

Energy contracting: how much can it contribute to energy efficiency in the residential sector?

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Abstract

Energy use for space heating and warm water in residential buildings accounts for more than a quarter of the final energy consumed in Germany. Yet, energy efficiency (EE) is not a priority for most building owners. At the same time Energy Contracting (EC) has climbed high on political agendas and has even reached the headlines of EE-legislation (2006/32/EC). But the realistic potential, the limits and obstacles of ESCo products in the residential sector are not well enough understood yet, as some political statements and the limited market success tell us.

Answers to these questions are thought in the framework of an ongoing research study for the German government. We have undertaken a conceptual analysis of Energy Supply Contracting (ESC) as the market prevailing product. And an economic analysis of transaction cost and a life cycle cost comparison between in-house and ESCo implementation. The results are compared with the empirical data of a comprehensive market query. We also studied statistical housing data to estimate suitable ESCo market potentials in the residential sector.

Over the range 30-1,000 kW_{th} installations, the life cycle cost comparison reveals no significant cost advantage for ESCo compared to in-house projects. We found a cost effective minimum project size of 100 kW_{th} for ESC-projects, derived from transaction cost accrued to implement ESC projects. This figure is confirmed by the market query.

The market query has further revealed around 250 ESCos, whose dominant product in the residential sector is Energy Supply Contracting. Based on their specialized know how, competent ESCos achieve an average efficiency gain of around 5%. They are more likely to implement innovative and renewable technologies. Although there is still a lack of market data, it can be implicitly derived from other market data and results of our query that the actual market coverage for ESC in the residential sector is between 10 and 20%.

In the German residential sector, a market potential of 12.3 TWh/a is considered “preferentially suitable” for ESC. This accounts for only 5.6% of the total statistical demand. An additional, “conditionally suitable” potential amounts to 102.0 TWh/a, mainly limited by small size of the buildings.

We conclude that the EC market potential for the residential sector is confined by two major restrictions:

1. Due to transaction costs ESC is restricted to projects > 100 kW_{th} in the residential sector.
2. With ESC as the prevailing product in the residential sector, efficiency gains are restricted to the boiler room and thus limited to around 20% compared to existing or 5% compared to new in-house installations.

We recommend EC product standardization to access the “conditionally suitable” market. Additional efficiency potentials of 20-50% can only be tapped, with comprehensive building technologies, building envelope and user behaviour approaches. And if EC product features are perceived as added values to its customers.

Energy Efficiency through Energy Services in the Residential Sector?

Final energy use for space heating and warm water in residential buildings accounts for more than a quarter of the final energy consumption in Germany. Yet, improvements in energy efficiency are not very high on the agenda of most building owners. Just as in other consumption sectors, the search for suitable energy efficiency implementation instruments is ongoing and the level of implementation is far from satisfactory as the increase in final energy consumption reveals.

Since the mid of this decade, Energy Contracting (EC) has climbed high on political agendas and has even reached the headlines of energy efficiency legislation (2006/32/EC). EC is cited many times as a smart multi-purpose-instrument, which could help legislation to overcome market barriers. E.g. in Germany's ongoing "Integrated Energy & Climate Policy (government program of August 07)" EC is mentioned more than a dozen times. But the realistic potential, the limits and obstacles of ESCo products in the residential sector are not well enough understood yet, as some political statements and the limited market success tell us.

Maybe the instrument has been overrated as a means to energy efficiency, wherever no better ideas for market driven instruments are available? How do life cycle cost between in-house and ESCo implementation compare? Is there a dominating EC-model in the market? How high is the achievable efficiency potential? Are there enough ESCos to deliver? And is this potential economically attractive for ESCos?

Answers to these questions are thought on the bases of an ongoing research study for the German government, commissioned to Bremer Energie Institut, Prognos, Energetic Solutions and legal expert Prof. Dr. Clemens Arzt. The study focuses on the project level¹.

We undertake a conceptual analysis of Energy Contracting products and an economic analysis of transaction cost for the implementation of ESC projects. And a comparison of in-house and ESCo life cycle cost. The results of these findings are assessed against the empirical data of market query with more than 300 participants from the market survey. We use statistical housing data to estimate suitable ESCo market potentials in the residential sector. The analyses are supplemented with more than fifteen years of practical Energy Contracting project and market experience of the authors.

