

Energy Certificate for Buildings: Field Test Evaluation

Summary of results

For the German Energy Agency

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1 Objective of the evaluation and methodical procedures

In their Directive on “energy performance of buildings”, the European Commission foresees the presentation of an energy certificate in cases of new construction, purchase or rental of buildings. Until 2006 at the latest, this directive has to be taken into account in national legislation. For this purpose, the German Energy Agency (dena) conducted a field test for residential buildings between the fall of 2003 and the end of 2004. The Fraunhofer ISI together with the Eco-Institute and the Fraunhofer Institute for Building Physics was assigned evaluation of the said field test.

1.1 Objectives and methodical procedures

With the objective of gaining insight into optimization of the dena energy certificate prototype and the precepts of its compilation, the field test was also subjected to an accompanying evaluation. Focus of the study was market acceptance and market effects of the energy certificate, implementation aspects of issuing the energy certificate and balancing the calculation procedures.

Focus of **market acceptance and market effects** intended was evaluation of the insight gained in terms of comprehensibility and acceptance of the energy certificate as well as the significance of the energy certificate for modernization investments. An additional point of focus was the design of the energy certificate.

All data contained in the energy certificates issued are recorded electronically in a dena database. The said data was assessed several times in the course of the project. A total of 3,925 energy certificates were taken into consideration in the evaluation process. By the conclusion of the project, 4,122 energy certificates had been issued. The database served as a basic address book for interviewing building proprietors, carried out in the form of in-depth telephone interviews, complete written data acquisition from all proprietors. Additional in-depth telephone interviews with the proprietors of buildings, representatives of joint ownership committees and tenants were conducted for in-depth treatment of specific questions. The first in-depth interviews were conducted with a total of 30 proprietors. The first qualitative reports on acceptance and assessment of the energy certificates were determined in the process. Six months later, a total of 1,138 questionnaires were sent to the owners of buildings within the framework of a complete data acquisition. The feedback was around 51% with 582 questionnaires. Telephone interviews of greater depth were conducted afterwards with a number of the interviewees.

The focus in terms of **balancing** concerned the practical suitability of the calculation procedures and their marginal effects. Insight had to be won on handling the proce-

dures and the accuracy of the different data acquisition and calculation procedures. Reliable geometric simplifications as well as values obtained by means of the tools used were assessed in (short or extensive) balancing of the acquisition procedures. In this process, a detailed sensitivity analysis on constructional and asset technological simplifications was performed. In addition to the above, an object in the area of Stuttgart was balanced out in accordance with both procedures.

In the focus of **implementation**, the evaluation was intended to provide insight into the qualifications of the various issuing experts, the suitability of the said experts and their approach to the said procedures in the field test. The issuing experts concerned were questioned in terms of their experience with data acquisition in the field test by telephone and in writing as well as the effort and costs required for issuing an energy certificate. In addition to this, the influence accredited to the procedures and simplifications used for data acquisition as well as to the qualifications of the issuing expert were empirically determined.

In the summer of 2004 the 69 issuing experts listed at the time and as well as a total of 369 persons in January 2005 were written to with a feedback of 247 questionnaires. In the fall of 2004 intensive telephone interviewing was carried out.

1.2 Results of the database assessment

The field test produced significant results in terms of structural features for buildings of all sizes, different participant groups and regions, a variety of issuing experts with differing qualifications, different calculation programs and procedures as well as a broad spectrum of energy framework conditions such as the sources of energy, means of heating, building construction and heating technological features.

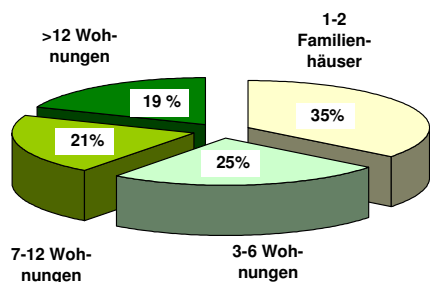


Fig. 1: Percentage distribution of buildings in the field test

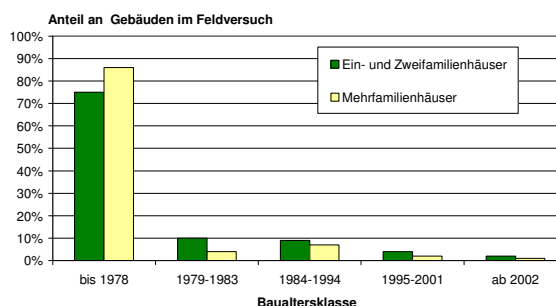


Fig. 2: Classification of the age of buildings in the field test essentially corresponds to building structures in Germany

All 33 field test participants submitted energy certificates, albeit in different numbers. Altogether a total of 393 issuing experts participated. With regard to their qualifications, on-site energy advisors represented the majority at 38%, those authorized to submit building specifications and approved master/advisory craftsmen represented almost a quarter each, and authorized EnEV staff represented 16%.

