptance of the modernisation by the lodgers and therefore plays an important role.

Possible steps could be:

- Election of in modernisation experienced companies due to a bidding with a following placing
- Exact planning and time specifications for the implementing companies
- Early date agreement with the lodgers

Aims and benefits:

- A qualitative and cost fitting implementation of the modernisation measures on schedule
- Minimisation of the stress and disturbances for the lodgers
- High acceptance of the modernisation measures

2.7 Phase 7 – Postprocessing

Documentation and removal of deficiencies

After the end of the constructional part of the modernisation measures a technical and business economical finishing operation as well as the removal of deficiencies has to be carried out. The documentation of the modernisation measures offers the opportunity to compare planning aims with the implemented measures and an evaluation of the planning and implementation due to a technical and housing industrial analysis. Therefore conclusions for future projects can be taken.

Possible steps could be:

- Technical and housing industrial documentation of the modernisation measures
- Final acceptance and deficiency protocol
- Short-term removal of deficiencies
- Continuing documentation of arising deficiencies

Aims and benefits:

- Complete documentation of the modernisation measures
- Securing of warranty claims
- Planning foundation for future modernisation projects
- Fast removal of deficiencies
- Dwellings free of defects

Lodger events

The modernisation of dwellings is always linked to disturbances of the lodgers. To get a successful completion of the modernisation the end of the construction works should be celebrated e.g. in form of a lodger festivity together with the inhabitants.

Possible steps could be:

- Participation of the lodgers in planning and implementation
- Early invitation to the lodger festivity of lodgers, neighbours and of the press
- Implementation of the lodger festivity
- Corporate-internal documentation of the lodger festivity e.g. in a lodger journal

Aims and benefits:

- Strengthening of the togetherness between the lodgers
- Increase of the acceptance of the implemented modernisation measures
- Positive presentation of the corporation

Adaptation of the rents

The completion of a modernisation – in combination with the removal of deficiencies – is the necessary adaptation of the rents. Precondition for the adaptation is the finishing of the constructional works. The possible extent of the adaptation of the rents is limited by legal demands and the market situation. A written declaration of the rent adaptation is needed so that the validity of the rent adaptation is secured two months after this declaration. The written declaration should be as detailed as possible and it should be adapted to the single lodger so that the adaptation can be reconstructed by the lodger.

3 Explanation of basics and economic efficiency calculation

3.1 Types of payment and interest rate for costing purposes

Dynamic methods of economic efficiency calculation shall reflect the effect of interest rates as exactly as possible. Therefore payments (out as well as in) and their specific interest rates have to be taken into account. The following chapters explain the terms and formula and give practical examples.

3.1.1 Capital-linked payments

Capital-linked payments imply all amounts of investment (one-off as well as periodically entered). The amount of investment at the beginning is represented by the symbol A_0. If periodic payments A_K are not available as annual costs they can be calculated with the following formula:

$$A_K = f_K \bullet A_0 \qquad [€/\text{period}] \qquad \text{(Gl. 1)}$$

with: f_K [%] factor for determining the periodic maintenance payments as a percentage of the investment amount per year

The total amount of capital-linked payments is equal to the sum of investments at the beginning and the periodically entered payments for repairs or maintenance.

Practical examples of capital-linked one-off payments are investments in new energy efficient CHPSystems, boilers or heating distribution systems. Periodic capitel-linked payments are all payments concerning repair aund maintenance.

3.1.2 Consumption-linked payments

Consumption-linked payments A_V include all costs for main energy, auxiliary energy and operating materials. The energy consumption of all energy types has to be multiplied with the specific energy price to receive the annual costs for consumption-linked payments. The formula is as follows:

$$A_V = \sum \left(k_Q \bullet Q + k_A \bullet A + k_B \bullet B \right) \qquad [€/\text{period}] \qquad \text{(Gl. 2)}$$

with:

	k_Q	[€/kWh]	main energy price
	Q	[kWh/period]	main energy consumption
	k_A	[€/kWh]	auxiliary energy price
	A	[kWh/period]	auxiliary energy consumption
	k_B	[€/unit]	price of operating materials
	B	[unit/period]	consumption of operating materials

Consumption-linked payments are for example composed of costs for fuel, oil, gas as energy and water , lubricating and cleaning materials as operating materials.

3.1.3 Operation-linked payments

Operation-linked payments A_B consist of individual amounts and/or percentage of the investment amounts for operating, cleaning, servicing, inspection, customer service, tank cleaning and inspection, fees, controls, accounting or other operation-linked payments. The following formula describes the composition of the operation-linked payments:

$$A_B = f_B \bullet A_0 + \sum G \qquad [€/period] \qquad \text{(Gl. 3)}$$

with:	f_B	[%]	factor for operation-linked payments as a percentage of the investment amount per year
	A_0	[€]	investment amount at the beginning
	G	[€/period]	individual amounts for operation-linked payments

3.1.4 Financing payments

The cost center financing payments consists of all payments due to financing by borrowing. Besides repayments and interest payments during the credit period handling charges of all kinds have to be integrated if they are not considered in the repayments.

There are two different kinds of capital repayment. First the annuity credit and second the credit repayable by instalments. Annuity credit means that during the whole credit period instalments of the same extent are paid. The annuity factor a_{FK} is calculated with the following formula:

$$a_{FK} = \frac{i_{FK} \bullet (1+i_{FK})^{TF}}{(1+i_{FK})^{TF} - 1} = \frac{i_{FK}}{1-(1+i_{FK})^{-TF}} \qquad \text{(Gl. 4)}$$

with:	i_{FK}	[%]	interest rate to be paid for borrowed capital
	TF	[period]	credit period

The annual instalment for servicing the borrowed capital A_{FK} is then:

$$A_{FK} = FK \bullet a_{FK} \qquad \text{(Gl. 5)}$$

with:	FK	[€]	credit amount

By financing the investment with a credit payable by instalment the instalments vary during the credit period. The annual repayment part is the same during the whole period while the interest payments become less due to the reduction of the residual debt. The repayment R_{FK} is calculated by the following formula:

$$R_{FK} = \frac{FK}{TF} \qquad [€] \qquad \text{(Gl. 6)}$$

with:	FK	[€]	credit amount
	TF	[period]	credit period

The interest payment I_{FKt} is calculated from the borrowed capital reduced by the repayments:

$$I_{FKt} = FK \bullet \left(1 - \frac{t-1}{TF}\right) \bullet i_{FK} \qquad [€] \qquad \text{(Gl. 7)}$$

with:			
	FK	[€]	credit amount
	TF	[period]	credit period
	i_{FK}	[%]	interest rate to be paid for borrowed capital
	t	[-]	period (1,2,…,TF)

The total annual amount of payments for the credit repayable by instalments is the sum of repayment and the interest payment:

$$A_{FK} = R_{FK} + I_{FKt} \qquad [€] \qquad \text{(Gl. 8)}$$

3.1.5 Other payments

Besides the above listed payments further payments in consequence of the investment can occur. These further payments are designated as other payments A_S. This type of payment includes insurance costs, general outgoings, taxes and proportionate administrative disbursements. Similar to the operation-linked payments the other payments can consist of individual amounts and/or percentages of the investment amounts.

$$A_S = f_S \bullet A_0 + \sum G \qquad [€/\text{period}] \qquad \text{(Gl. 9)}$$

with:			
	f_S	[%]	factor for operation-linked payments as a percentage of the investment amount per year
	A_0	[€]	investment amount at the beginning
	G	[€/period]	individual amounts for operation-linked payments

3.1.6 Lodgements

Lodgements describe possible savings during the utilization of the investment object as well as liquidation proceeds at the end of the service life. Lodgements can be capital-linked, consumption-linked, operation-linked savings or the savings can be allocated to one of the other cost centers. The liquidation proceeds are an example of capital-linked lodgements where as energy savings or energy feed-ins are consumption-linked lodgements. Investment grants and premiums as well as investment subsidies can be described as financing lodgements while lodgements from rents can be indicated as operation-linked lodgements.

The calculation of the lodgements is the same as the calculation of the payments depending on the type of cost center. To receive the proper total amount of profit or loss the lodgements have to be set against the payments.

3.1.7 Change rates for payments

Dynamic economic efficiency calculation has the aim to reflect the effect of interest rates and price changes during the service life of the object as exactly as possible. Therefore change rates for the different payments have to be included in the financing tool.

The payment change rate *j* indicates the percentage by which the payment ascends or descends compared to the previous period during the assessment period. The course of the price change has an exponential pattern so that the determination of the price change has to be painstakingly estimated. Price developments from the past cannot be directly transferred to the future. The change rate has to be individually determind for each payment.

3.1.8 Interest rate for costing purposes

The interest rate could be interpreted as a comparison interest rate. It is needed for calculating cash and capital values or for discounting interests on payments.

3.2 Economic efficiency calculation methods

For the determination of economic efficiency of investments many different approaches are possible. This report is restricted to the application of two common calculation methods with different outcomes: on the one hand the annuity method with annual average payments as basis and on the other hand the capital value method with the capital value as sum of all payments discounted at the initial time point.

3.2.1 Annuity method

The annuity method is based on the transformation of non-periodic and periodic payments with changing amounts over an assessment period into constant periodic payments. Due to this procedure is it possible to sum up all types of payment even if they occur in various periods. To receive annual average payments over the assessment period an annuity factor *a* is calculated for each payment with the following formula:

$$a = \frac{q^T \bullet (q-1)}{q^T - 1} = a(q,T) \qquad \text{(Gl. 10)}$$

with:	q	[%]	interest factor
	T	[a]	assessment period

This annuity factor is needed to generate the annuity of non-periodic investments and to calculate a price-dynamic annuity factor for periodic payments which also integrates the cash value factor to mirror the changes over the assessment period as exactly as possible. The formula for the cash value factor *b(T,q,r)* is as follows:

$$b(T,q,r) = \frac{1-\left(\frac{r}{q}\right)^T}{q-r} = \frac{1-\left(\frac{1+j}{1+i}\right)^T}{i-j} \qquad r \neq q \qquad \text{(Gl. 11)}$$

$$b(T,q,r) = \frac{T}{q} = \frac{T}{1+i} \qquad r = q \qquad \text{(Gl. 12)}$$

with	q		interest factor ($q = 1+i$)
	r		price change rate ($r = 1+j$)
	T	[a]	assessment period

The price-dynamic annuity factor *ba* is the result of the multiplication of cash value factor and annuity factor:

$$ba = b(T,q,r) \bullet a(q,T) \qquad \text{(Gl. 13)}$$

To calculate the exact annuity of an one-off investment a possible residual value must be taken into account. There for a residual value factor R is calculated with the following formula:

$$R = \frac{TN - T}{TN} \bullet q^{-T} \qquad \text{(Gl. 14)}$$

with: T [a] assessment period
TN [a] service life

Based on this factor the residual value of an investment at the start of the assessment period is as follows:

$$RW = R \bullet A_0 \quad [€] \qquad \text{(Gl. 15)}$$

with: A_0 [€] amount of investment

Combining the annuities for non-periodic and periodic investments will result in the total annuity of capital-linked disbursements. The annuity of one-off payments is calculated with this formula

$$AN_I = A_0 \bullet (1 - R) \bullet a \quad [€/a] \qquad \text{(Gl. 16)}$$

while the annuity of periodic payments is calculated in the following way:

$$AN_P = f \bullet A_0 \bullet ba \quad [€/a] \qquad \text{(Gl. 17)}$$

So the sum of both is the total amount of capital-linked payments:

$$AN_K = A_0 \bullet (1 - R) \bullet a + f \bullet A_0 \bullet ba \quad [€/a] \qquad \text{(Gl. 18)}$$

Except of the capital-linked payments all other cost centers consist only of periodic payments so that just the amount of investment is replaced by the specific costs for each payment either through a percentage of the investment in the beginning or through an payment for the specified cost center.

$$AN_X = f_X \bullet A_0 \bullet ba_x \qquad \text{(Gl. 19)}$$

$$AN_X = A_X \bullet ba_X \qquad \text{(Gl. 20)}$$

with: f_X [%] factor for payments as a percentage of the investment amount per year
ba_X price-dynamic annuity factor for payments
A_X [€] specific payment
X=V,B,S,E,F

The annuity for lodgements is calculated the same as the payments so that the total annuity is the result of the following formula:

$$AN = AN_E - (AN_K + AN_V + AN_B + AN_S + AN_F) \quad [€/a] \qquad \text{(Gl. 21)}$$

with:			
	AN_E	[€/a]	Annuity of the lodgements
	AN_K	[€/a]	Annuity of the capital-linked payments
	AN_V	[€/a]	Annuity of the consumption-linked payments
	AN_B	[€/a]	Annuity of the operation-linked payments
	AN_F	[€/a]	Annuity of the financing payments
	AN_S	[€/a]	Annuity of the other payments

3.2.2 Capital value method

With the capital value method all payments are discounted or added the accrued interest at the initial time point. The capital value *K* is equal to the sum of all discounted payments at the initial time point t_0 reduced by the initial amount of investment and represents the surplus yielded by an investment at the beginning of the assessment period.

$$K = -A_0 + \sum_{t=1}^{T} \frac{E_t - A_t}{q^t} \quad [€] \qquad \text{(Gl. 22)}$$

with:			
	A_0	[€]	amount of investment
	T	[a]	assessment period
	t	[-]	period (1,2,…,TN)
	E_t	[€]	lodgement at the end of period *t*
	A_t	[€]	payment at the end of period *t*
	q^t	[%]	accrued interest factor

The sum of all discounted payments wihtout the initial investment is called cash value *B*.To receive a calculation appropriate to practical economy efficiency evaluation price-dynamic payment sequences have to be considered. To integrate price-dynamics a cash value factor *b(T,q,r)* is calculated with the following formulas:

$$b(T,q,r) = \frac{1-\left(\frac{r}{q}\right)^T}{q-r} = \frac{1-\left(\frac{1+j}{1+i}\right)^T}{i-j} \qquad r \neq q \qquad \text{(Gl. 11)}$$

$$b(T,q,r) = \frac{T}{q} = \frac{T}{1+i} \qquad r = q \qquad \text{(Gl. 12)}$$

with			
	q		interest factor ($q = 1+i$)
	r		price change rate ($r = 1+j$)
	T	[a]	assessment period

The cash value is according to these formulas:

$$B = Z \bullet b(T, q, r) \qquad \text{(Gl. 23)}$$

with: Z [€] first payment

Formula 23 describes the cash value if the components have all the same service life and the same acquisition time point. If the various components have different life times and acquisition time points a substitute value has to be calculated which considers the residual values and adjusts the components to a common assessment period. The adjustment factor *f* is calculated with the following formula:

$$f = \frac{b(T - t_k, q, r)}{b(TN, q, r)} \qquad \text{(Gl. 24)}$$

with : $b(T\text{-}t_K,q,r)$ cash value factor for later acquisation
$b(TN,q,r)$ cash value factor for service life

Formula 24 can also be used for acquisitions at the beginning of the assessment period due to the fact that t_K is then 0 and the assessment period is fully considered.
According to the above elucidated formulas the cash value is calculated as follows:

$$B = f \bullet \frac{A_0}{q^t} = \frac{b(T - t_K, q, r)}{b(TN, q, r)} \bullet \frac{A_0}{q^t} \qquad \text{(Gl. 25)}$$

The capital value is the outcome of the cash value reduced by the initial investment:

$$K = -A_0 + B \qquad [€] \qquad \text{(Gl. 26)}$$

The economic efficiency of an investment can be immediately determined from the equation 26. If *K* is positiv the investment generates a profit. If *K* is negativ the investment will end in losses and is not worthwhile. *K*=0 is the limiting value between economic efficiency and economic inefficiency.