What Energy Contracting models deliver – and what not

DEFINITION AND CONCEPT

We focus on some key features here, assuming that the reader has a basic knowledge of the Energy-Contracting (EC) concept and building energy efficiency in the residential sector. In a narrow sense we define

Energy Contracting – also labelled as ESCo or Energy Service – is a comprehensive energy service product to improve energy performance and cost efficiency of buildings or production facilities sustainably. An Energy Service Company implements a customized efficiency package (consisting of planning, building, operation&-maintenance, optimization, fuel purchase, (co-)financing, user behaviour), takes over technical as well as commercial implementation and operation risks and provides guarantees for it's all inclusive cost and results. Over the whole project term of typically 10 to 15 years in the housing sector, after [Bleyl+Schinnerl 2008].

The Energy-Contracting concept shifts the focus away from the sale of the units of final energy (like fuel or electricity) towards the desired benefits and services derived from the use of the energy, e.g. the lowest cost of keeping a room warm, air-conditioned or lit (see figure 1). The EC-model aims at providing useful energy or energy savings at minimal project cycle cost to the end user. And it achieves environmental benefits due to the associated energy and emission savings.

Energy-contracting models provide an instrument to optimise life- or project cycle performance, including the operation phase of the building. The ESCo is not only responsible for the construction but also for the operation and maintenance of the facility at a predetermined and guaranteed price. Thus the ESCo has an inherent interest to take good care of quality assurance at the construction site, optimize the operation and perform proper maintenance.

At Energy Supply Contracting efficient supply of useful energy such as heat, steam or compressed air is contracted and measured in Megawatt hours (MWh) delivered. The model usually includes purchasing of fuels and is comparable to district heating or cogeneration supply contracts. And the scope of energy efficiency measures is limited to the energy supply side, e.g. the boiler house.

As for Energy Performance Contracting, the focus is on reducing final energy consumption through demand side management (dsm) energy efficiency measures. The scope is extended to the entire building including measures such as building engineering, user behaviour or the building envelope insulation as indicated in Figure 1. The business model is based on a savings guarantee compared to a predefined baseline, also labelled as Negawatt hours (NWh).

Figure 1 illustrates an energy added value chain from primary to useful energy and energy savings with the respective business models. The figure shows the two basic Energy-Contracting models: Energy Supply Contracting and Energy Performance Contracting (EPC) and indications of typical measures carried out:

In the residential sector, Energy Contracting almost exclusively occurs as ESC, to be more precise: Heat Supply Contracting (HSC), also labelled as "commercial heat supply" or "contract chauffage". Also take over of existing installations under a EC-regime can make good sense for all parties involved. Although EPC² or innovative supply technologies like combined heat and power systems³ could lift much higher efficiency po-

1. The decision as to whether Energy Contracting is a suitable implementation tool has some implications, which can only be solved on the political level such as the "split incentive" also known as "investor-user-dilemma": The building owner has no incentive to invest in energy efficiency or optimization, because fuel cost are paid by the tenant

2. EPC projects in the residential sector are only known to the authors from Grazer Energieagentur GmbH, Austria (cf. www.grazer-ea.at)