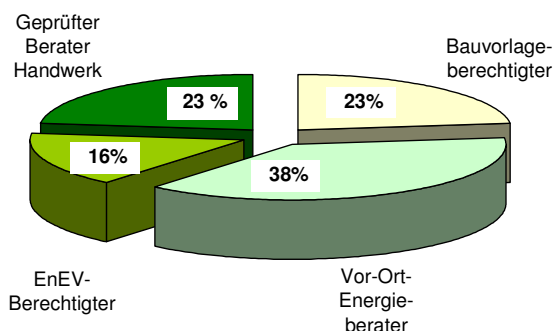


Fig. 3: qualifications of the 393 active issuing experts in the field test

Illustration texts	
1	approved master/advisory craftsmen
2	authorized to submit building specifications
3	authorized EnEV staff
4	On-site energy advisor

In 60% of the cases involved, the issuing experts undertook simplifications in the acquisition of data; otherwise the "extensive" procedure was used. Apart from the master/advisory craftsmen who were obliged to use only the "short" procedure, only a slight correlation with the qualifications of the issuing experts was revealed.

In only a relatively small number of buildings, round 10% of detached single and duplex houses and round 20% of apartment houses had thorough modernization been carried out in accordance with the energy certificate. The remainder received concrete recommendations from the issuing experts, which should lead to an average sinking of the primary energy requirements by approx. one third where recommendation 1 is followed and by almost 40% where recommendation 2 is also followed.

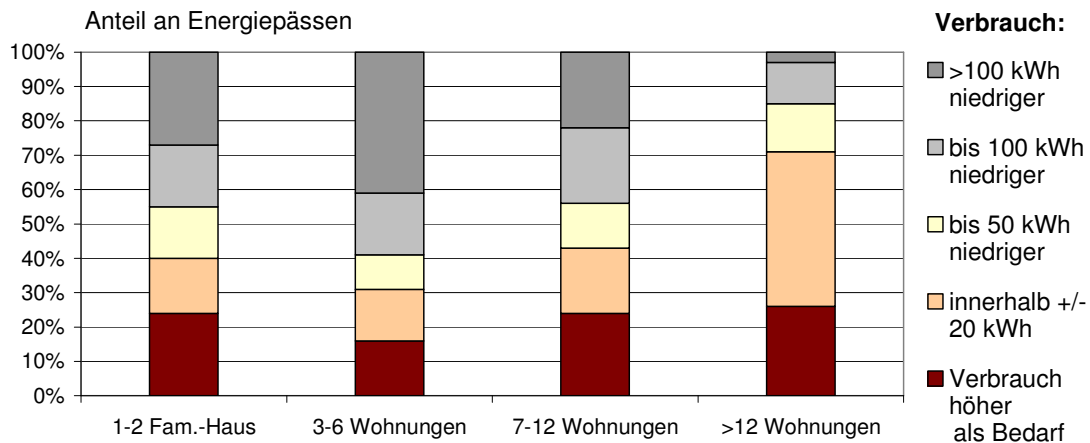


Fig. 4: Deviation of operational energy consumption and calculated energy consumption with respect to the size of the building

Illustration texts		
1	Anteil an ...	percentage of energy certificates
2	Verbrauch	operational consumption
3	Niedriger – innerhalb – höher als Bedarf	lower – within – higher than calculated consumption
4	1 – 2 Fam.-Haus	1 and 2-family houses
5	Wohnungen	apartments

Comparison between the calculated energy consumption and operational metered energy consumption, assuming the latter was shown unequivocally and plausibly in the energy certificate, indicates considerable deviations in all sizes of buildings. In most cases, the calculated energy consumptions were higher than the operational metered consumptions.