3.2.3 Amortisation method

The amortisation of a measure can be calculated in two ways a static and a dynamic one. The static calculation of the payback period does not consider the interest and price change rates. It simply sets the investment cost off against the energy cost savings and calculates the payback period.
The following formula describes the static amortisation method:

$$Payback\_period = A_O / ES \qquad \text{(Gl. 27)}$$

with: A_0 [€] amount of investment
ES [€] energy cost savings

The dynamic amortisation method considers the price change rates and the price change factor for energy costs so that the measure can be investigated for an assessment period or for the duration of the service life of a measure.

The dynamic amortisation method uses the following formula to calculate the payback period considering future developments in the financial and energy market:

$$Payback\_period = \frac{\log((1-\frac{A_0 * q}{ES}) * (1-\frac{r}{q}))}{\log(\frac{r}{q})} \qquad \text{(Gl. 28)}$$

with:

A_0	[€]	amount of investment
ES	[€]	energy cost savings
q		interest factor ($q = 1+i$)
r		price change rate ($r = 1+j$)

3.3 Sensitivity analysis

Economic efficiency criteria depend on parameter changes. The sensitivity analysis serves for the determination to what extent parameter changes change the results of the economic efficiency calculation. There for this analysis can be used for risk assessment and risk reduction.

To realise a sensitivity analysis it is needed to determine critical values of the following parameters:

- Lodgements *E**
- Disbursements *A**
- Price increase rates *j**
- Interest rate for costing purposes *i**
- Service life *TN**
- Assessment period *T**

Further it is necessary to determine risk classes to which the investment objects are assigned. Possible risk classes could be the following:

- Largely without risk
- Limited risk whereby invested capital is not lost ±0
- Incorporating substantial risk

The risk classes and the critical parameters as well as fluctuation ranges have to be determined by the investor. Basically the limitations are determined of the upper and lower interval limits of the economic criterion and its optimum conditions:

$$K \geq 0 \qquad AN \geq 0 \qquad i_m \geq i$$

The assignment of objects to risk classes can be simplified by the use of decision tables. A possible decision table might look like this:

			1st Sr	*2nd SR*	*3rd SR*	*4th SR*	*5th SR*
Condition part		*1st RC relative*	Y	-	Y	-	-
	1st C	*2nd RC future*	-	Y	-	Y	-
		3rd RC anticipated E	-	-	-	-	Y
		1st RC relative	Y	-	Y	-	-
	2nd C	*2nd RC future*	-	Y	-	Y	-
		3rd RC anticipated j_E	-	-	-	-	Y
		1st RC relative	Y	Y	-	-	-
	3rd C	*2nd RC future*	-	-	Y	Y	-
		3rd RC anticipated A	-	-	-	-	Y
		1st RC relative	Y	Y	-	-	-
	4th C	*2nd RC future*	-	-	Y	Y	-
		3rd RC anticipated j_A	-	-	-	-	Y
		1st RC relative	Y	Y	-	-	-
	5th C	*2nd RC future*	-	-	Y	Y	-
		3rd RC anticipated i	-	-	-	-	Y
Action part	*1st A*	*Acceptable risk because a positiv economic result is to be expected*	X				
	2nd A	*Still risk-acceptable because at most interest loss is anticipated*		X	X		
	3rd A	*High risk due to interest losses but no capital investment losses are expected*				X	
	4th A	*Unacceptable high risk because losses of capital investment are also anticipated*					X

Tabelle 1 Decision Table. VDI 6025.

If various objects come out of this decision table with the same result and there cannot be determined which investment should be made the amortization duration can be used as a further risk factor. The calculation of amortization duration is not part of this report since it is not adequate to calculate the economic efficiency of energy efficient retrofitting of social housings.

3.4 Guideline for the application of the developed calculating tool

3.4.1 Input parameter tables

The input parameter tables for payments and lodgements serve as an acquisition of all parameters needed to calculate the capital value as well as the annuities. With one table for payments and one for lodgements all parameters are collected at once and all calculations use these data and so are based on the same parameters.

There are four general parameters which count for all calculations. The rate of interest for costing purposes *i* has to be exactly considered. Normally there will be a common rate used for all economic efficiency calculations defined by economic experts. The assessment period *T* can be chosen individually according to the particular decision strategy. The length of period can be determined as year, half year, quarter year or month. It would be reasonable to use an annual period for the economic calculation of retrofitting measures in the social building sector. To calculate the economic rent the input of the total living area in m² is needed. The above mentioned parameters are entered only once for both payments and lodgements.

	A	B	C	D	E	F	G
1	**General parameters**						
2							
3	rate of interest for costing purposes [%/period]	i =			Living area according to II.BV		
4	Assessment period [period]	T =					
5	Length of period (e.g.: year, half year, quarter year, month)						
6							
7	**Payments**						
8							
9	**Capital-linked payments**		Measure 1	Measure 2	Measure 3	Measure 4	Measure 5
10	**Investment amounts**						
11	Amount of payment when due [€]	A_0 =	0	0	0	0	0
12	Due after t_K periods	t_K=	0	0	0	0	0
13	Price change rate [%]	j =					
14	Service life [a]	TN =	1	1	1	1	1
15	parameters are needed for each measure						
16	tool must be expanded individually for each measure						
17							
18	**Payments for repairs**						
19	Amount of payment when due [€]	A_0 =					
20	proportion of the investment	f_K =					
21	Due after t_K periods	t_K=					
22	Price change rate [%]	j =					
23	Service life [a]	TN =	1	1	1	1	1
24	parameters are needed for each measure						
25	tool must be expanded individually for each measure						
26							
27	**Consumption-linked payments**						
28	**Energy consumption payments**						
29	Amount of payment when due [€]	A_0 =					
30	Due after t_K periods	t_K=					
31	Price change rate [%]	j =					
32	Service life [a]	TN =	1	1	1	1	1
33	parameters are needed for each energy type						
34	tool must be expanded individually for each energy type						

Figure 1 exemplary section of the input parameter table for payments

All other parameters are to be entered seperatly for lodgements and payments. Basically for all cost centers the same parameters are needed. The only exception are the financing costs but the especially needed parameters will be explained later in this chapter.

The input parameter tables are structured according to the types of payments and lodgements as capital-linked, consumption-linked and so on. This structure is ought to simplify the acquisition of the payments and lodgements. At the moment for each cost center ten measures can be entered. If it is necessary the tables and calculation sheets can be expanded individually. In the consumption-linked sector there are some lines with a gray background. These disbursements and lodgements can occur but they are not considered in the calculation sheet jet. If these matters of expense appear they can be considered as a measure of energy consumption payments or as a reduction of energy costs, otherwise the calculation sheets have to be expanded.

The approaches for the acquisition of lodgements and payments are the same. For each measure regardless of capital-linked, consumption-linked, operation-linked or other payments the amount of the investment A_0 is needed either as a total amount for the measure or as a percentage of the initial amount of investment f_K. The time point when the investment is due t_K has to be acquired likewise to consider the discounting of the investment to the initial timepoint of the assessment period. The price change rate j is not a common rate for all cost centers, for each measure this rate can be different. Price change rates can be assumed from economic studies to the appropriate measure. To calculate residual values the length of the service life *TN* has to be acquired. The consideration of different service lifes is necessary to exactly determine the cash values and annuities of the investment. For annual costs or lodgements the service life is 1. The value for the service life has always to be 1 or higher because without value or with 0 as value the formulas in the calculation sheets do not function due to a division by 0.

The necessary input parameters for capital-linked, operation-linked, consumption-linked and other values are explained above. Only the financing payments need further parameters to be considered exactly. The financing of retrofitting measures can be done with borrowed capital or own capital or a mixture of both. The insertion of own capital is considered with the rate of interest for costing purposes. Additionally needed capital can be borrowed on many different ways. It can be one credit or the investment amount can be composed of multiple credits. Each credit can have an own financing rate and credit period especially if it is a state-aided credit. Due to these facts the financing amount *FK*, the financing rate i_{FK} and the credit period T_{FK} have to be acquired for each credit in addition to service life, price change rate and time point when the investment is due.

3.4.2 Economic efficiency calculation tool

The calculation tool calculates the annuity of an investment as well as the capital value of the same investment. Besides the two input parameter tables it consists of three other sheets. One sheet is the calculation table for the annuity method and the other two calculate the payments and lodgements needed for the capital value method. Both economic calculation methods are based on the same input parameters which are entered in the in chapter 6.1 described way.

Annuity method calculation

The annuity method sheet (Figure 2) calculates the annuities of the investments. The data needed for this calculation is taken from the input parameter tables and it is not needed to enter it again. The price-dynamic annuity factors *ba* are calculated from the formula (Gl. 13) described in chapter 4.2.1 and the annuity *AN* accordingly from formulas 19 and 20. Each measure is initially calculated seperatly und will then be added up to total annuity of the cost center. The result of the annuity calculation is a total annuity of all cost factors. This annuity is inserted in a formula calculating the economic rent, which apportions the total annuity to the living area. Due to this an annual economic rent and a monthly economic rent per m² can be read-off.

	A	B	C	D	E	F	G	H
1	Obect:	q =	0,0	%		Total amount	Measure 1	Measure 2
2		T =	0	years				
3	**Investment amount**	A_0			1		-	-
4	Service life	TN =			2		1	1
5	annuity factor	a (q,T)	#DIV/0!		3		#DIV/0!	#DIV/0!
5	Residual value factor	RF (q,T,TN)			4		1,000	1,000
7	Residual value	RW =			5		-	-
8	**Investment-linked payments**	AN_I =			6	#DIV/0!	#DIV/0!	#DIV/0!
9	Price change factor for repairs	f_K =			7		0	0
10	Factor for repairs in % of investment amount	f_K =			8		0	0
11	Payments for repairs in 1st year				9		-	-
12	Price-dynamic annuity factor	b_{IN} =			10		#DIV/0!	#DIV/0!
13	**Annuity of payments for repairs**	AN_{IN} =			11	#DIV/0!	#DIV/0!	#DIV/0!
14	**payments**	AN_K =			12	#DIV/0!	#DIV/0!	#DIV/0!
15	Price change factor for main energy	f_{E1} =			13		0	0
16	Payments for main energy in 1st year	$A_{V1,1}$ =			14		0	0
17	Price-dynamic annuity factor for main energy	b_{V1} =			15		#DIV/0!	#DIV/0!
18	**Annuity of annual cost for main energy**	AN_{V1} =			16	#DIV/0!	#DIV/0!	#DIV/0!

Figure 2 exemplary section of the annuity method calculation tool

Capital value calculation

The capital value method table is working similar to the annuity method calculation table. One difference is the division into two separate tables, one for the payments and one for the lodgements. The necessary input parameters are transferred from the according input parameter table so that it is not needed to enter the parameters twice. The required accrued interst factor q^{tk} and the cash value factors for service life *b(TN,q,r)* and for assessment period *b(T-tk,q,r)* are automatically calculated from the formulas 11 and 12 described in chapter 4.2.2, due to the fact that the formulas are integreted in the calculation table and linked to the input parameter tables.

Similar to the annuity method calculation each measure will first be calculated seperatly and then be summed up to a cost center. As a result the cash value of the payments and the cash value of the lodgements can be read-off. According to formula 26 the capital value is the sum of the cash values of the lodgements reduced by the cash value of the payments.

An application example can be found in the appendix.

	A	B	C	D	E	F	G	H	I	J	K
1		Object:		interest rate for costing purposes [%/Periods]		assessment period [Periods]		Length of period			
2		Measure:		i =	0	T =	0	year	half year	quarter year	month
3		1	2	3	4	5	6	7	8		9
4		Payments	Payment amount when due [t]	Due after t_K Periods	Accrued interest factor q^{tk}	Price change rate j %	Service life TN	Cash value factor			Cash value adjusted to T (substitute value)
5								b(T- tk,q,r)	b(TN,q,r)		(2)*(4)*(7)/(8)
6	one-off payments	**Capital-linked payments**									-
7		Measure 1	-	0	1	0	1	0,000	1,000		-
8		Measure 2	-	0	1	0	1	0,000	1,000		-
9		Measure 3	-	0	1	0	1	0,000	1,000		-
10		Measure 4	-	0	1	0	1	0,000	1,000		-
11		Measure 5	-	0	1	0	1	0,000	1,000		-
12		Measure 6	-	0	1	0	1	0,000	1,000		-
13		Measure 7	-	0	1	0	1	0,000	1,000		-
14		Measure 8	-	0	1	0	1	0,000	1,000		-
15		Measure 9	-	0	1	0	1	0,000	1,000		-
16		Measure 10	-	0	1	0	1	0,000	1,000		-
17		**Payments for repairs**									-
18		Measure 1	-	0	1	0	1	0,000	1,000		-
19		Measure 2	-	0	1	0	1	0,000	1,000		-
20		Measure 3	-	0	1	0	1	0,000	1,000		-
21		Measure 4	-	0	1	0	1	0,000	1,000		-
22		Measure 5	-	0	1	0	1	0,000	1,000		-
23		Measure 6	-	0	1	0	1	0,000	1,000		-
24		Measure 7	-	0	1	0	1	0,000	1,000		-
25		Measure 8	-	0	1	0	1	0,000	1,000		-
26		Measure 9	-	0	1	0	1	0,000	1,000		-
27		Measure 10	-	0	1	0	1	0,000	1,000		-

Figure 3 exemplary section of the capital value method calculation tool

4 Existing support programmes

4.1 Types of support programmes

Basically the existing support programmes can be divided in three different groups:

- Energy efficient retrofitting (including the use of renewable energy sources)
- Building of rentable flats
- Energy consulting

The following table shows the classification of the actually available support programmes split up in the above mentioned groups:

Energy efficient retrofitting	*Building of rentable flats*	*Energy consulting*
– Ecologic construction – Modernise living space – CO2-building retrofitting program – Generate solar energy – Law for the priority of renewable energies – Combined power and heat generation law – Market incentive program for the support of renewable energies – Natural gas support program	– Support for building new rentable flats	– On-site consultation – Building-check energy – Energy consulting by consumer advice centers – Start-consultation energy – Solar-Check NRW – Energy consultation on-site – Renovation initiative Ruhr area

Table 1: Classification of the support programmes

4.2 Support program group "Energy efficient retrofitting"

4.2.1 Ecologic construction

Target Group

Authorised for requests are responsible bodies of investments in selfused or rented residential buildings (e.g. private persons, housing corporations, municipalities, districts, communal associations as well as public corporations or institutes).

Regional validity

Federal republic

Description

Supported are residential buildings.

1. Construction, fabrication or first purchase of KfW-energy saving buildings 40 and of passive houses

Requirement to receive a support for KfW-energy saving houses 40 is that the annual primary enrgy demand Qp is maximal 40 kWh per m² building floor space AN. Further the specific heat loss due to

transmission (HT) by the heat transferring surface of the building has to be 45% below the maximum value determined in the EnEV.

Requirement to receive a support for passive houses is that the annual primary energy demand Qp is maximal 40 kWh per m² building floor space AN and that the annual thermal heating demand is maximal 15 kWh per m² living space.

2. Construction, fabrication or first purchase of KfW-energy saving buildings 60

Requirement to receive a support for KfW-energy saving buildings is that the annual primary energy demand Qp is maximal 60 kWh per m² building floor space AN. Further the specific heat loss due to transmission (HT) by the heat transferring surface of the building has to be 30% below the maximum value determined in the EnEv.

These requirements have to be proved by an official expert.

3. Installation of heating engineering based on renewable energies, combined power and heat and local or long-distance heating in new buildings

Financed are:

- solar thermal installations, if necessary including the installation of central heating
- bio mass installations as automatically feeded central heating installations
- wood gasifier central heating installations
- heat pumps
- geothermat transmitters
- exhaust-air plants with regulated exterior wall vents as well as ventilating systems
- Installations for the supply with heat by combined power and heat (local or long-distance heating, single installations, block-type thermal power stations, fuel cells)
- heat transfer stations and the pipeline network needed by local and long-distance heating

In combination with the installation of a heating system a hydraulic adjustment has always to be executed.

The requirements determined in the EnEV have always to be complied.

Amount of support:

- KfW-energy saving buildings 40 and 60 as well as passive houses are supported with 100% of the building costs (without cost for the estate) but maximal 50.000,- EUR per accommodation unit
- The installation of heating engineering based on renewable energies, combined power and heat and local or long-distance heating are supported with 100% of the investment costs but maximal 50.000,- EUR per accommodation unit

Conditions:

The payment will be 100% for KfW-energy saving buildings 40 and passive houses and 96% for KfW-energy saving buildings 60 and heating engineering. The credits can be recalled in one but maximal four parts.

Accumulation

A combination of a credit out of this program with other KfW-credits (e.g. KfW-proprietary program) or with other suports is allowed if the sum of the supports does not exceed the sum of the investments.

A combination of the support for heating engineering based on renewable energies, combined power and heat or local or long-distance heating in new buildings with KfW.energy saving buildings 40 or 60 or with the passive house program is not possible.

4.2.2 Modernise living space

Target group

Authorised for requests are responsible bodies of investments in selfused or rented residential buildings (e.g. private persons, housing corporations, municipalities, districts, communal associations as well as public corporations or institutes).

Regional validity

Federal republic

Description

Supported are measures concerning residential buildings as well as residential establishments and nursing homes.

STANDARD-measures
1. Modernisation and restoration of residential buildings

- constructional measures to enhance the utility value (e.g. layout of the flat, sanitary installations, water supply)
- constructional measures to enhance the general living conditions (e.g. extension of balconies / loggias, upgrades of lifts)
- restoration measures to remove constructional defects in form of repair or renewal (e.g. flooring and windows)
- senior-friendly and handicapped accessible alteration (e.g. barrier-free habitation)
- renewal of heating engineering in form of central heating systems based on gas/oil (condensing boilers - without usage of renewable energies) including measures which arise from this renewal
- constructional measures after a partly deconstruction e.g. roof system

2. Enhancement of the outside facilities of multifamily-dwellings with three or more accommodation units, e.g. fabrication of green areas, building-specific outside facilities, construction of playgrounds.

3. Measures for the deconstruction of vacant and permanantly unused rented residential buildings in eastern Germany and Berlin (East) in the context of city alterations including the measures to disengage the flats and to adapt the estates for an anew usage.

ÖKO-PLUS-measures
1. heat protection of the exterior building surface

Insulation of

- the exterior walls
- the roof
- the highest ceiling in contact with not dismantled rooms direct under the roof
- the cellar ceiling, the ground touching exterioir surfaces of heated rooms or the walls between heated and not heated rooms

2. Renewal of heating engineering based on renewable energies, combined power and heat and local or long-distance heating

Financed are:

- solarthermal installations, if necessary including the renewal of central heating systems
- biomass systems
- wood gasifier central heating systems with performance and firing regulation
- heat pumps

- exhaust-air plants with regulated exterior wall vents as well as ventilating systems
- Installations for the supply with heat by combined power and heat
- heat transfer stations and the pipeline network needed by local and long-distance heating
- Special regulation: replacement of coal, oil and gas single ovens as well as night storage heaters by the installation of central heating systems based on upper heating value technology

In combination with the installation of a heating system a hydraulic adjustment has always to be executed.

The proportion of the support can be 100%, for a modernisation complying the requirements of the STANDARD program maximal 100.000,- EUR per accommodation unit. Maximal 50.000,- EUR are the support amount for measures conform with the ÖKO-PLUS program. For the deconstruction of buildings maximal 125,- EUR per m² deconstructed space are the amount of support.

Conditions:

The payment of the ÖKO-PLUS program will be 100 %. If the STANDARD program is chosen 96 % will be pay-off.

The rate of interest of the credit will be determined optionally for 5 or 10 years. If credits have a duration of 10 years the rate of interest will be determined for the whole credit period. If credits have a duration longer than 10 years the rate of interest will be newly determined after 10 years.

The redemption will take place after the redemption-free years in three months annuities.

Accumulation

The combination of a credit from this program with other KfW-credits (especially KfW-proprietary programm, KfW-CO2 building retrofitting program credit and generate solar energy) or other support programs is allowed if the sum of the support does not exceed the sum of the investment.

A combination with the KfW-CO2 building retrofitting program with subsidies is not possible.

4.2.3 CO2-building retrofitting program

Credit

Target group

Authorised for requests are responsible bodies of investments in selfused or rented residential buildings (e.g. private persons, housing corporations, municipalities, districts, communal associations as well as public corporations or institutes).

Regional validity

Federal republic

Description

The KfW-CO2 building retrofitting program is part of the national climate protection program and is meant to be a longterm financing method with reduced rates of interest for measures concerning the saving of energy and the reduction of CO2-expulsion of buildings which were finished before 31.12.1983. Supported are measures concerning residential buildings as well as residential establishments and nursing homes.

The interest rate will be reduced during the first 10 years due to federal funds.

Supported are:

- energy efficient retrofittings comparable to or better than the performance of new buildings determined in the EnEV
- Underselling of the EnEV new building standard by 30%
- Measure packages to save energy

If the new building standards for the annual primary energy demand and the heat loss due to transmission (§ 3 EnEV) are complied or undersold a partly acquittal is granted in height of 5% of the total granted credit amount. If the standards are undersold by 30% or more the partly acquittal will be 12,5% of the total granted credit amount.

Special support "archetype projects"

The energetic retrofitting of buildings with underselling the new building standards of the EnEV by 50% or more can be seperately. Requirement for this support is the compliance of the requirements specifications determined by the German Energy Agency (dena).

The following measure packages are supported:

Measure package 0

- Thermal insulation of the exterior walls
- Thermal insulation of the roof or of the highest ceiling
- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows

Measure package 1

- Replacement of the heating system
- Thermal insulation of the roof or of the highest ceiling
- Thermal insulation of the exterior walls

Measure package 2

- Replacement of the heating system
- Thermal insulation of the roof or the highest ceiling
- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows

Measure package 3

- replacement of the heating system
- replacement of the windows
- thermal insulation of the exterior walls

The implementation of measure packages 0 to 3 always includes all exterior walls, the whole roof, the whole cellar ceiling, all ground touching exterior surfaces of heated rooms and all walls between heated and not heated rooms if the measures are part of the chosen measure package.

The measure packages can be extended by single measures from other packages.

Measure package 4

A minimum of three measures recommended by an official expert from the list below have to be implemented in form of a package. Exceptions concerning the scale of the measures are possible but have to be substantiated by an official expert.

- Thermal insulation of exterior walls
- Thermal insulation of the roof or of the highest ceiling
- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows
- Replacement of the heating system
- Installation of a ventilating system

In all cases all exterior walls, the whole roof, the cellar ceiling, all ground touching exterior surfaces or all walls between heated and not heated rooms have to be insulated or all windows have to be replaced if these measures are part of the chosen measure package 4.

Financing percentage / credit amount

Supported are up to 100% of the supportable investment costs including additional costs (architects, energy saving consultation) but maximal 50.000,- EUR per accommodation unit.

Conditions (Time point 11.01.2007):

- Credit duration 20 years with 3 redemption-free starting years: Rate of interest 2,50 % (nominal) and 2,52 % (effective) determined for 10 years
- Credit duration 30 years with 5 redemption-free starting years: Rate of interest 2,65 % (nominal) and 7,34 % (effective) determined for 10 years

Accumulation

An accumulation is possible if the sums of credits and subsidies does not exceed the sum of the investment. An accumulation with the subsidy-variant of the CO2-building retrofitting program is not possible.

Subsidy

Target group

Authorised for request are natural persons who are owners of selfused or rented single-or two-family houses as well as owners of selfused or rented freehold flats which are part of an proprietary association.

Regional validity

Ferderal republic

Description

The KfW-CO2 building retrofitting program is part of the national climate protection program and is meant to be a longterm financing method with reduced rates of interest for measures concerning the saving of energy and the reduction of CO2-expulsion of buildings which were finished before 31.12.1983.

Supported are the following measures:

- Energy efficient retrofitting complying the new building standards determined in the EnEV or better
- Underselling of the EnEV new building standard by 30%

If the new building standards for the annual primary energy demand and the heat loss due to transmission (§ 3 EnEV) are complied or undersold a subsidy is granted in height of 10% of the supportable investment costs but maximal 5.000,- EUR per accommodation unit. If the standards are undersold by 30% or more the subsidy will be 17,5% of the supportable investment costs but maximal 8.750,- EUR per accommodation unit.

The following measure packages are supported for residential buildings built before 31.12.1994:

Measure package 0

- Thermal insulation of the exterior walls
- Thermal insulation of the roof or of the highest ceiling
- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows

Measure package 1

- Replacement of the heating system
- Thermal insulation of the roof or of the highest ceiling
- Thermal insulation of the exterior walls

Measure package 2

- Replacement of the heating system
- Thermal insulation of the roof or the highest ceiling
- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows

Measure package 3

- replacement of the heating system
- replacement of the windows
- thermal insulation of the exterior walls

The implementation of the measure packages always includes all exterior walls, the whole roof, the whole cellar ceiling, all ground touching exterior surfaces of heated rooms and all walls between heated and not heated rooms if the measures are part of the chosen measure package.

The measure packages can be extended by single measures from other packages.

Measure package 4

A minimum of three measures recommended by an official expert from the list below have to be implemented in form of a package. Exceptions concerning the scale of the measures are possible but have to be substantiated by an official expert.

- Thermal insulation of exterior walls
- Thermal insulation of the roof or of the highest ceiling

- Thermal insulation of the cellar ceiling, of ground touching exterior surfaces of heated rooms or of walls between heated and not heated rooms
- Replacement of the windows
- Replacement of the heating system
- Installation of a ventilating system

This measure package is supported with a subsiy in the height of 5% of the supportable investment costs but with maximal 2.500,- EUR per accommodation unit.

In case of proprietary the supportable investment costs are calculated considering the percentage of the joint ownership.

Accumulation

An accumulation with a credit is not possible. In case of buildings built before 1983 an accumulation with other subsidies is possible if the maximum value of 10% of the supportable costs is not exceeded.

If single measures included in measure packages are supported by third persons the remaining measures will be supported by this program.

4.2.4 Generate solar energy

Target group

Authorised for requests are responsible bodies of investments in measures concerning the construction, extension or purchase of smaller photovoltaic-installations (e.g. private or non-commercial petitioners, commercial petitioners, freelancer, agriculturists) whose installations are complying the requirements determined in the EEG.

Regional validity

Federal republic

Description

Supported is the construction, extension or the purchase of a photovoltaic installation as well as the purchase of a percentage of a photovoltaic installation in the context of a civil law association.

The proportion of the support can be 100% of the supportable investment costs but maximal 50.000,- EUR.

The credit duration can be up to 20 years with minimum one and maximal 3 redemption-free starting years or the duration can be 10 years with minimum one and maximal two redemption-free years. The pay-off will be 96%. The redemption will will be payed in three-months annuities after the redemption-free starting years. The valid rates of interesf can be recalled on www.kfw-foerderbank.de.

Accumulation

An additional financing of photovoltaic installations which are supproted by this program with other KfW oder ERP programs is not possible. A combination of a credit out of this program with other support programs is possible if the support does not exceed the sum of investments.

4.2.5 Law for the priority of renewable energies (EEG)

Target group

Authorised for requests are operators of electricity generating installations using renewable energies.

Regional validity

Federal republic

Description

The EEG regulates:

- the priority of the connection of electricity generating installations using renewable energies and mine gas with the general electricity supply network in the federal republic including german
- the priority of the buy-off, transfer and payment of this electricity by the network operators
- the nationwide equalisation of the bought-off and paid electricity

This law does not include installations which belong to 25% or more percent to the Federal republic of Germany or one of its countries and which are put into operation before 31.06.2004.

The minimum payment rates for installations which are put into operation in 2006 are as follows:

- Photovoltaic: Installations with an electric power below 5 MW are supported. The minimum payment for electricity produced in supportable installations is 40,60 Cent/kWh. This also counts for big open space installations if they are lying in an area of a legally binding land-use plan. If the installations are installed on top of a building or on the side of a noise protection wall the payment will be enhanced to 51,80 Cent/kWh if the electric power is up to 30kW. Is the produced electric power 30 kW or higher the payment will be enlarged to 49,28 Cent/kWh. Beginning with an electric power of 100 kW the payment will rise to 48,74 Cent/kWh. The minimum payment rate will rise another 5 Cent/kWh if the installation is not installed on the roof or as the roof construction and forms an essential part of the building (PV module on the facade). The payment for solar electricity will remain for 20 years. Since January 2005 the payment for new installations is sinking about 5% per year. If the installation is not installed on a building or a noise protection wall the degression is 6,5% per year.

- waterpower: the payment for small installations up to 500kW which are not connected with barrages, weir or are constructed with out continuing cross buildings and which are allowed before 31.12.2007 is 9,67 Cent/kWh. If the installed electric is up to 5 MW the payment is 6,65 Cent/kWh. The payment duration is 30 years.

A payment for electric power out of big waterpower installations with more than 5 MW up to 150 MW will only be paid if the installtion will be renovated or extended until 31.12.2012. The measures have to result in a higher capacity concerning the electric power of 15% and they have to improve the ecologic state of the water. The payment for the additionally produced electricity is 7,51 Cent/kWh for up to 500 kW, 6,51 Cent/kWh for up to 10 MW, 5,98 Cent/kWh for up to 20 MW, 4,46 Cent/kWh for up to 50 MW and 3,62 Cent/kWh for up to 150 MW. This payment for installations with more than 5 MW will be quaranteed for 15 years. The degression for new installations since January 2005 is 1% per year.

- Landfill, mine and sewage gas: The payment will be 7,44 Cent/kWh for installations with up to 500kW, above 500 kW up to 5 MW it will be 6,45 Cent/kWh. For electricity produced in mine gas installations with a electricity production above 5 MW the payment is 6,45 Cent/kWh. Is landfill or sewage gas used the performance above 5 MW will be paid with the market rate. The minimum payment rates will rise about 2,0 Cent/kWh if the electricity is produced with innovative methods e.g. fuel cells, gas turbines, Organic-Rankine-installations, Kaline-Cycle-installations or stirling-motors. The annual degression of the payment for new installations is 1,5% since January 2005. The duration of these payments is 20 years.

- bio mass: Installations with a performance above 20 MW are not supported. The basic payment is for installations with a performance up to 150 kW 11,16 Cent/kWh, above 150 kW up to 500 kW it is 9,60 Cent/kWh; from 500 kW up to 5 MW it is 8,64 Cent/kWh and above 5 MW up to 20 MW it is 8,15 Cent/kWh. If old wood of the category A III / IV is used for the initial operation since 01.07.2006 the payment is 3,78 Cent/kWh. The payment duration is 20 years. The degression for new installations is sinking about 1,5% per year since January 2005.