2. Market acceptance and comprehension of the energy certificate

2.1 Fundamental acceptance of the energy certificate

The energy certificates were well accepted by private owners and equally so by some of the housing societies. Considerable satisfaction was expressed by all target groups questioned with regard to the predefined criteria, both in terms of the issuing experts and the procedures involved in the issue of energy certificates. Restrictions were expressed by certain housing societies who assessed the process somewhat more critically with regard to its duration and their own effort involved. The overall appearance of

the energy certificate has an appealing effect on the proprietors; the coloration creates a good impression. Black and white copies of the energy certificate may, however, lead to problems in terms of the legibility of the graphics involved. The scope covered was also found to be essentially right.

Energy certificates in their present form, with a perspective of local/national legislation and passing on to their tenants as from 2006, are rejected by the majority of housing societies. A number of larger landlords, however, view themselves as "pioneers" and are showing interest in the energy certificate in its tested form: among other things, they draw attention to current modernization activities and see no problem in correlating the latter with the issue of an energy certificate.

Greatest acceptance of an energy certificate is to be found among those using their property themselves. They understand the "message" of the energy certificate as providing a factually effective and independent estimate of the energetic quality of their house and find out whether they ought to modernize or not. With respect to this, they view the costs of attaining an energy certificate as being relative and within reason.

2.2 Comprehension of the energy certificate form

The written interviewing of proprietors showed that the representations in the energy certificate and the terminology used, such as primary and end energy consumption or CO₂ emission, were understood to a large extent. Difficulties in comprehension occurred in expressions such as "system cost figure", the difference between primary and end energy demand and the various surface area references. It must be said, however, that not all proprietors dealt with the terminology in individual cases. No differences were found in comprehension of the energy certificates in terms of social-structure features or construction technology prior knowledge of the proprietors.

The energy certificate itself, was unanimously assessed as very good in terms of the predefined criteria such as "attractive", "serious", "(graphically) clear", "comprehensible" and "of appropriate scope" by own property users and private landlords alike. Estimation by housing societies was somewhat more critical throughout but still remained clearly in the positive range.

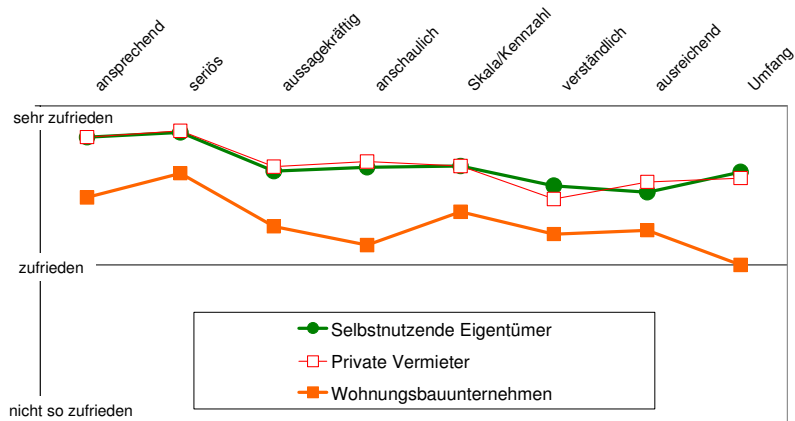


Fig. 5: Assessment of the energy certificate

Illustration texts		
1	ansprechend	attractive
2	seriös	serious
3	Skala/Kennzahl	scale/index
4	verständlich	comprehensible
5	ausreichend	adequate
6	Umfang	scope
7	sehr zufrieden	very satisfied
8	nicht so zufrieden	not very satisfied
9	Selbstnutzende Eigentümer	own property users
10	Private Vermieter	private landlords
11	Wohnungsbauunternehmen	housing societies

Two variants were tested for the "label" on the front cover:



Fig. 6: Classification

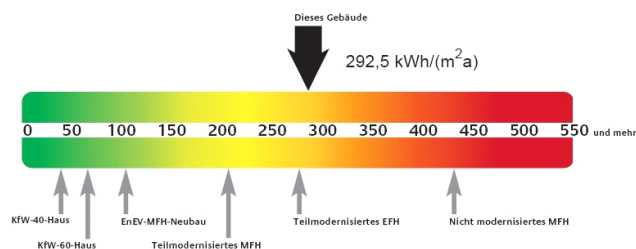


Fig. 7: Color gradient strip

Illustration texts	
1	Dieses Gebäude this building
2	Haus house
3	Neubau new building
4	Teilmodernisiertes partly modernized
5	Nicht modernisiertes non-modernized

The participants in the field test could choose the label they wanted in each case. Both labels were presented to the proprietors in the questionnaire. The participants questioned assessed the label they had on their own energy certificate better than the other one in each case but saw slight advantages in the color gradient strip. This was particularly true for housing societies.

2.3 Market requirements of the housing industry

The principle reasons for rejecting the energy certificates by certain sections of the housing societies/industry are above all the costs of the energy certificate for an extensive building inventory and possible differences between the calculated energy requirements and the actual energy consumption or heating costs. It is also feared that pressure may be exerted on the housing societies by the tenants as a result of the modernization recommendations in the energy certificate. As can be deduced from the questionnaires, certain housing societies also assume that the tenants may not properly understand the energy certificate in its present form and use it as a means of applying pressure – disadvantages that could not be confirmed by the relatively few tenant interviews available.

Private landlords see considerably less difficulties in this respect and have more frequently informed their tenants about the energy certificate.

Based on the results of interviews, it is assumed that a majority of private landlords as well as a number of housing societies are only prepared to pass on the energy certificate to their tenants and use it as a marketing instrument in a perhaps "slimmed down" form. In this way influence can indeed be made felt on the housing market. Furthermore, many private landlords as well as own-property users are interested in learning more about the energetic condition of their housing objects or receiving confirmation of the same from a neutral and efficient source.

2.4 Effects of the energy certificate

Modernization recommendations or clues were provided in most energy certificates. On average they lead to a saving of 30 to 40% primary energy.

The said clues were comprehensible for the main part but not fundamentally new for those questioned and usually possessed too little detail for immediate implementation. This was not, however, expected from the energy certificate as a rule. Certain housing societies have either already implemented the recommendations concerned since the energy certificate was issued as a follow-up to modernization, or may wish to put the measures into effect within the framework of current modernization activities in the next few years. As far as they are concerned, the energy certificate hardly plays a role as a prompt for modernization.

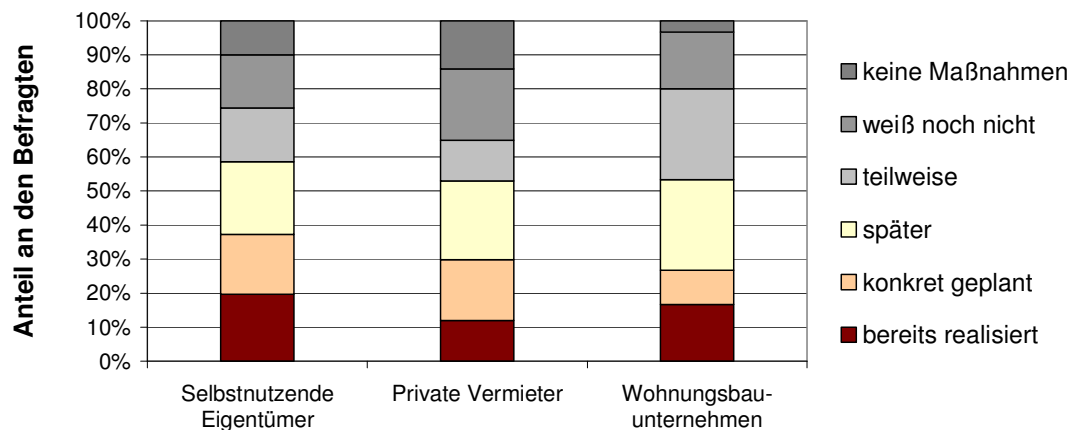


Fig. 8 Implementation of modernization activities

Illustration texts		
1	Anteil der Befragten	percentage of those questioned
2	keine Maßnahmen	no measures taken
3	weiß noch nicht	not yet decided
4	teilweise	partially
5	später	later
6	konkret geplant	positively planned
7	bereits realisiert	already implemented

The energy certificate provides confirmation of current planning for the majority of proprietors; nonetheless it prompted almost 30% of private owners to definite implementation of modernization activities. The majority of those questioned indicated that they were in a better position to estimate the energetic quality of their house using the energy certificate. Two thirds of the private owners welcomed the EU Directive and also expect an effect on the market from this source. The latter is only true for 40% of housing societies.