The payment will rise if the electricity is produced only by plant or ingredients of plants which occur in agricultural, forestry or gardening companies or in context with landscape conservation and do not need a further harvest, conservation or preparation or alteration for a usage in a bio mass installation or they are won from liquid manure or a certain mash. The payment will rise about 6,0 Cent/kWh for installation with a performance up to 500 kW and up to a performance of 5 MW it will rise about 4,0 Cent/kWh. Installations which burn wood the basic payment will rise 6,0 cnet/kWh for a performance up to 500 kW and 2,5 Cent/kWh for a performance up to 5 MW. The basic payment will rise further 2,0 Cent/kWh if the electricity is produced in the context of the combined power and heat law. Therefore the payment for combined power and heat installations with a performance up to 150 kW is 13,16 Cent/kWh, 11,60 Cent/kWh for a performance up to 500 kW, 10,64 Cent/kWh if the perfomrance is up to 5 MW and for a further performance up to 20 MW the payment is 10,15 Cent/kWh. The payment rates for combined power and heat installations which work with renewable raw material are 19,16 Cent/kWh for a performance up to 150 kW, up to 500 kW 17,60 Cent/kWh, up to 5 MW 14,64 Cent/kWh and up to a performance of 20 MW it is 10,15 Cent/kWh. The payment for the production of electricity in "innovative" combined power and heat installations is 15,16 Cent/kWh for up to 150 kW, 13,60 Cent/kWh for up to 500 kW, 12,64 Cent/kWh for up to 5 MW and 10,15 Cent/kWh for a performance up to 20 MW. The application range of this payment regulation for electricity produced from bio mass, especially which materials are accepted as bio mass, is determined in the bio mass edict.

- Geothermic installations: installations which start operating before 01. January 2010 will get a payment in height of 15,0 Cent/kWh if the performance is up to 5 MW, a further performance up to 10 MW will be paid with 14,0 Cent/kWh, a performance up to 20 MW will be paid with 8,95 Cent/kWh and above 20 MW the payment will be 7,16 Cent/kWh for a duration of 20 years. The annual degression of the payment for new installations is 1% starting from January 2010.

- wind energy: For the first 5 years 8,36 Cent/kWh will be paid and after this period 5,28 Cent/kWh. The respite will be prolonged in comparison to reference installations if the earnings are poor. This especially counts for so called Repowering installations where small, old installations are replaced by modern and more powerful installations and so the installed performance is rised minimum for the triple. The payment will not be paid if an expertise shows that the installations cannot reach at least 60% of the reference earnings at their location. The annual degression of the payment is 2% since January 2005.

Offshore installations will receive a starting payment in height of 9,1 Cent/kWh adjusted to the location for a duration between 12 and 20 years. This heightened starting payment will be paid if the installation starts to operate before January 2011. The basic payment afterwards will be 6,19 Cent/kWh. The annual degression of the payment will not start until 2008.

4.2.6 Combined power and heat generation law

Target group

Authorised for requests are operators of supportable combined power and heat installations. As operator of a combined power and heat installation is accepted who supply the general supply network with current. The operator characteristic is not linked to the position of the owner of the installation.

Regional validity

Federal Republic

Description

The following combined power and heat installations are supportable:

- CHP-installations, which started operating before 31.12.1989 (old inventory installations)

- CHP-installations, which started operating since 01.01.1990 (new inventory installations), as well as old inventory installations which were renovated 01.01.1990 and 31.03.2002 and started operating again

- Old inventory installations which were modernised or replaced by a new installation and again started operating between 01.04.2002 and 31.12.2005 (modernised installations).

A right to receive an extra pay for the supply with current exists additionally for new built installations which started operating after 01.04.2002:

- small CHP-installations (up to 2 MWel) if they do not displace already existing long-distance heating installations working with combined power and heat

- Fuel cell installations

Height and duration of the extra pay:

- inducted electricity produced with new built fuel cell installations and small block-type thermal power stations with a performance up to 50kWel: 5,11 Cent/kWh over 10 years

- new installations up to 2 MWel: 2,25 Cent/kWh. The extra pay is terminated until 2010 and afterwards it will sink to 1,94 Cent

- CHP-installations in the inventory: Marginal extra payments which are terminated and have a degressive progress

Accumulation

CHP-electricity which is paid on the foundation of the EEG is not part of the scope of this law.

4.2.7 Market incentive program for the support of renewable energies

Program part bio mass

Target Group

Authorised for requests are private persons, freeelancer, small and middle-size companies as well as communes, communal companies, associations, other bodies of the public law and incorporated societeis. The requestor has to be owner, tenant or lodger of the estate on which the installation is to be installed.

Regional validity

Federal Republic

Description

1.Anewed requests for projects which were denied in 2006

Requestors who made a support request to the BAFA already in 2006 and were denied the support because of missing budget ressources can make a new request until 31. July 2007. An anewed request is also possible for requestors who began with the investment without notice of denial of the BAFA.

For a new request the investment has to be finished before the request. In addition to the request a complete report on expenditure of funds has to be submitted. Since 22. January 2007 the BAFA provides new forms on its homepage. The payment rates for these requests are realigned to the support directive from the 12th of June 2006.

2.New request method for first time requests

Beginning in 2007 the basic support is replaced by a new simpler, citizen-friendly and more effective support method. The requestor's duty to make a request at the BAFA before the signing of delivery and service contracts ceases to exist. The request can be made not until 15. March 2007. An earlier request is not possible due to the change of the request method. Supportable are projects which were begun since 16. October 2006 and which are finished at the time point of the request.

The requestors are recommended to inform themselves about the installation variants and if the chosen installation complies the requirement for a support in context of the support directive. Further information about this theme are shortly available at the BAFA homepage.

In addition to the request evidence of the operational readiness of the installation is required. The request has to be made within six months of the fabrication of the operational readiness of the installation. For requestors who finished their installation in the period between 16. October 2006 and 31. March 2007 the request respite ends on 30. September 2007.

For especially innovative installations of the above mentioned technologies a higher support can be granted in form of an "innovation bonus" (see below). In this case the request has to be made before the signing of delivery or service contracts!

New support rate since 2007 - Basic support

Automatically feeded bio mass boilers

The support for pellet boilers, pellet ovens and combination boilers with a performance up to 100 kW nominal heat capacity: 24,- EUR/kW, minimum 1.000,- EUR.

Wood chips boilers: 500,- EUR per installation.

Split logs gasifier boilerswith a performance between 15 kW and 30 kW nominal heat capacity:

The support is 750,- EUR per installation.

With these support rates the actual market development and the strong demand of supported technologies is accommodated.

Improved support of innovations

A new development in this directive is the "innovation bonus" for especially innovative installations and methods. The new support directive regulates which methods and installations can be supported. In brief regulations which determine the technical requirements for a support will be published. Until then no request are possible. The request has to be made before the signing of delivery and service contracts! Is this fact missed the support can only be in the context of the basic support.

Accumulation

Still unknown

Program part solar thermal installations

Target Group

Authorised for requests are private persons, freeelancer, small and middle-size companies as well as communes, communal companies, associations, other bodies of the public law and incorporated societeis. The requestor has to be owner, tenant or lodger of the estate on which the installation is to be installed.

Regional validity

Federal Republic

Description

The new support directives of the maret incentive program will presumably published in the Bundesanzeiger in the middle of January 2007 and therefore come into effect.

1.Anewed requests for projects which were denied in 2006

Requestors who made a support request to the BAFA already in 2006 and were denied the support because of missing budget ressources can make a new request until 31. July 2007. An anewed request is also possible for requestors who began with the investment without notice of denial of the BAFA.

For a new request the investment has to be finished before the request. In addition to the request a complete report on expenditure of funds has to be submitted. Since 22. January 2007 the BAFA provides new forms on its homepage. The payment rates for these requests are realigned to the support directive from the 12th of June 2006.

2. New request method for first time requests

Beginning in 2007 the basic support is replaced by a new simpler, citizen-friendly and more effective support method. The requestor's duty to make a request at the BAFA before the signing of delivery and service contracts ceases to exist. Supportable are projects which were begun since 16. October 2006 and which are finished at the time point of the request.

Supported are solar thermal collector installations with a gross collector area up to 40m². Request can be made from 15. März 2007 onwards. An earlier request is not possible due to the change of the request method.

- Installations for the supply with warm water

The subsidy is 40,- EUR per commenced m² installed gross collector area for installations with a maximum total gross collector area of 40m² but it has to reach a minimum of 275,- EUR.

- Installations for a combined supply with warm water and heat, for the supply with process heat and for solar cooling with up to 40m² installed gross collector area

The support is 70,- EUR per commenced m² installed gross collector area.

The implementation of a project has in future not to wait until a request can be made or until a request has been approved by the BAFA. The requestors are recommended to inform themselves about the installation variants and if the chosen installation complies the requirement for a support in context of the support directive. Further information about this theme are shortly available at the BAFA homepage.

In addition to the request evidence of the operational readiness of the installation is required. The request has to be made within six months of the fabrication of the operational readiness of the installation. For requestors who finished their installation in the period between 16. October 2006 and 31. March 2007 the request respite ends on 30. September 2007.

For especially innovative installations of the above mentioned technologies a higher support can be granted in form of an "innovation bonus". The new support directive regulates which methods and installations can be supported.

In brief regulations which determine the technical requirements for a support will be published. Until then no requests are possible. The request has to be made before the signing of delivery and service contracts! Is this fact missed the support can only be in the context of the basic support.

Delimitation in case of solar collector installations

Solar collector installations can be supported in the context of this program from the BAFA or from the KfW. The delimitation is determined by the size of the installation. The BAFA supports installations with less or exact 40m² gross collector area. The KfW supports installations with more than 40m² gross collector area.

Delimitation between basic support and innovation bonus in the BAFA program

Solar collector installations used for supply with warm water or a combined supply with warm water and heat with a gross collector area below 20m² can be supported with the basic support. The fabrication of the installation can start without making a request at the BAFA before.

Solar collector installations with a gross collector area between 20 and 40m² can either be supported with the basic support or if the requierements are complied get the innovation bonus. The support requirement for the innovation bonus is that the delivery and service contracts have not been signed before the request has been made. Is this fact missed the support can only be in the context of the basic support. The same counts for solar collector installations used for the supply with process heat and for solar cooling.

Accumulation

Still unknown

4.2.8 Natural gas support program

Target group

Authorised for request of a heating system transposition or a natural gas car are clients of the Stadtwerke Hamm GmbH.

The support of an natural gas check can be requested once per residential building by a craftsmen.

Regional validity

Northrhine-Westfalia, Stadtwerke Hamm

Description

Supported are the following measures:

1. Transposition of the heating system

The transposition of a heating system from a solid or liquid fuel to natural gas or to long-distance heating is supported as follows:

- Installations with up to 30 kW: 350,- EUR
- Installations above 30 kW: 550,- EUR

2. Natural gas check

The examination of the natural gas pipes in a residential building is supported by a cooperation partner of the Stadtwerke Hamm GmbH out of the Hammerr installations handcraft or by the Stadtwerke themselves. The costs for the natural gas check are 60,- EUR. 30,- EUR from this sum are overtaken by the Stadtwerke in the context of this support program.

3. Natural gas cars

The first purchase of a natural gas car as well as the transposition to natural gas usage are supported with a subsidy in height of 555,- EUR. In total 55 cars will be supported.

Accumulation

Not possible

4.3 Support program group: "Building of rentable flats"

4.3.1 Support for building new rentable flats

Target group

Authorised for requests are natural and juristic persons in form of owners or as other entitled to dispose who will fabricate living room for households whose income does not exceed the income limit determined in § 9 Abs. 2 WoFG in combination with § 1 VO WoFG NRW (income group A) as well as for households with a higher economic potencial whose income exceeds the income limit determined in § 9 Abs. 2 WoFG in combination with § 1 VO WoFG NRW by 40% (income group B).

Regional validity

Northrhine-Westfalia

Description

Supported is the building of new rentable flats and of freehold flats which are meant to be rented in form of

- Group flats for disabled people
- Rentable one-family houses
- free financed flats if adequate replacement flats can be occupied

Kind and height of the support:

Support lump sum: In case of a building credit the amount of the support will be determined by the location of the flat (rent level) and by the income of the flat searching people. The credit will be 800,- EUR up to a maximum of 1.200,-EUR (income group A) and 365,- EUR up to 765,- EUR (income group B).

For flats with up to 62m² the support lump sum will rise about 5.000,- EUR per flat for income group A and about 2.000,- EUR for income group B.

Further additional credits are granted:

These will serve to cover additional expenditures caused by the town planning in the environment of buildings which:

- have an extremly high value considering the town planning and lie in a city renovation area
- are a monument or memorial
- lie in a memorial area

The height of the support lump sum is per m² living space in residential buildings built

- before 1870 (timbered houses): 250,- EUR
- before 1870 (massive construction): 175,- EUR
- before 1918: 150,- EUR
- before 1948: 110,- EUR

Credit conditons

The interest rates will be reduced to 0,5 % p.a. for the duration of the rent and occupation bonding.

Acquittance 1% p.a. plus saved interest rates.

The credit will have an interest bearing which lies 2% above the basic interest rate but max. 6%.

The administrative costs share is calculated with once 0,4 %, continous 0,5 % p.a of the building credit after athe acquittance of the building credit it will be 50% calculated from half of the credit amount.

Interest rates, acquittance and the administrative costs share have to be paid once in a half-year.

The pay-off will be in 2 rates if the credit amout is up to 25.600,- EUR, 50% at the beginning of the construction and 50% if the structural work is finished. If the credit amount is higher than that it will be paid in three rates, 20% at the beginning of the construction, 45% if the structural work is finished and 35% if the building is finished and the move-in is possible.

For the cover of additional expenditures due to the removement of sealaning compounds, greening, the fabrication and stylance of garden areas and courtyards on private estates additional credit in height of 31,- EUR/m² are granted. Supported are only closed settlements with minimum 30 accommodation units. The supported measures include constructional measures on the estate wich serve the community (e.g. playgrounds, parking space and traffic installations).

Accumulation

The support of building projects for which public or non-public budgets were granted or for whose modernisation budget from the modernisation programs and/or energy saving programs (KfW-programs) of the federeal republic or the countries have been used is not possible/allowed.

4.4 Support program group: "Energy consultating"

4.4.1 On-site consultation

Target group

Authorised for requests are natural and juristic persons, judicial independant companies out of the commercial economy including the housing industry and the agricultural economy, all institutions with non-commercial or ecclesiastical background. Lodgers or tenants of buildings are also authorised for requests if they have the permission of the owner in written form.

Regional validity

Federal Republic

Description

Supported is the on-site consultation which enfolds the constructional heat protection as well as the production and distribution of heat including the supply with warm water and the usage of renewable energy. It has to be implemented by an engineer or architect. The consultation is carried out with the delivery and explanantion of the written consultation report.

The maximum subsidy is for:

- One- and two-family housings 175,- EUR
- Buildings with minimum three accommodation units 250,- EUR

Costs exceeding this subsidies as well as the purchase tax have to be paid by the house owner.

The request will be made by a consultant who is also the receiver of the subsidy. The receiver of the consultation will get a bill with the sum reduced by the subsidy.

Accumulation

An accumulation is possible. The energy saving consultation on-site can be used as an evidence in the context of measure package 4 of the CO2-building retrofitting program.

4.4.2 Building-Check Energy

Target Group

Authorised for request are house owners.

Regional Validity

Northrhine-Westphalia

Description

The compilation of diagnostics concerning the building energy for residential buildings which were completed before 1981 and did not receive until now a thermotechnical retrofitting. The incurring costs are shared between the state NRW (52 Euros) and the house owner (25 Euros).