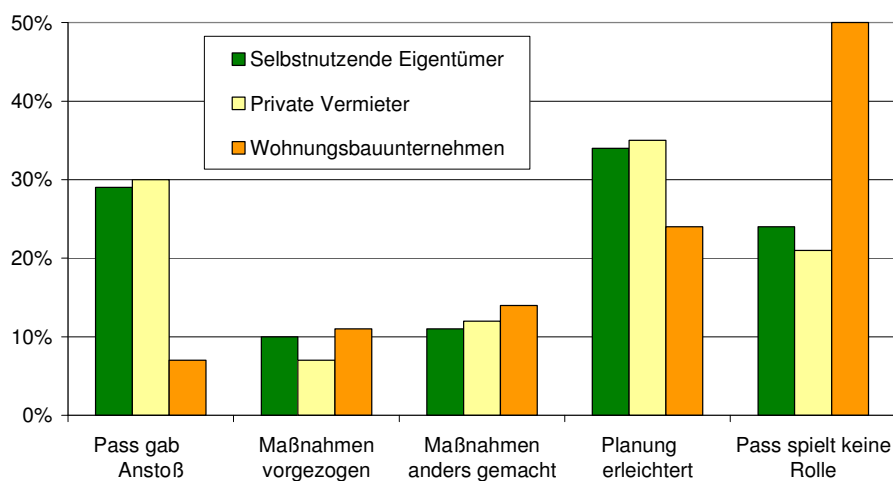


Fig. 9: Effects of the energy certificate on the implementation of modernization activities

Illustration texts		
1	Pass gab Anstoß	energy certificate prompts activity
2	Maßnahmen vorgezogen	activities given priority
3	Maßnahmen anders gemacht	activities implemented differently
4	Planung erleichtert	planning facilitated
5	Pass spielt keine Rolle	energy certificate plays no part

3 Qualification and acceptance of the issuing expert

3.1 Assessment of the issuing expert by the proprietor

The expectations of proprietors from the energy certificate consisted above all in factually realistic and objective information about the energetic condition of their buildings as well as information on activities for improving energetic quality and sinking heating costs.

The issuing experts were assessed as good without exception, both in terms of their efficiency and neutrality and in terms of communication with the proprietors. Around half of those questioned in all groups of proprietors stated that the issuing expert had presented documentation of its qualifications, e.g. a certificate. Reservations with regard to craftsmen as an issuing expert were very seldom.

As a rule, the issuing experts personally presented and explained the energy certificate to the proprietors. Regardless of the qualifications of the issuing experts, the majority of proprietors were satisfied with the explanations. The nature of the procedure used ("short procedure", extensive procedure") had no influence on the satisfaction of the proprietors either.

The in-depth interviews revealed that the proprietors were frequently unable to distinguish between the issue of the energy certificate and energy advisory services conducted simultaneously or beforehand, meaning that an overall picture emerges here.

3.2 Assessment of the energy certificate by the issuing expert

Viewed as a whole, the energy certificate of the issuing experts is estimated as an easily manageable instrument. Improvement suggestions are concentrated on design aspects, stages in the sequence of programs and the framework set for the assessments.

In the majority of cases, the issuing experts considered the framework conditions set by the field test participants as well as their informational and regional training as more important than the origin of their qualifications. The particularly good managerial care and coordination was underlined in some regions. Regional informational meetings were regarded as very helpful and desirable for further progress in the implementation of energy certificates.

As far as the issuing experts are concerned, the energy certificate signifies an additional acquisition in an already well-established field of business. The effort involved in acquisition is classified as relatively small, and in some cases the issuing experts were well supported by the participants in the test phase.