4.4.3 Energy Consultation of Consumer Advice Centres

Target Group

Authorised for request are private end-consumers (house owners, constructors, potential buyers, landlords or tenants)

Regional Validity

Federal Republic

Description

The following measures will be supported:

1. Energy Consultation in the Consumer Advice Centres of the federal states for the following topics:

constructional heat protection (construction, insulation material, thermal bridges, air-tightness)

building services (heat generator, controller, heat distribution, ventilating system)

renewable energy sources (biomass, thermal solar systems, photovoltaic systems)

consumers' comportment (correct heating and aerating)

saving electricity (energy saving household appliances, illuminating, stand-by losses)

support options

implementation of measures by personal contribution

Appointments are allocated by the Consumers Advice Centres. The incurring costs are 5 Euros.

2. On-site Case Management

After the initial consultation at the Consumers Advice Centre it is possible to arrange an expanded consultation on-site. This includes the examination of special detailed problems and the discussion of the implementation of single measures. The consultation is subsidised with 169,50 Euros. The incurring costs for the customer is 45 Euros.

Accumulation

The support for on-site case management will not be provided if a consultation of equal quality and theme was already implemented for the respective building (prevention of double-support).

4.4.4 Initial Energy Consultation

Target Group

Authorised for request are house owners.

Regional Validity

Northrhine-Westphalia

Description

Supported are first-time energy building check including an energy consultation. The "Energy Start-Consultation" will provide house owners with an analysis of the housing stock, proposals for energy-saving measures, costing of these measures and their efficiency as well as information on the support programme. In the context of a common campaign of the Architectural Association NRW and the Engineering / Construction Association NRW the Ministry for urban development and housing NRW supports this consultation with 52 Euros. As the consultants commit themselves to giving their services for 100 Euros the incurring costs for house owners are 48 Euros.

Precondition for the subsidy is the completion of the relevant building before 1st January 1980. Applications will be submitted via the commissioned architect or engineer.

An accumulation with the support programme "Building Check Energy" is possible.

4.4.5 Solar-Check NRW

Target Group

Authorised for requests are house owners

Regional Validity

Northrhine-Westphalia

Description

Supported are examinations by craftsmen, in order to find out if the installation of thermal solar energy system or a photovoltaic system is possible. The incurring costs are 77 Euros whereof the Ministry for urban development an housing Northrhine-Westphalia pays 52 Euros on the basis of the REN-Programme. The house owner pays the difference of 25 Euros. Only residential buildings with maximum six accommodation units can be examined.

4.4.6 On-site Energy Consultation

Target Group

Authorised for requests are private persons

Regional Validity

Northrhine-Westphalia

Description

Supported are on-site energy consultations in selected municipalities.

In order to reach a long-lasting energy efficiency the Consumer Advice Centre Northrhine-Westphalia offers such a consultation in consumers' homes for a small fee. The energy consultation comprises the following measures:

1. On-site energy efficiency consultations

An energy efficiency consultation comprises a survey and an oral consultation on all topics of the field of energetic consultation. It gives advices on saving measures and focal points for refurbishment. Incurring costs are 50 Euros for a maximum of 1.5 hours and 10 Euros for an additional half an hour or parts thereof.

2. Diagnostics of the heat insulation

On the basis of a survey (building type, number of floors, living space, outer shell) an assessment of the heating energy consumption is made. The incurring costs are 50 Euros.

3. Diagnostics of the heating system

The diagnostics of the heating system involve an analysis of the heating including the warming of drinking water. The incurring costs are 50 Euros.

4. Solar energy check (electricity)

The solar energy check comprises the examination of the existing supply engineering for the application of a photovoltaic system. The incurring costs are 50 Euros.

5. Solar energy check (heating)

The solar energy check comprises the examination of the existing supply engineering for the application of a heating system for drinking water. The check is upgraded by a first income prognosis. The incurring costs are 50 Euros.

6. Diagnostics of humidity

Diagnostics of humidity comprise the inspection of damages and the taking of measured data. The following consultation searches for causes and tries to find solutions. The incurring costs are 50 Euros.

7. Diagnostics of humidity – plus

If causes for damages are difficult to identify the plus-option offers in addition to the diagnostics of humidity a report with detailed measured data and an explication if desired. The incurring costs are 100 Euros.

8. Electricity diagnostics

Within an on-site-consultation the electricity consumption of the household will be examined and advices for saving electricity are given. The incurring costs are 75 Euros.

9. Electricity report

The electricity report is more detailed than the electricity diagnostics. It identifies different electricity consumption values like stand-by-consumption or a precise time response of the electricity consumption. An electricity report will be compiled. The incurring costs are 150 Euros.

10. Building energy report

The building energy report is compiled on the basis of solid data acquisition of building and the heating system including the system for warming of the drinking water. The incurring costs are 230 Euros for residential buildings with 1-2 accommodation units and 390 Euros for residential buildings with 3-6 accommodation units. On demand a CO2-certificate for KfW-support will be issued.

11. Certificate for the provision of a partly acquittal within the KfW-CO2-Building Retrofitting Programme

A building energy report and the documentation of projected investments for energyefficiency will be compiled. Like this achievable potential CO2-reductions can be quantified. Within a second on-site-visit the appropriate implementation of the measures needs to be examined. Accordingly a certificate will be issued. The incurring costs are 480 Euros for buildings with 1-2 accommodation units and 640 Euros for buildings with 3-6 accommodation units.

Accumulation

possible

4.4.7 Initiative for Retrofitting (Sanierungsinitiative Ruhrgebiet)

Target Group

Authorised for requests are private persons

Regional Validity

Northrhine-Westphalia

Description

Supported are on-site energy consultations in selected municipalities.

In order to reach a long-lasting energy efficiency the Consumer Advice Centre Northrhine-Westphalia offers such a consultation in consumers' homes for a small fee. The energy consultation comprises the following measures:

1. On-site energy efficiency consultations

An energy efficiency consultation comprises a survey and an oral consultation on all topics of the field of energetic consultation. It gives advices on saving measures and focal points for refurbishment. Incurring costs are 50 Euros for a maximum of 1.5 hours and 10 Euros for an additional half an hour or parts thereof.

2. Diagnostics of the heating system

The diagnostics of the heating system involve an analysis of the heating including the warming of drinking water. The incurring costs are 50 Euros.

3. Solar energy check (electricity)

The solar energy check comprises the examination of the existing supply engineering for the application of a photovoltaic system. The incurring costs are 50 Euros.

4. Solar energy check (heating)

The solar energy check comprises the examination of the existing supply engineering for the application of a heating system for drinking water. The check is upgraded by a first income prognosis. The incurring costs are 50 Euros.

5. Diagnostics of the heat insulation

On the basis of a survey (building type, number of floors, living space, outer shell) an assessment of the heating energy consumption is made. The incurring costs are 50 Euros.

6. Diagnostics of humidity

Diagnostics of humidity comprise the inspection of damages and the taking of measured data. The following consultation searches for causes and tries to find solutions. The incurring costs are 50 Euros.

7. Building energy report

The building energy report is compiled on the basis of solid data acquisition of building and the heating system including the system for warming of the drinking water. The incurring costs are 230 Euros for residential buildings with 1-2 accommodation units and 390 Euros for residential buildings with 3-6 accommodation units. On demand a CO2-certificate for KfW-support will be issued.

Accumulation

possible

5 Further incentive programmes

5.1 Heat contracting

Heatcontracting is a service which is normally offered by middle-class heating installation companies as well as public and private energy providers. Core of the contract is the outsourcing of the investments in a first construction or a modernisation of central heating systems from the owner of the building to the contractor.

The building owner grants the contractor the exclusive right to provide the lodgers or the realty with heating warmth and/or warm water from a central heating system in a heating provision contract with a long-term duration (10-15 years). Due to the long duration of the contract the investor can allocate the investment costs to a duration of 10 to 15 years. Modern heating systems often have a high efficiency which saves a lot of energy therefore the “investment cost additional charge” calculated over the 10 to 15 years will not be observed at first the first sight because it is equalized by the saved energy costs.

The investor user dilemma can be solved with this system.

5.2 Climate protection fond Hannover

Together with the capital of Lower Saxony, Hanover, the Stadtwerke Hannover AG have initiated a climate protection fund which was founded in June 1998 when the *proKlima* partnership contract was signed with additional partners. This fund is unique in Germany and Europe.

Together with all local municipal fund members, the Stadtwerke Hannover AG provides up to 5.1 million Euros annually to assist its customers and members of the public in their efforts to actively support climate protection measures. The major part of the fund is derived from the Stadtwerke Hannover AG’s profits from the previous year and a gas price component. In this way, the Stadtwerke Hannover AG’s customers also participate in this fund as consumers and are thus involved in the climate protection offensive in Hanover. Hanover ranks first among all municipal fund partners.

The inclusion of the cities of Ronnenberg and Hemmingen as new members in the *proKlima* partnership contract in 1999 as well as the rising demand for energy-saving programs in particular confirms that all foundation members are right in thinking that *proKlima* is a great success and its implementation really pays off. Together with the City of Hanover and its suburbs, Langenhagen, Laatzen, Seelze, Hemmingen und Ronnenberg, the Stadtwerke Hannover AG has managed to raise the volume of funds to 5.1 million Euros annually, and at the same time provides assistance to its customers and members of the public in active climate protection.

proKlima is supported non-materially and with know-how by the following partners: Trade Corporation of Hanover, National Association of Energy Consumers, Consumer Advice Center of Lower Saxony, Citizens Action Group for Environmental Protection, Ruhrgas AG and Thüga AG. The partnership contract constitutes a model for cooperative climate protection global thinking) through the combination of management interests, consumer needs and local activities (local action). All shareholders of the Stadtwerke Hannover AG, the license-granting municipalities and lobbies for clients' interests have agreed to the founding and aims of the *proKlima* climate protection fund:

The conclusion of a nationwide unique partnership contract "for the promotion and progress monitoring of measures and third party projects for climate protection, which otherwise would not have been realized or only realized to a limited extent due to a lack of economic efficiency . . ."

The following criteria will form the basis for supporting individual projects or establishing programs:

- CO_2-efficiency (Euros/metric tons of avoided CO_2),
- absolute amount of avoided CO_2,
- multiplier effect,
- level of innovation

proKlima supports the following with financial aid:

- additional measures which could not have been implemented without financial aid and for which the applicants are not financially committed,
- economically unacceptable costs which are not offset by reduced energy costs,
- generally speaking, only measures which are realized in the supported area.

Among these are major individual projects, such as the "Solar-Wochen" (promotion event for solar energy) in Hanover, the environmentally-friendly Kronsberghof bio-gas plants or the passive residential development area, Lummerlund, on Kronsberg as well as the Herrenhausen hydroelectric power station, whose turbines generate ecological electricity referred to as "enercity®Strom&care".

Furthermore, *proKlima* supports building structure improvements with the help of public support programs (see below) by issuing low energy consumption certificates and resulting follow-up measures, (e.g. better insulation, optimized windows, gas heaters with efficient calorific ratings or the use of cogeneration), innovative standards for new buildings (such as the method of passive house construction), solar panels for water heating and the use of solar energy in schools, organizations, and public institutions.

The following five public support programs are currently implemented:

- energy modernization of existing residential ("older") buildings
- energy modernization of club houses
- heat energy conservation in new apartment complexes
- solar water heating
- solar energy & climate protection in schools, organizations
- and public institutions.

The Board of Trustees and advisory council decide on individual projects and the setting-up of support programs. Manfred Müller, councillor of the city of Hanover, is chairman of the board whereas the advisory council is headed by Jans-Paul Ernsting, Managing Director of the Trade Corporation of Hanover.

proKlima is headquartered in the Stadtwerke Hannover AG building. The office decides on projects within the framework of the public support program measures and is responsible for the management and progress monitoring of the climate protection fund. In addition, it cooperates with reputable institutions with regard to studies, impulse programs and innovative projects. The office also takes part in local climate protection activities via "networking" with the City of Hanover or the Hanover Region e.g.:

The old building campaign "Bärenstarke Dämmung" ("*Mammoth insulation*") is canvassing for optimally insulated buildings and the "Solarenergie kommt!" ("*Solar energy is on the march!*") campaign aims at stimulating the demand solar energy utilization.

5.3 Personal contribution (muscle mortgage)

Muscle mortgage describes the personal contribution in the context of building or purchase of a real estate. The usage of muscle mortgage or personal contribution has the aim to reduce the costs for craftsmen by personal manpower which can also be given by kinsman or neighbours.

With a higher proportion of personal contribution and of own capital the probability of a positive decision for a credit or support programmes is rising.

The risk exists to overestimate the height of a muscle mortgage and to underestimate the expanse and needed qualification or the missing guarantees for the self-made parts. Building or modernisation are linked to a high time expanse, which can even be enlarged due to a longer construction period caused by an inefficient professional qualification.

But beside the financial savings personal contribution can have a positive effect on the relationship between lodgers and housing company. The lodger gets more connected to his dwelling and he can influence the design by himself. All the facts will lead to a more stable situation inside of the quarter and will facilitate the implementation of energy efficient modernisation measures.

5.4 Social concepts

Social concepts can strengthen the identification of the lodgers with their quarter. As an addition to the energy efficient retrofitting they can help to enlarge the acceptance of the retrofitting measures and they can improve the relationship between lodger and housing company.

The field of social concepts is large so that I will only illustrate barrier-free living, seniors or youths mentoring and quarter management.

5.4.1 Barrier-free living

The demographic change leads to an older population and therefore the lodgers will get older and their new needs have to be considered. Stairs are real barriers and too small doors do not allow the usage of walking frames or wheelchairs. To facilitate the life of seniors and to adjust the dwellings for future needs some of the dwellings should be modified to barrier-free flats. Especially flats on the ground floor are qualified for such a modification. Another strategy could be to heighten the level on the outside so that an entrance at-grate is possible. Inside the dwellings the doors, bathrooms and movement areas have to be adjusted to a barrier-free standard.

These measures will strengthen the identification of the lodgers with their homes so that the support for the energy efficient modernisation measures will rise. The lodgers feel that they are involved in the process and that their needs are considered so that their acceptance and the relationship to the housing company are improved.

5.4.2 Seniors or youths mentoring

For a functioning community inside of a quarter it is important to create a feeling of togetherness between the inhabitants. New and old lodgers have to be brought together. To achieve this aim senior and/or youths mentoring can be the right method. If it is possible a recreation room should be part of the modernisation measures so that groups can meet each other, learn, play, or just talk. A coach can support the activities and therefore the development of a unity. The mentoring will help to create a stable neighbourhood and by this way the attractiveness of the quarter will be enlarged.

5.4.3 Quarter Management

The grave economic changes in the last years have impacts even on the cities. The cityscape is polarising and it comes to effects of crowding out.

Against this background the previous strategy of the city renovation with primarily constructional spatial and thorough aims seems not to be effective in an optimal way. The complex problem situation in the developing overburdened neighbourhoods and quarters marked by low income, high unemployment, decayed building substance and a lack of neighbourly help can only be solved with an integrative method. For this method a coaction of social work, business development and urban planning is essential.

The central ideas of the quarter management are the integration of actors and aims as well as the principle of qualification instead of mentoring.

The instrument "quarter management" is characterised by the consolidation of actors from the sectors of administration, private economy, societies and not organised inhabitants. The objective target is likewise an integration of the different aspects of business development, social qualification and constructional development of the quarter.

The second main feature of the quarter management is the introduction of an activation strategy. The inhabitants of the quarters shall be activated und get involved in the improvement process. The encouragement to self-help and the development of a responsibility towards the quarter and the development of self-supporting inhabitant organisations is the aim of this strategy.

To achieve the above mentioned aims there are different instruments:

- The central control is carried out by a quarter manager initiated by the public authorities. He will ensure the implementation of the subsidies but he also has the duty to establish new support possibilities on the location.
- In most cases a quarter bureau is installed that on the one hand provides the administrative infrastructure for the quarter management and on the other hand can be used as a point of reference and a meeting point for the inhabitant organisations.
- An important element is a so-called quarter fond, a subvention fund by which small short-term measures inside of the quarter can be financed, e.g. beautification activities, festivals or playgrounds. The dissemination of these subsidies is decided by an inhabitant jury composed of several inhabitants under the lead of the quarter management.

6 Conclusion

The term "improved tailored financing program" already shows that in each case a specialised financing scheme is important. Therefore it is difficult to determine one improved tailored financing program for all cases, instead of a single scheme it is better to develop a method to analyse the situation of the actual project and to identify the right financing and incentive programmes fitting to the analysed situation.

A common tool if the decision to invest in energetic retrofitting is taken is the economic efficiency calculation. This calculation delivers the basis for comparison of different retrofitting measures. The final decision for or against a retrofitting measure will be taken after a sensitivity analysis of all compared measures has been made. This procedure is valid for all projects but it is a new calculation in each case.

The application examples of the calculation tool show the different results of the economic efficiency calculation in Greece, Spain and Germany.

7 Application example

7.1 Explanation of the required input data

List of Input Data

It depends to the individual cases, what payments and lodgements are relevant. Make it as simple as possible - but take all for the problem occuring financial data into account. This is often more important than the precision of the single values.

General parameters

rate of interest for costing purposes [%/period] i =
Assessment period [period] T =
Length of period (e.g.: year, half year, quarter year, month)

Payments

Capital-linked payments
Investment amounts
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each measure
tool must be expanded individually for each measure

Payments for repairs
Amount of payment when due [€] A_0 =
proportion of the investment f_K =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each measure
tool must be expanded individually for each measure

Consumption-linked payments
Energy consumption payments
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Operating materials payments
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Help energy payments
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Delivery and Storage payments
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Operation-linked payments
Amount of payment when due [€] A_0 =
proportion of the investment f_K =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each entry
tool must be expanded individually for each entry

Other payments
Amount of payment when due [€] A_0 =
proportion of the investment f_K =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each entry
tool must be expanded individually for each entry

Financing payments
financing amount FK =
financing rate i_{FK} =
credit period T_{FK} =
parameters are needed for each credit
tool must be expanded individually for each credit

Lodgements

Capital-linked lodgements
Sales revenues
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each sale
tool must be expanded individually for each sale

Consumption-linked lodgements
Reduction of energy costs
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Energy supply
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Operation-linked lodgements
Amount of payment when due [€] A_0 =
proportion of the investment f_K =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each entry
tool must be expanded individually for each entry

Other lodgements
Amount of payment when due [€] A_0 =
proportion of the investment f_K =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each entry
tool must be expanded individually for each entry

Financing lodgements
Amount of payment when due [€] A_0 =
Due after t_K periods $t_{K=}$
Price change rate [%] j =
Service life [a] TN =
parameters are needed for each energy type
tool must be expanded individually for each energy type

Examples for the Required Data

The description of the parameters can be found in “D 5.1 Financial Guide – General Concept and Tool”. This Guide shows also the equations for the calculation. The following list gives some examples for input data:

Rate of interest for costing purposes: e.g. 2,5 %

General increase of prices in the country

Assessment period: e.g. 50 years

How long is the time-span that should be analysed?

This has nothing to do with the pay-back time. For an owner of a building or flat it can be e.g. the time up to that he wanted to stay in his home, before selling it and going to an old people's home.

The assessment period could also be chosen as the lifetime of an investment.

Length of period: e.g. 1 year

The assessment period must be divided in periods. All other financial calculations will be structured in this period. If the calculations needed to be on monthly basis oder half year, than this periods have to be taken.

Prices e.g. all at the time "zero"

General all prices will be taken as prices at the time zero, when the assessment period starts. Through the price change rate the prices will be calculated for later payments. The price change rates of the various payments could be different or equal to the general interest of costing purposes. If the energy price change rate is higher than the general interest of costing purposes e.g. retrofitting measures are under good conditions.

Payments are investments, energy-payments, maintenance, cleaning etc.

Payments are all costs that the party, for which the calculation will be done (usually the owner), that must be payed during the assessment period. If two cases have to be compared it is suggestiv, that the payments, that are equal between the two cases should not be taken into account. If there are e.g. different life-times of some components during the assessment period, than the investment of this components is relevant.

Capital-linked payments; e.g. 20.000 € for heat insulation with a service life of 30 years and a price change rate of 2,5 %.

In most cases an investigation has to be evaluated at the time zero of the assessment period. When this investment should be compared with an alternative in which the investment will be done in 10 years and the length of period is years, than this payment will take after 10 periods. Normally it is also necessary to take a price change rate for the capital-linked payment and the service life of this investment. If the service life ends within the assessment period, then a second investment will be calculated on the basis of the today's costs and the price change rate for this kind of investment.

Payments for repairs; e.g. new painting of a wall every 15 years, witch costs 30% of the investment (including scaffolding, repairing cracks etc.)

Amount of payment when due. The first repair payment has to be done after x periods. Usually this time is identical with time zero plus life time. But if various cases should be compared with different times of investment than the various repairs will lead to different costs, also due to the price change rate effects.

Consumption-linked payments; energy consumption payments based on the calculations of energy demand after (!) the investment.

If the consumption-linked payments are completely energy consumptions than the payments for the energy delivery are basis for the input of period length and price change rates. In the case of energy consumption the service life is identical with the period. Energy consumption has to be given for every kind of energy (electricity, oil etc.)

Operating materials payment, help energy payments, delivery and storage payments and operation-linked payments are similar to calculate like consumption-linked payments.

Financing payments; e.g. costs for borrowed capital

The financing rate (e.g. 4 %) includes repayment and interest, through the contract time it is defined how much periods the repayment takes. The calculation must be done for each credit if there are more than one credits.

Lodgements are incoming payments

Capital-linked lodgements

In some economic evaluations sales must taken into account; this are capital-linked lodgements. This can e.g. take place as selling the flat or selling parts of a building. The point of time has to be given as amount of periods, usually in years.

Consumption-linked lodgements

In the calculation scenario the energy savings in €/period are consumption-linked lodgments.

While the energy costs after the retrofitting are consumption-linked payments, the amount of energy-safing is the consumption-linked lodgement. This must be defined by the periods when it takes place, by the price change rate and service life time.

In the case of energy usually the periods are equal to the consumption-linked payments. When the energy changes with the retrofitting - e.g. from electricity to oil - there could also change the price change rate and the service life time due to other delivery and account structures.

Energy supply

In some cases like combined heat and power generation plants, energy could be sold to others. The lodgements must be calculated for the over all calculation.

Financial lodgement

Grants due to support programs as far as they are available are important parts of the economic calculation. As all other financial data amount, time (period) and price change rate is necessary.

In the case of one single grant the price change is Zero as well as the service life time. When e.g. grants are monthly payed it could be, that they will rise with a specified rate. This is then the price change rate. In the case that a monthly rate will be payed for a fixed time e.g. until the owner retires, then the resulting time-span is the service life time.

7.2 Application example - Northrhine-westfalia

Object description

A multiple-family dwelling in Essen will be used as an application example. It is about a three-story multiple-family dwelling built in 1957. The object is located in the Stolbergstraße in Essen. The 18 3-room-apartements shall be energy efficient retrofitted. The aim of the modernisation is a 6-liter low energy building.

The construction is that of a solid building with a rear ventilated saddleback roof. The exterior walls consist of brickwalls which are plastered. The house end is additionally insulated. The ceilings are constructed of ferroconcrete while the windows consist of insulation glass.

Figure 4

Multiple family-dwelling front elevation and elevation of house end

Statement of costs and input parameters

Basic data of economic efficiency calculation

- Basic technical data
  - Dwellings 18
  - Total living area 1070m²
  - Assessment period 25 years
  - Rate of interest for costing purposes 5%
  - Period length year
- Capital-linked investment
  - Total investment amount 468.973,-€
  - Price change rate 2%
  - Service life 35 years
- Capital-linked recurring payments
  - Repairs 24.594,-€/a
  - Price change rate 1,1%
- Consumption-linked payments (from calculation of energy requirements)
  - Energy consumption before modernisation 189kWh/m²a
  - Energy costs (electricity) 0,074€/kWh
  - Energy consumption after modernisation 59kWh/m²a
  - Energy costs (district heat) 0,050€/kWh
  - Price change rate 4%
- Operation-linked payments
  - Administrative costs 8.280€/a
  - Price change rate 1,1%
- Financing payments
  - Borrowed capital 100% 468.973,-€

  - Financing rate 2% (kfw-Promotion)
  - Credit period 20 years
- Lodgements consumption-linked
  - Reduction of energy consumption 130kWh * 0,074€/kWh + 59kWh * 0,024€/kWh
  - Reduction of vacancy from 3% to 0%
- Lodgements operation-linked
  - Rents before modernisation 5,16€/m²
  - Price change rate 1,5%
- Lodgements from financing
  - Partial acquittal 20%

Implementation of parameters in calculation tool

First the economic rent will be calculated. To receive the economic rent for the energy efficient retrofitting it is necessary to exclude lodgments due to rents. With the economic rent for the retrofitting it is possible to make a comparison between the capital value with lodgements due to the old rent and the capital value based on lodgements due to the new economic rent.

General parameters						
rate of interest for costing purposes [%/period]	i =	5		Living area according to II.BV		1070
Assessment period [period]	T =	25				
Length of period (e.g.: year, half year, quarter year, month)	year					
Payments						
Capital-linked payments		Measure 1	Measure 2	Measure 3	Measure 4	Measure 5
Investment amounts						
Amount of payment when due [€]	A_0 =	468.973,00	0	0	0	0
Due after f_K periods	f_K=	0	0	0	0	0
Price change rate [%]	j =	2				
Service life [a]	TN =	35	1	1	1	1
parameters are needed for each measure						
tool must be expanded individually for each measure						
Payments for repairs						
Amount of payment when due [€]	A_0 =	24.595,00				
proportion of the investment	f_K =	5,24				
Due after f_K periods	f_K=	0				
Price change rate [%]	j =	1,1				
Service life [a]	TN =	1	1	1	1	1
parameters are needed for each measure						
tool must be expanded individually for each measure						
Consumption-linked payments						
Energy consumption payments						
Amount of payment when due [€]	A_0 =	3.156,50				
Due after f_K periods	f_K=	0				
Price change rate [%]	j =	4				
Service life [a]	TN =	1	1	1	1	1
parameters are needed for each energy type						
tool must be expanded individually for each energy type						
Operating materials payments						
Amount of payment when due [€]	A_0 =		Please use energy consumption as input form			
Due after f_K periods	f_K=					
Price change rate [%]	j =					
Service life [a]	TN =					
parameters are needed for each energy type						
tool must be expanded individually for each energy type						
Auxiliary energy payments						
Amount of payment when due [€]	A_0 =					
Due after f_K periods	f_K=					
Price change rate [%]	j =					
Service life [a]	TN =					
parameters are needed for each energy type						
tool must be expanded individually for each energy type						
Delivery and Storage payments						
Amount of payment when due [€]	A_0 =					
Due after f_K periods	f_K=					
Price change rate [%]	j =					
Service life [a]	TN =					
parameters are needed for each energy type						
tool must be expanded individually for each energy type						
Operation-linked payments						
Amount of payment when due [€]	A_0 =	8.280,00				
proportion of the investment	f_K =	1,77				
Due after f_K periods	f_K=	0				
Price change rate [%]	j =	1,1				
Service life [a]	TN =	1	1	1	1	1
parameters are needed for each entry						
tool must be expanded individually for each entry						
Other payments						
Amount of payment when due [€]	A_0 =					
proportion of the investment	f_K =					
Due after f_K periods	f_K=					
Price change rate [%]	j =					
Service life [a]	TN =	1	1	1	1	1
parameters are needed for each entry						
tool must be expanded individually for each entry						
Financing payments						
financing amount	FK =	468.973,00				
financing rate	f_{FK} =	5	1	1	1	1
credit period	T_{FK} =	20	1	1	1	1
Due after f_K periods	f_K=	0				
Service Life [a]	TN =	1	1	1	1	1
Price change rate [%]	j =	2				
parameters are needed for each credit						
tool must be expanded individually for each credit						

Figure 5 Input parameter of payments for application example

Lodgements				
Capital-linked lodgements		Measure 1	Measure 2	Measure 3
Sales revenues				
Amount of payment when due [€]	A_0 =			
Due after t_K periods	t_K=			
Price change rate [%]	j =			
Service life [a]	TN =	1	1	1
parameters are needed for each sale				
tool must be expanded individually for each sale				
Payments for repairs				
Amount of payment when due [€]	A_0 =			
proportion of the investment	f_K =			
Due after t_K periods	t_K=			
Price change rate [%]	j =			
Service life [a]	TN =	1	1	1
parameters are needed for each measure				
tool must be expanded individually for each measure				
Consumption-linked lodgements				
Reduction of energy costs				
Amount of payment when due [€]	A_0 =	11.808,52		
Due after t_K periods	t_K=	1		
Price change rate [%]	j =	4		
Service life [a]	TN =	1	1	1
parameters are needed for each energy type				
tool must be expanded individually for each energy type				
Energy supply				
Amount of payment when due [€]	A_0 =		Please use energy consump	
Due after t_K periods	t_K=			
Price change rate [%]	j =			
Service life [a]	TN =			
parameters are needed for each energy type				
tool must be expanded individually for each energy type				
Operation-linked lodgements				
Amount of payment when due [€]	A_0 =	66.254,40		
proportion of the investment	f_K =			
Due after t_K periods	t_K=	0		
Price change rate [%]	j =	1,5		
Service life [a]	TN =	1	1	1
parameters are needed for each entry				
tool must be expanded individually for each entry				
Other lodgements				
Amount of payment when due [€]	A_0 =			
proportion of the investment	f_K =			
Due after t_K periods	t_K=			
Price change rate [%]	j =			
Service life [a]	TN =	1	1	1
parameters are needed for each entry				
tool must be expanded individually for each entry				
Financing lodgements				
Amount of payment when due [€]	A_0 =	468973		
Proportion of investment	f_B=	20		
Price change rate [%]	j =	2		
Service life [a]	TN =	20	1	1
Due after t_K periods	t_K=	0		
parameters are needed for each energy type				
tool must be expanded individually for each energy type				