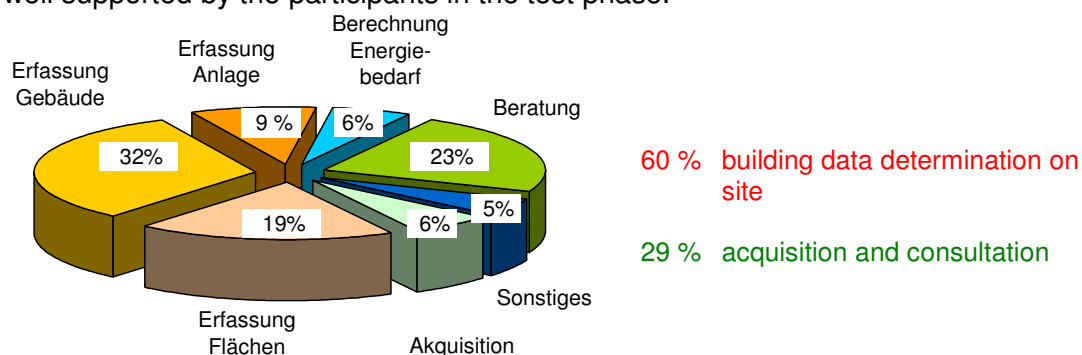


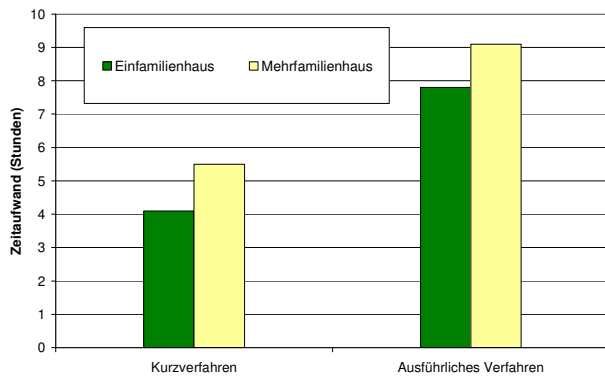
Fig. 10: Effort involved in issuing the energy certificate

according to the estimation of the issuing expert

Illustration texts		
1	Erfassung Gebäude	building data determination
2	Erfassung Anlage	asset data determination
3	Berechnung Energiebedarf	energy requirement calculation
4	Beratung	consultation/advisory service
5	Erfassung Flächen	surface area determination
6	Akquisition	acquisition
7	Sonstiges	other aspects

4 Costs of the energy certificate

According to the estimation of the majority of experts, the issue of energy certificates may proceed via the short procedure as well as via the more extensive procedure for all sizes of buildings with a proper approach to the costs involved. The average time consumed is close together for the individual professional groups. The energy certificate for one-family detached houses obtained using the extensive procedure can be issued within three to six hours, the same as for all sizes of building if the short procedure is used. Where houses with several families are concerned, the time consumed is between five and ten hours if the extensive procedure is used. At an average hourly charge of about 50 euros the costs arising are between 150 and 500 euros per energy certificate. If the most frequent value per procedure is determined, the costs for the majority of one-family houses are found to be around 150 euros (price range between 100 and 300 euros). In houses with several families this is around 250 euros (range between 200 and 500 euros). As can be seen, the price ranges of the individual procedures are relatively close together.



Average hourly charge of the issuing experts:

altogether 53,00 euros

including:

building engineers 56,70 euros

architects 57,90 euros

master craftsmen 54,80 euros

chimney sweeps 43,80 euros

statics engineers 48,70 euros

(price range from 20 to 80 euros)

Fig. 11: Data supplied by issuing experts on their time consumption and hourly charge

Illustration texts	
1	Einfamilienhaus one-family detached house
2	Mehrfamilienhaus house with several families

The cost aspect was investigated in a number of interviews. A written proprietor interview was carried out in November 2004 where the proprietor was requested to provide his/her own data on the costs of the energy certificate. Frequently, the proprietor was unable to distinguish between the costs of the energy certificate and a simultaneous energy consultation. Almost half the own-property users received the energy certificate without charge according to the data they provided. Just as shown by the intensive telephone interview in June, issue of the certificate frequently took place within the framework of an energy consultation meeting or immediately subsequent to the same. All or almost all the energy certificates were effectively free of charge for four field test participants. As far as private landlords and housing societies were concerned, no (extra) costs were incurred in almost 30% of the cases; almost 40% paid between 200 and 500 euros, 10% in fact paid more, whereas only 18% of own-property users paid more than 200 euros. The majority of those questioned found the costs to be reasonable in all price categories less than 500 euros; the latter was judged to be too high by almost half the participants, but 5% still considered it to be favorable. Cost tolerance by housing societies was considerably less than in the two other groups. Two thirds of the energy certificates issued by craftsmen were free of charge; the remaining third was also more favorable in price than the average. These results are closely connected with the subsidy strategy of the field test participants and the spectrum of their issuing experts. These influences can hardly be separated from one another and any additional interpretation of the data obtained from user interviews will be disregarded.

To obtain a clearer statement on the subject of energy certificate costs, a second written interview with this particular emphasis was conducted by the issuing experts in January of 2005 in which questions were also posed with regard to subsidies. Additional cost assessment was achieved by considering only those energy certificates which had been issued without a subsidy or sponsored funding.