Figure 6 Input parameter of lodgments for application example

Object: TKIM Stolbergstraße	q =	5,0	%		Total amount	Measure 1	Measure 2
	T =	25	years				
Investment amount	A_0			1		468.973,00	-
Service life	TN =			2		35	1
annuity factor	a (q,T)	0,071		3		0,071	0,071
Residual value factor	R (q,T,TN)			4		0,084	-7,087
Residual value	RW =			5		39.568,29	-
Investment-linked payments	A/N_I =			6	30.467,32	30.467,32	-
Price change factor for repairs	r_K =			7		1,1	0
Factor for repairs in % of investment amount	f_K =			8		5,24	0
Payments for repairs in 1st year				9		24.574,19	-
Price-dynamic annuity factor	ba_{IN} =			10		1,11	1,00
Annuity of payments for repairs	A/N_{IN} =			11	27.352,51	27.352,51	-
Annuity of capital-linked payments	A/N_K =			12	57.819,83	57.819,83	-
Price change factor for main energy	r_{E1} =			13		4	0
Payments for main energy in 1st year	$A_{V1,1}$ =			14		3156,5	0
Price-dynamic annuity factor for main energy	ba_{V1} =			15		1,51	1,00
Annuity of annual cost for main energy	A/N_{V1} =			16	4.765,25	4.765,25	-
Price change factor for auxiliary energy	r_{E2} =			17		0	0
Payments for auxiliary energy in 1st year	$A_{V1,2}$ =			18		0	0
Price-dynamic annuity factor for auxiliary energy	ba_{V2} =			19		1,00	1,00
Annuity of annual cost for auxiliary energy	A/N_{V2} =			20	-	-	-
Annuity of consumption-linked payments	A/N_V =			25	4.765,25	4.765,25	-
Price change factor for operation-linked payments	r_B =			26		1,1	0
Factor for operation-linked payments in % of investment amount	f_B =			27		1,77	0
Payments for operation-linked payments in 1st year	A_B =			28		8.300,82	-
Price-dynamic annuity factor	ba_B =			29		1,11	1,00
Annuity of payments for operation-linked payments	A/N_B =			30	9.239,30	9.239,30	-
Price change factor for other payments	r_S =			31		0	0
Factor for other payments in % of investment amount	f_S =			32		0	0
Payments for other payments in 1st year	A_S =			33		-	-
Price-dynamic annuity factor	ba_S =			34		1,00	1,00
Annuity of payments for other payments	A/N_S =			35	-	-	-
Amount of financing	FK =			36		468973	0
Financing rate	i_{FK} =			37		5	1
credit period	T_{FK} =			38		20	1
Annuity factor for financing payments	a_{FK} =			39		0,080	1,010
Annuity of financing payments	A/N_F =			40	37.631,61	37.631,607	-
Price change factor for lodgements	r_{E1} =			41		-	-
Payments for lodgements in 1st year	$A_{V1,1}$ =			42		-	-
Price-dynamic annuity factor for lodgements	ba_{V1} =			43		1,00	1,00
Annuity of annual savings through lodgements	A/N_{V1} =			44	-	-	-
Price change factor for energy savings	r_{E2} =			45		4	0
Payments for energy savings in 1st year	$A_{V1,2}$ =			46		11808,52	0
Price-dynamic annuity factor for energy savings	ba_{V2} =			47		1,51	1,00
Annuity of annual savings through energy saving	A/N_{V3} =			48	17.826,89	17.826,89	-
Price change factor for part debt relief	r_B =			49		2	0
Factor for part debt relief in % of investment amount	f_B =			50		20	0
Payments for part debt relief in 1st year	A_B =			51		4.689,73	-
Price-dynamic annuity factor	ba_B =			52		1,22	1,00
Annuity of part debt relief	A/N_B =			53	5.717,99	5.717,99	-
Annuity of annual payments				54	109.455,99		
Annuity of annual lodgements				55	23.544,88		
Total annuity of all cost factors	A/N =			56	- 85.911,11		

Allocation of annual payments to monthly m²-rent			
Annuities	-	85.911,112	[€]
living area according to II. BV		1070	[m²]
Annual economic rent/m²		- 80,291	[€/m²a]
Monthly economic rent/m²		**- 6,691**	[€/m²]

Figure 7 Result of the annuity method calculation

	Object: TKIM Stolbergstraße		interest rate for costing purposes [%/Periods]		assessment period [Periods]		Length of period			
	Measure:		i =	5	T =	25	year	half year	quarter year	month
	1	2	3	4	5	6	7	8		9
	Payments	Payment amount when due [€]	Due after t_K Periods	Accrued interest factor q^{tk}	Price change rate j %	Service life T/N	Cash value factor			Cash value adjusted to T (substitute value)
							b(T-tk,q,r)	b(T/N,q,r)		(2)/(4) * (7)/(8)
one-off payments	**Capital-linked payments**									**379.278,49**
	Measure 1	468.973,00	0	1	2	35	17,184	21,248		379.278,49
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
Recurring payments	**Payments for repairs**									**385.831,32**
	Measure 1	24.595,00	0	1	1,1	1	15,687	1,000		385.831,32
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
	Consumption-linked payments									**67.161,21**
	Energy type 1	3.156,50	0	1	4	1	21,277	1,000		67.161,21
	Energy type 2	0	0	1	0	1	14,094	1,000		-
	Energy type 3	0	0	1	0	1	14,094	1,000		-
	Energy type 4	0	0	1	0	1	14,094	1,000		-
	Energy type 5	0	0	1	0	1	14,094	1,000		-
	Energy type 6	0	0	1	0	1	14,094	1,000		-
	Energy type 7	0	0	1	0	1	14,094	1,000		-
	Energy type 8	0	0	1	0	1	14,094	1,000		-
	Energy type 9	0	0	1	0	1	14,094	1,000		-
	Energy type 10	0	0	1	0	1	14,094	1,000		-
	Operation-linked payments									**129.891,58**
	Entry 1	8.280,00	0	1	1,1	1	15,687	1,000		129.891,58
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Other payments									**-**
	Entry 1	-	0	1	0	1	14,094	1,000		-
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Financing payments									**646.667,18**
	Financing method 1	37.631,61	0	1	2	1	17,184	1,000		646.667,18
	Financing method 2	-	0	1	0	1	14,094	1,000		-
	Financing method 3	-	0	1	0	1	14,094	1,000		-
	Financing method 4	-	0	1	0	1	14,094	1,000		-
	Financing method 5	-	0	1	0	1	14,094	1,000		-
	Financing method 6	-	0	1	0	1	14,094	1,000		-
	Financing method 7	-	0	1	0	1	14,094	1,000		-
	Financing method 8	-	0	1	0	1	14,094	1,000		-
	Financing method 9	-	0	1	0	1	14,094	1,000		-
	Financing method 10	-	0	1	0	1	14,094	1,000		-
							Total payments			**1.608.829,78**
	Capital value K =Lodgements - Payments =	- 186.252,19								

Figure 8 Payment and total result of capital value method calculation

	Object: TKIM Stolbergstraße		interest rate for costing purposes [%/Periods]		assessment period [Periods]		Length of period			
	Measure:		i =	5	T =	25	year	half year	quarter year	month
	1	2	3	4	5	6	7	8		9
	Lodgements	Lodgement amount when due [€]	Due after t_K Periods	Accrued interest factor q^{tk}	Price change rate j %	Service life TN	Cash value factor b(T-tk,q,r)	Cash value factor b(TN,q,r)		Cash value adjusted to T (substitute value) (2)/(4) * (7)/(8)
one-off lodgements	**Capital-linked lodgements**									-
	Measure 1	-	0	1	0	1	14,094	1,000		-
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
Recurring lodgements	**lodgements for repairs**									-
	Measure 1	-	0	1	0	1	14,094	1,000		-
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
	Consumption-linked lodgements									**230.774,06**
	Energy type 1	11.808,52	1	1,05	4	1	20,520	1,000		230.774,06
	Energy type 2	0	0	1	0	1	14,094	1,000		-
	Energy type 3	0	0	1	0	1	14,094	1,000		-
	Energy type 4	0	0	1	0	1	14,094	1,000		-
	Energy type 5	0	0	1	0	1	14,094	1,000		-
	Energy type 6	0	0	1	0	1	14,094	1,000		-
	Energy type 7	0	0	1	0	1	14,094	1,000		-
	Energy type 8	0	0	1	0	1	14,094	1,000		-
	Energy type 9	0	0	1	0	1	14,094	1,000		-
	Energy type 10	0	0	1	0	1	14,094	1,000		-
	Operation-linked lodgements									**1.081.899,93**
	Entry 1	66.254,40	0	1	1,5	1	16,329	1,000		1.081.899,93
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Other lodgements									-
	Entry 1	-	0	1	0	1	14,094	1,000		-
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Financing lodgements									**109.903,60**
	Financing method 1	93.794,60	0	1	2	20	17,184	14,665		109.903,60
	Financing method 2	0	0	1	0	1	14,094	1,000		-
	Financing method 3	0	0	1	0	1	14,094	1,000		-
	Financing method 4	0	0	1	0	1	14,094	1,000		-
	Financing method 5	0	0	1	0	1	14,094	1,000		-
	Financing method 6	0	0	1	0	1	14,094	1,000		-
	Financing method 7	0	0	1	0	1	14,094	1,000		-
	Financing method 8	0	0	1	0	1	14,094	1,000		-
	Financing method 9	0	0	1	0	1	14,094	1,000		-
	Financing method 10	0	0	1	0	1	14,094	1,000		-
							Total lodgements			**1.422.577,59**

Figure 9 Lodgements due to the old rent

	Object: TKIM Stolbergstraße		interest rate for costing purposes [%/Periods]		assessment period [Periods]		Length of period			
	Measure:		i =	5	T =	25	year	half year	quarter year	month
	1	2	3	4	5	6	7	8		9
	Lodgements	Lodgement amount when due [€]	Due after t_K Periods	Accrued interest factor q^{tk}	Price change rate j %	Service life TN	Cash value factor			Cash value adjusted to T (substitute value)
							$b(T\text{-}tk,q,r)$	$b(TN,q,r)$		(2)/(4) * (7)/(8)
one-off lodgements	**Capital-linked lodgements**									**-**
	Measure 1	-	0	1	0	1	14,094	1,000		-
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
Recurring lodgements	**lodgements for repairs**									**-**
	Measure 1	-	0	1	0	1	14,094	1,000		-
	Measure 2	-	0	1	0	1	14,094	1,000		-
	Measure 3	-	0	1	0	1	14,094	1,000		-
	Measure 4	-	0	1	0	1	14,094	1,000		-
	Measure 5	-	0	1	0	1	14,094	1,000		-
	Measure 6	-	0	1	0	1	14,094	1,000		-
	Measure 7	-	0	1	0	1	14,094	1,000		-
	Measure 8	-	0	1	0	1	14,094	1,000		-
	Measure 9	-	0	1	0	1	14,094	1,000		-
	Measure 10	-	0	1	0	1	14,094	1,000		-
	Consumption-linked lodgements									**230.774,06**
	Energy type 1	11.808,52	1	1,05	4	1	20,520	1,000		230.774,06
	Energy type 2	0	0	1	0	1	14,094	1,000		-
	Energy type 3	0	0	1	0	1	14,094	1,000		-
	Energy type 4	0	0	1	0	1	14,094	1,000		-
	Energy type 5	0	0	1	0	1	14,094	1,000		-
	Energy type 6	0	0	1	0	1	14,094	1,000		-
	Energy type 7	0	0	1	0	1	14,094	1,000		-
	Energy type 8	0	0	1	0	1	14,094	1,000		-
	Energy type 9	0	0	1	0	1	14,094	1,000		-
	Energy type 10	0	0	1	0	1	14,094	1,000		-
	Operation-linked lodgements									**1.402.686,04**
	Entry 1	85.899,00	0	1	1,5	1	16,329	1,000		1.402.686,04
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Other lodgements									**-**
	Entry 1	-	0	1	0	1	14,094	1,000		-
	Entry 2	0	0	1	0	1	14,094	1,000		-
	Entry 3	0	0	1	0	1	14,094	1,000		-
	Entry 4	0	0	1	0	1	14,094	1,000		-
	Entry 5	0	0	1	0	1	14,094	1,000		-
	Entry 6	0	0	1	0	1	14,094	1,000		-
	Entry 7	0	0	1	0	1	14,094	1,000		-
	Entry 8	0	0	1	0	1	14,094	1,000		-
	Entry 9	0	0	1	0	1	14,094	1,000		-
	Entry 10	0	0	1	0	1	14,094	1,000		-
	Financing lodgements									**109.903,60**
	Financing method 1	93.794,60	0	1	2	20	17,184	14,665		109.903,60
	Financing method 2	0	0	1	0	1	14,094	1,000		-
	Financing method 3	0	0	1	0	1	14,094	1,000		-
	Financing method 4	0	0	1	0	1	14,094	1,000		-
	Financing method 5	0	0	1	0	1	14,094	1,000		-
	Financing method 6	0	0	1	0	1	14,094	1,000		-
	Financing method 7	0	0	1	0	1	14,094	1,000		-
	Financing method 8	0	0	1	0	1	14,094	1,000		-
	Financing method 9	0	0	1	0	1	14,094	1,000		-
	Financing method 10	0	0	1	0	1	14,094	1,000		-
							Total lodgements			**1.743.363,70**

Figure 10 Lodgements due to the economic rent calculated with the annuity method calculation

Capital value K =Lodgements - Payments =	134.533,92

Figure 11 Capital value of the energy efficient retrofitting based on lodgements due to the calculated economic rent

7.3 Application example – Greece Typ 1

This object is an 8-storey apartment building in Amaroussion with a total floor area of 2080m² comprising 24 apartements. It was built in 1977 and shows the typical construction characteristics of most social housings of the period. The building is heated by a central oil-heating system and radiators in each flat.

For this object the following measures are examined: insulation of the exterior hull, replacement of windows and the heating system, shading, ventilation, ceiling fans and combinations of some of the mentioned measures.

Economic efficiency – Shading

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	9000
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	4275
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	920
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 7.552,142	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 3,631	[€/m²a]
Monthly economic rent/m²	**- 0,303**	[€/m²]

Capital value K =Lodgements - Payments	
= 41.985,23 – 203.790,05 =	**- 161.804,82**

Economic efficiency – Shading + Ventilation

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	9000
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	3083
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2111
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 2.655,716	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 1,277	[€/m²a]
Monthly economic rent/m²	**- 0,106**	[€/m²]

Capital value K =Lodgements - Payments = 96.337,84 – 149.391,80 =	**- 53.053,96**

Economic efficiency – Ceiling fans

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	3600
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	2436
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2759
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	400,272	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	0,192	[€/m²a]
Monthly economic rent/m²	**0,016**	[€/m²]

Capital value K =Lodgements - Payments = 125.910,04 – 114.647,84 =	**11.262,20**

Economic efficiency – Shading + Ventilation + Ceiling fans

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	12600
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	2285
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	8104
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	11.034,560	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	5,305	[€/m²a]
Monthly economic rent/m²	**0,442**	[€/m²]

Capital value K =Lodgements - Payments = 369.835,09 – 116.452,44 =	**253.382,65**

Economic efficiency – Façade

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	71400
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	2430
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1
Financing payments		
financing amount	*FK* =	71400
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	*TN* =	15
Price change rate [%]	*j* =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	3771
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 8.328,748	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 4,004	[€/m²a]
Monthly economic rent/m²	**- 0,334**	[€/m²]

Capital value K =Lodgements - Payments = 172.093,79 – 187.298,40 =	**- 15.204,61**

Economic efficiency – Windows

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	99200
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	4293
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	99200
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1908
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 20.300,353	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 9,760	[€/m²a]
Monthly economic rent/m²	**- 0,813**	[€/m²]

Capital value K =Lodgements - Payments	
= 87.073,71 – 302.066,29 =	**- 214.992,58**

Economic efficiency – Façade + Windows

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	170600
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	631
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	170600
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	5570
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 16.769,744	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 8,062	[€/m²a]
Monthly economic rent/m²	**- 0,672**	[€/m²]

Capital value K =Lodgements - Payments	
= 254.193,17 – 211.349,47 =	**42.843,69**

Economic efficiency – Heating System

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	20200
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	3720
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	20200
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2480
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 5.735,117	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 2,757	[€/m²a]
Monthly economic rent/m²	**- 0,230**	[€/m²]

Capital value K =Lodgements - Payments = 113.177,57 – 191.381,66 =	**- 78.204,10**

Economic efficiency – Façade + Windows + Heating System

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	190800
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	760
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	190800
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	5441
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 20.487,115	[€]
living area according to II. BV	2080	[m²]
Annual economic rent/m²	- 9,850	[€/m²a]
Monthly economic rent/m²	**- 0,821**	[€/m²]

Capital value K =Lodgements - Payments = 248.306,11 – 238.851,85 =	**9.454,26**

7.4 Application example – Greece Typ 2

This application example is a 4-storey apartment building in Amaroussian. It has a total floor area of 1200m² which are divided into 16 apartements. It was also built in 1977 and shows the typical constructional characteristics of this period. The heating energy is supplied by a central oil-fired heating system with a distribution by radiators in each flat.