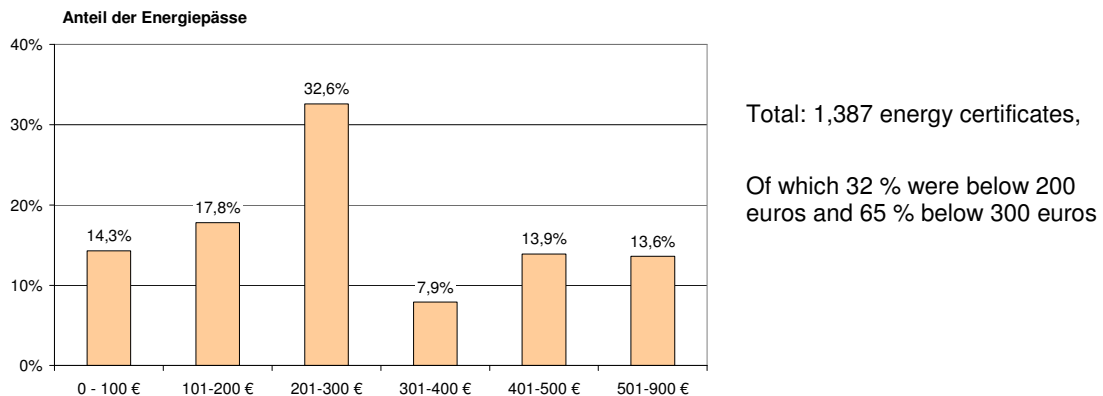


Fig. 12: Costs of energy certificates without subsidies and sponsoring

5 Results of the sensitivity analysis

The short procedure for data acquisition is distinguished from the extensive procedure by a series of reliable simplifications in capturing data from the building. Assessment of the simplifications is performed by means of a sensitivity analysis. Types of buildings taken from the IKARUS database¹ were assessed using their actual surface area and volume characteristic/reference values and the maximum of reliable elements (dormers, façade projections/offsets etc.). In addition to the above, a non-modernized and modernized variant was studied.

5.1 Geometric simplifications

Reliable geometric simplifications for the short procedure concern the neglect of the following elements:

- dormer windows which occupy less than one third of the total roof surface,

¹ Reiß, J. und Erhorn, H.: Stand und Tendenzen der Neubautätigkeit in Deutschland – Analyse und Entwicklung energierelevanter Gebäudedaten (Status and tendencies of new building activity in Germany – analysis and development of energy relevant building data). gi – Gesundheitsingenieur 115, Vol. 5 (1994)

- projections and offsets in the façade with a depth of up to 20 cm,
- additional surfaces in the area of basement steps,
- heatable rooms in the otherwise unheated roof-space (loft) or basement with a floor space of less than one third of the of the total floor-space of the loft or basement.

In addition to the above, the surface area of windows which are not conspicuously large or small may be estimated as approx. 20% of the living space and the accuracy of the measurements reduced to 50 cm.

- The greatest deviations were incurred by neglecting dormers, heated basement rooms and basement steps.
- Deviations are relatively independent of the design of the building (non-modernized or modernized older buildings).
- Deviations have more noticeable effects on the characteristic parameters of the absolute values of the areas concerned than those related to the usable floor space. The reason for this is the accompanying change in volume associated with the usable floor space ($A_N=0,32 * V$).
- The simplifications have greater effects on smaller types of building.
- Estimation of the window areas as 20% of the living space generates lower deviations.

Tables have been made available to energy certificate issuing experts in the working tools section and are intended to provide U-values as realistic as possible for superstructures with enveloping surfaces which cannot be derived from the drawings. Monitoring the values in these tables was conducted by comparison with the U-values calculated in detail from two concrete buildings taken from the database. Careful and professional use of these tools led to only slight deviations between the extensive and short procedures. The U-values for thermally insulated glazing at 1.9 or 1.6 W/m²K are relatively poor; innovative thermal insulation glazing used for modernization today exhibit much improved values of 1.3 W/m²K. It is worth mentioning, however, that the values used in simplifications should not be over-exaggerated on the positive side.

5.2 Asset technological simplifications

In accordance with Table 10, reliable asset technological simplifications consist of the following fixed values for asset technology:

- Pipe lengths may be calculated from the floor space of the building in accordance with DIN V 4701-10

- The thermal insulation of the pipes can be subdivided into "moderate" and in accordance with the "Heating Installations Ordinance (HeizAnIV)"

It has been observed that the values chosen for a moderate design and a design in accordance with the HeizAnIV, adopted by dena as a simplification for the energy certificate issue, exhibits considerable deviations from comparable parameters calculated in accordance with the National Standard, DIN V 4701-10, in each case. The result is that design in accordance with the HeizAnIV adopted by dena causes clearly higher pipe losses than the standard design in accordance with DIN V 4701-10 in small buildings.

5.3 Conclusions

The capture of data should be as detailed as possible. Certain simplifications may be permitted as limitations if no detailed information is present or its determination is too expensive or time consuming.

Simplifications should not, as a rule, lead to an improvement of the results. Neglect of surface areas or parts of buildings should be compensated for by an additional extra charge on the loss items in the energy balance sheet.

Additional charges as above should not be delegated to the heating energy requirements at a flat-rate, but to the individual items influenced in the balance sheet (transmission, ventilation, solar effects).

Neglected parts of the building should be listed in the energy certificate so that references to modernization include a (general) indication of the modernization potential of these parts of the building.

Assessment should be carried out using absolute values (kWh/a) since the main objective of reducing absolute energy requirements should not be stranded by an unfortunate choice of reference surfaces. Only the final result (usable, end or primary energy) may be related to particular reference surfaces. To what extent the usable space assigned by EnEV is really sensible here should be discussed again by those responsible for National Standards. It would appear more sensible to use the same definition as that used for calculating the heating bill.

6 Recommendations

In summary, it should be noted that the energy certificate is considered as very sensible for private owners, in particular when they use their house themselves. The "mes-

sage" of the energy certificate is clear: the idea of such verification of energetic quality is welcomed by most, and an effect on the housing market may also be expected. For this reason, the rating of the energy certificate should be kept firmly in hand.

Criticism of primary energy needs as a central reference value generated most particularly by the housing industry and in individual cases by private persons as well reflects the favorable application of energy sources/carriers such as district heating and wood. This problem has to be solved; otherwise acceptance of the energy certificate in the housing industry, including some private landlords, is at risk.

The costs of energy certificates have kept to a reasonable and accepted order of magnitude. Unique costs for all energy certificates cannot be implemented because of the varying effort and expenditure involved. As a result of growing experience of the issuing experts may in fact be lowered to some extent in future.

It must be made clear to proprietors that an energy certificate cannot replace detailed energy or modernization consultation. Modernization recommendations in the short form are useful since they influence the decision-making process. Data on how much energy can effectively be saved is also useful as clues to future action. Finally, it is up to the issuing experts to motivate proprietors to take part in detailed energy consultation or implement the proposals put forward.

The flow of color on both versions of the label has been well received. The recognition value using the EU label for household equipment hardly plays a role. A clear advantage of the color flow is nomination of the characteristic/reference values and solid comparison values.

The coloration of the energy certificate has had a good effect and should be kept up for this reason but restricted to the most important pages. It should be noted that the colored pages are still applicable even if they have been copied or printed out in black and white in exceptional cases. Clear separation of the core information in the energy certificate would satisfy the interests of the housing industry, which in general considers the energy certificate as too extensive to pass on to tenants.

A market effect of the energy certificate is to be expected if it is initially able to assert itself among own-property users. The latter are particularly interested in the condition of their objects since they also pay the heating costs. A similar argument also applies to landlords who themselves live in the objects concerned. This may well induce a multiplier effect.

The fear that tenants basically fail to understand energy certificates, press for investments in modernization or even demand reductions in rent cannot be completely removed on account of the relatively small numbers of tenants interviewed; nonetheless

positive reactions of tenants to energy certificates have at least been described by private landlords.

The formal qualifications of the issuing expert had no influence on assessment of the energy certificate and performance of the issuing expert by the proprietor. For this reason, nothing speaks against the authorization of craftsmen. The use of clearly defined procedures and reliable programs should lead to comparable results even where the qualifications of the issuing expert are different. In terms of the concepts of proprietors, the quality of energy certificates should be safeguarded via certification from the issuing expert. On their side, the issuing experts would appreciate interdisciplinary regional progressive training courses and exchanges of experience. Liability questions in connection with energy certificates, e.g. classification of buildings or modernization recommendations, need to be clarified and the issuing experts correspondingly informed.

Following the broad introduction of energy certificates, the data contained therein represent a valuable database for energy statistics of private households in Germany. For this reason, it would be sensible to continue gathering data as in the field test, in such a way that the issuing experts transfer the data to a central registry. For this purpose, measures will have to be conceived to improve evaluation, e.g. by standardization of the information on energy carriers/sources and their intended use.