For this object the following measures are examined: insulation of the exterior hull, replacement of windows and the heating system, shading, ventilation, ceiling fans and combinations of some of the mentioned measures.

Economic efficiency – Shading

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	11000
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	3429
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	180
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 7.480,677	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	- 6,234	[€/m²a]
Monthly economic rent/m²	**- 0,519**	[€/m²]

Capital value K =Lodgements - Payments = 8.214,50 – 167.114,26 =	**- 158.899,76**

Economic efficiency – Shading + Ventilation

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	11000
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	1907
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1702
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 1.226,074	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	- 1,022	[€/m²a]
Monthly economic rent/m²	**- 0,085**	[€/m²]

Capital value K =Lodgements - Payments = 77.672,67 – 97.656,09 = **- 19.983,42**

Economic efficiency – Ceiling fans

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	2400
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	10
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	1444
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2165
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,49
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	1.305,857	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	1,088	[€/m²a]
Monthly economic rent/m²	**0,091**	[€/m²]

Capital value K =Lodgements - Payments = 98.802,19 – 68.217,39 =	**30.584,80**

Economic efficiency – Façade

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	39200
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	1500
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	39200
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	3015
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 2.972,493	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	- 2,477	[€/m²a]
Monthly economic rent/m²	**- 0,206**	[€/m²]

Capital value K =Lodgements - Payments	
= 137.592,89 – 110.400,72 =	**27.192,17**

Economic efficiency – Windows

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	62000
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	2638
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	62000
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1877
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 11.188,537	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	- 9,324	[€/m²a]
Monthly economic rent/m²	**- 0,777**	[€/m²]

Capital value K =Lodgements - Payments	
= 85.658,99 – 186.732,10 =	**- 101.073,11**

Economic efficiency – Heating System

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	12120
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	2709
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1
Financing payments		
financing amount	FK =	12120
financing rate	i_{FK} =	6,67
credit period	T_{FK} =	15
Due after t_K periods	t_K=	1
Service Life [a]	TN =	15
Price change rate [%]	j =	3,5
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1806
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,49
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 3.767,733	[€]
living area according to II. BV	1200	[m²]
Annual economic rent/m²	- 3,140	[€/m²a]
Monthly economic rent/m²	**- 0,262**	[€/m²]

Capital value K =Lodgements - Payments = 82.418,83 – 136.597,43 =	**- 54.178,60**

7.5 Application example – Spain Typ 1

The first object chosen for the application example is the building Calle Azoz. The building is an H-shaped flat building consisting of a groud floor with storage places and 8 floors with 4 dwellings on each floor. This building belongs to the typical flat buildings from the period of 1960 to 1970. The heating of the building is supplied by a central heating system while there is no mechanical ventilation.

In this application example the following single measures are calculated for their economic efficiency:

insulation of exterior walls and roof, replacement of windows and the heating system. Additionally a variation with a package of all measures will be examined.

Economic efficiency – Façade

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	82720
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	3843
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2744
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 5.565,868	[€]
living area according to II. BV	1312	[m²]
Annual economic rent/m²	- 4,242	[€/m²a]
Monthly economic rent/m²	**- 0,354**	[€/m²]

Capital value K =Lodgements - Payments = 90.313,35 – 206.407,47 =	**- 116.094,12**

Economic efficiency – Roof

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	26400
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	6545
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	39
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 10.839,61	[€]
living area according to II. BV	1312	[m²]
Annual economic rent/m²	- 8,262	[€/m²a]
Monthly economic rent/m²	**- 0,688**	[€/m²]

Capital value K =Lodgements - Payments = 1.283,61 – 240.923,01 =	**- 239.639,41**

Economic efficiency – Windows

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	67000
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	5252
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1334
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 9.137,018	[€]
living area according to II. BV	1312	[m²]
Annual economic rent/m²	- 6,964	[€/m²a]
Monthly economic rent/m²	**- 0,580**	[€/m²]

Capital value K =Lodgements - Payments = 43.905,98 – 237.593,52 =	**- 193.687,54**

Economic efficiency – Heating System

General parameters		
rate of interest for costing purposes [%/period]	i =	3,5
Assessment period [period]	T =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	13500
Due after t_K periods	t_K=	1
Price change rate [%]	j =	3,5
Service life [a]	TN =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	5269
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	1317
Due after t_K periods	t_K=	1
Price change rate [%]	j =	2
Service life [a]	TN =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 6.497,774	[€]
living area according to II. BV	1312	[m²]
Annual economic rent/m²	- 4,953	[€/m²a]
Monthly economic rent/m²	**- 0,413**	[€/m²]

Capital value K =Lodgements - Payments = 43.346,46 – 186.462,22 =	**- 143.115,76**

Economic efficiency – Measure package

General parameters					
rate of interest for costing purposes [%/period]	*i* =	3,5		Living area according to II.BV	
Assessment period [period]	*T* =	50			
Length of period (e.g.: year, half year, quarter year, month)		year			
Payments					
Capital-linked payments		Windows	Facade	Heating system	Roof
Investment amounts					
Amount of payment when due [€]	A_0 =	67000	82720	13500	26400
Due after t_K periods	t_K=	1	1	1	1
Price change rate [%]	*j* =	3,5	3,5	3,5	3,5
Service life [a]	*TN* =	25	30	25	30
Consumption-linked payments					
Energy consumption payments					
Amount of payment when due [€]	A_0 =	2552			
Due after t_K periods	t_K=	1			
Price change rate [%]	*j* =	2			
Service life [a]	*TN* =	1	1	1	1
Lodgements					
Consumption-linked lodgements					
Reduction of energy costs					
Amount of payment when due [€]	A_0 =	4034			
Due after t_K periods	t_K=	1			
Price change rate [%]	*j* =	2			
Service life [a]	*TN* =	1	1	1	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 7.071,858	[€]
living area according to II. BV	1312	[m²]
Annual economic rent/m²	- 5,390	[€/m²a]
Monthly economic rent/m²	**- 0,449**	[€/m²]

Capital value K =Lodgements - Payments	
= 132.771,15 – 267.201,78 =	**- 134.430,62**

7.6 Application example – Spain Typ 2

The second object with available economic calculation data is the building Chantrea. It is a typical linear 4-storey building with a pitched roof built in the period between 1940 and 1950. Four dwellings are located on each floor. This building is heated by a central heating system with an assumed efficiency of 88%. A mechanical ventilation system does not exist.

In this application example the following single measures are calculated for their economic efficiency:

insulation of exterior walls and roof, replacement of windows and the heating system. Additionally a variation with a package of all measures will be examined.

Economic efficiency – Façade

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	207600
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	9202
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	7317
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 12.682,852	[€]
living area according to II. BV	2176	[m²]
Annual economic rent/m²	- 5,829	[€/m²a]
Monthly economic rent/m²	**- 0,486**	[€/m²]

Capital value K =Lodgements - Payments	
= 240.824,63 – 503.445,39 =	**- 262.620,77**

Economic efficiency – Roof

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	23000
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	30
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	16270
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	249
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 24.687,916	[€]
living area according to II. BV	2176	[m²]
Annual economic rent/m²	- 11,346	[€/m²a]
Monthly economic rent/m²	**- 0,945**	[€/m²]

Capital value K =Lodgements - Payments = 8.195,34 – 557.717,19 =	**- 549.521,84**

Economic efficiency – Windows

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	190000
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	13583
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	2936
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 25.228,097	[€]
living area according to II. BV	2176	[m²]
Annual economic rent/m²	- 11,594	[€/m²a]
Monthly economic rent/m²	**- 0,966**	[€/m²]

Capital value K =Lodgements - Payments = 96.632,65 – 630.632,54 =	**- 533.999,89**

Economic efficiency – Heating System

General parameters		
rate of interest for costing purposes [%/period]	*i* =	3,5
Assessment period [period]	*T* =	50
Length of period (e.g.: year, half year, quarter year, month)		year
Payments		
Capital-linked payments		Measure 1
Investment amounts		
Amount of payment when due [€]	A_0 =	23500
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	3,5
Service life [a]	*TN* =	25
Consumption-linked payments		
Energy consumption payments		
Amount of payment when due [€]	A_0 =	13215
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1
Lodgements		
Consumption-linked lodgements		
Reduction of energy costs		
Amount of payment when due [€]	A_0 =	3304
Due after t_K periods	t_K=	1
Price change rate [%]	*j* =	2
Service life [a]	*TN* =	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 15.774,81	[€]
living area according to II. BV	2176	[m²]
Annual economic rent/m²	- 7,249	[€/m²a]
Monthly economic rent/m²	**- 0,604**	[€/m²]

Capital value K =Lodgements - Payments = 108.744,64 – 457.650,98 =	**- 348.906,33**

Economic efficiency – Measure package

General parameters					
rate of interest for costing purposes [%/period]	*i* =	3,5		Living area according to II.BV	
Assessment period [period]	*T* =	50			
Length of period (e.g.: year, half year, quarter year, month)		year			
Payments					
Capital-linked payments		Windows	Facade	Heating system	Roof
Investment amounts					
Amount of payment when due [€]	A_0 =	190000	207600	23500	23000
Due after t_K periods	t_K=	1	1	1	1
Price change rate [%]	*j* =	3,5	3,5	3,5	3,5
Service life [a]	*TN* =	25	30	25	30
Consumption-linked payments					
Energy consumption payments					
Amount of payment when due [€]	A_0 =	5529			
Due after t_K periods	t_K=	1			
Price change rate [%]	*j* =	2			
Service life [a]	*TN* =	1	1	1	1
Lodgements					
Consumption-linked lodgements					
Reduction of energy costs					
Amount of payment when due [€]	A_0 =	10361			
Due after t_K periods	t_K=	1			
Price change rate [%]	*j* =	2			
Service life [a]	*TN* =	1	1	1	1

Results:

Allocation of annual payments to monthly m²-rent		
Annuities	- 14.622,054	[€]
living area according to II. BV	2176	[m²]
Annual economic rent/m²	- 6,720	[€/m²a]
Monthly economic rent/m²	**- 0,560**	[€/m²]

Capital value K =Lodgements - Payments	
= 341.011,88 – 611.058,26 =	**- 270.046,37**

8 Excursus: U-Value Tool

The economic efficiency calculation can also be used for an optimization of single construction elements. Depending on the change of the U-value due to a retrofitting measure the energy savings and costs can be calculated and set off against the investment costs. The result of this calculation will be the payback period.

Determination of the U-value

U-value old

Heat transmission resistance exterior			0,14
Layer	Thickness in m	Rated value for heat conductance in W/(mK)	Heat resistance in m²K/W
Plaster	0,025	0,87	0,03
Brick	0,3	0,46	0,65
Plaster	0,015	0,87	0,02
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
Heat transmission resistance indoor			0,07

Heat resistance R_{ges}	**0,91**	**m²K/W**
Coefficient for heat transmission - U-Value	**1,10**	**W/(m²K)**
thermal bridge addition Single calculation below	0	W/(m²K)
Coefficient for heat transmission - U-Value including the thermal bridge	**1,10**	**W/(m²K)**

U-value new

Heat transmission resistance exterior			0,14
Layer	Thickness in m	Rated value for heat conductance in W/(mK)	Heat resistance in m²K/W
Plaster	0,025	0,87	0,03
Insulation	0,12	0,04	3,00
	0,008	0,7	0,01
Brick	0,3	0,46	0,65
Plaster	0,015	0,87	0,02
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
	0	1	0,00
Heat transmission resistance indoor			0,07

Heat resistance R_{ges}	**3,92**	**m²K/W**
Coefficient for heat transmission - U-Value	**0,26**	**W/(m²K)**
thermal bridge addition Single calculation below	0	W/(m²K)
Coefficient for heat transmission - U-Value including the thermal bridge	**0,26**	**W/(m²K)**

Fx-Value					
Exterior wall, window	1				
	old	new			
Heat limit temperature	1877	1265	days		
Heizgrenztemperatur	15	12	°C		
Inside temperature	19	19	°C		
location	Düsseldorf	Düsseldorf			
Old condition					
Thermal bridge	0,294	0,017	0,017	0,017	
Length of thermal bridge	30	30	30	30	m
New condition					
Thermal bridge	0,294	0,017	0,017	0,017	
Length of thermal bridge	30	30	30	30	m
Considered area	100	m²			
Q old	**5427**	kWh/a			
Q new	**1089**	kWh/a			
ΔQ	**4338**	kWh/a			

Figure 12 Calculation of the U-value and the corresponding energy losses

Calculation of the energy costs and savings

Q old	5427	kWh/a
Q new	1089	kWh/a
ΔQ	4338	kWh/a
machine operating expanse factor		
Constant temperature boiler	1,38	old
Condensing boiler 55/45	1,05	new
Qh old	**7489**	kWh/a
Qh new	**1143**	kWh/a
ΔQh	**6346**	kWh/a
Energy costs old	0,14	€/kWh
Energy costs new	0,07	€/kWh
Energy costs old	**1048,43**	€
Energy costs new	**80,03**	€
Energy cost savings	**888,38**	€

Figure 13 Calculation of the energy costs and savings including the heating system losses

Calculation of the investment costs

Investment costs	20.000,00	€
Energy cost savings	5,00	€
Interest rate	6	%
Price change rate	3	%
Assessment period	20	years
Service life	35	years
Cash value factor b(T-tk,q,r)	14,562	
Cash value factor b(TN,q,r)	21,130	
Total costs	13.782,76	€
Price change factor for energy costs	4	%
Payment interval	1	years
Cash value factor for energy cost savings b(T-tk,q,r)	15,840	
Cash value factor for energy cost savings b(TN,q,r)	0,943	
Energy cost savings during the assessment period	83,95	€
Total costs minus energy cost savings	13.698,81	€

Figure 14 Calculation of the capital value of the investment

Calculation of the payback period

Investment costs	20.000,00	€
Energy cost savings	888,38	€
Interest rate	6	%
Price change factor for energy costs	4	%
Payback Period	**31**	**years**

Figure 15 Calculation of the payback period

9 Literature and other sources

[1] Verein deutscher Ingenieure: VDI 6025 – Economy calculation systems for capital goods and plants.Fassung November 1996. Beuth Verlag GmbH. 1996

[2] Verein deutscher Ingenieure: VDI 6027 – Economic efficiency of building installations – Fundamentals and economic calculation. Fassung September 2000. Beuth Verlag GmbH. 2000

[3] Ehling, K.: Tageslichtsysteme: Lichttechnische Bewertung und Wirtschaftlichkeit. Fortschritt-Berichte VDI, Reihe 4 Bauingenieurwesen, Nr. 165. VDI Verlag GmbH. 2000

[4] Kühne-Büning, L.; Nordalm, V.; Steveling, L.: Grundlagen der Wohnungs- und Immobilienwirtschaft. Fritz Knapp Verlag. 2005

[5] Möller, D.: Planungs- und Bauökonomie – Band 1: Grundlagen der wirtschaftlichen Bauplanung. Oldenbourg Verlag. 2001

[6] Schmidt, R.: Haustechnik für das Holzhaus. mikado (2006), Heft 8, S. 30-35

[7] AG Passivhaus GmbH: Vorausrechnen und sparen. mikado (2006), Heft 8, S. 50-53