3. Berlin Energy Agency and Hessen Energy have carried out a number of CHP-

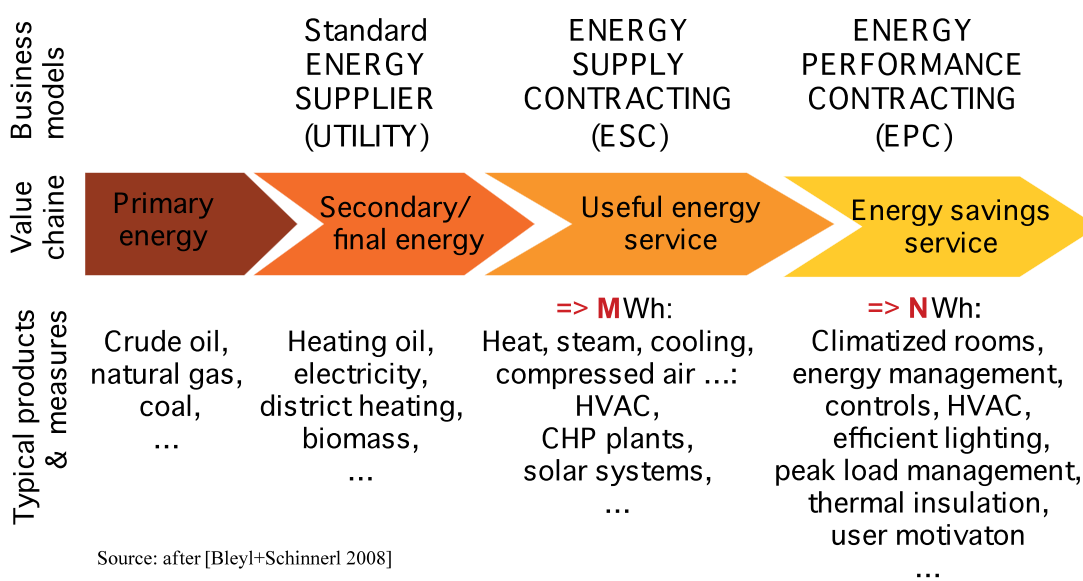


Figure 1. Energy service value chain, business models, typical products and measures

tentials in the residential sector, these contracting models only occur as niche products in practice (cf. chapters “EE-potentials of different EC-models” and “Market query”).

Contrary to widespread opinions, the ESCo service package does not need to include financing. Financing can be provided either by the building owner or the ESCo. Or including a financing institution (FI) as a third party to take over financing matters and risks may make good sense. In any case the ESCo can be used as a vehicle and facilitator for financing. Decisive to decision-making should be who can offer the best overall financing conditions. **For more details: [Bleyl+Suer 2006]**. And who is contractually obliged to pay for the capital cost of the heat supply system. In the residential sector, participation of the owner of the building for at least a share of the investment cost can provide a solution that is acceptable and fair for all three parties – building owner, tenant and ESCo – involved.

EFFICIENCY POTENTIALS OF DIFFERENT ENERGY CONTRACTING MODELS

The consideration of this chapter concerns the scope of energy efficiency potentials accessible through the different EC-models in the market.

Energy Supply Contracting (including solar ESC) is basically limited to improving the efficiency of the final energy conversion from final (fuel) to useful energy. Typically confined by the walls of boiler room (cf. Figure 2). This translates into typical efficiency gains of about 20% from old to new installations, e.g. through condensing boilers, frequency controlled high efficiency pumps and regular operation&maintenance procedures. And associated CO₂ reductions which may be higher, if low carbon or renewable fuels are applied.⁴ Also for existing installations, efficiency gains of typically 10% can be achieved (in many cases with little investments) by putting them under

an EC-regime, due to the inherent incentives to reduce final energy consumption of the EC model.

The scopes of different EC-models and example efficiency measures are illustrated in Figure 2.

The scope of the Energy Performance Contracting and the new Integrated Energy Contracting model encompasses the complete building, e.g. energy management and controls, HVAC-technologies like hydraulic adjustment of the building heat distribution network or air conditioning or lighting. And not to forget: The behaviour of the building occupant. In the case of comprehensive refurbishment of buildings, also refurbishment of the building shell through better insulation, exchange of windows or passive solar shading is included [Bleyl+Schinnerl 2008a], examples documented in [GEA 2009].

Based on their specialized know how and their life cycle cost approach, competent ESCos are more likely to install innovative high efficient and renewable technologies, like combined heat and power systems, solar thermal, local heating networks or renewable fuels compared to building owners, who have other priorities on their core agenda.

Economic Assessment of Energy Supply Contracting compared to In-House Implementation

TRANSACTION COST OF ENERGY SUPPLY CONTRACTING PROJECTS

EC is an innovative and complex product, which is far from a standard off-the-shelf-buy (as is the case for most measures to lift energy efficiency potentials). In this chapter, we briefly describe typical transaction efforts for thermal installations between 30 – 1.000 kW_{therm} as applied in the residential sector. And we estimate transaction cost and put them in relation to their investment cost.

Transaction cost are seldom mentioned or even quantified, when analyzing EC and its obstacles for market penetration, but they may constitute a significant obstacle to EC market penetration. The amount of the transaction cost relating to the

projects in the residential buildings with direct delivery of electricity to the final customer (cf. www.berliner-e-agentur.de, www.hessenenergie.de)

4. Generally any building design should first of all focus on all possible demand reduction potentials. Only afterwards, the remaining demand should be supplied as efficiently as possible. Especially if Renewables are involved.

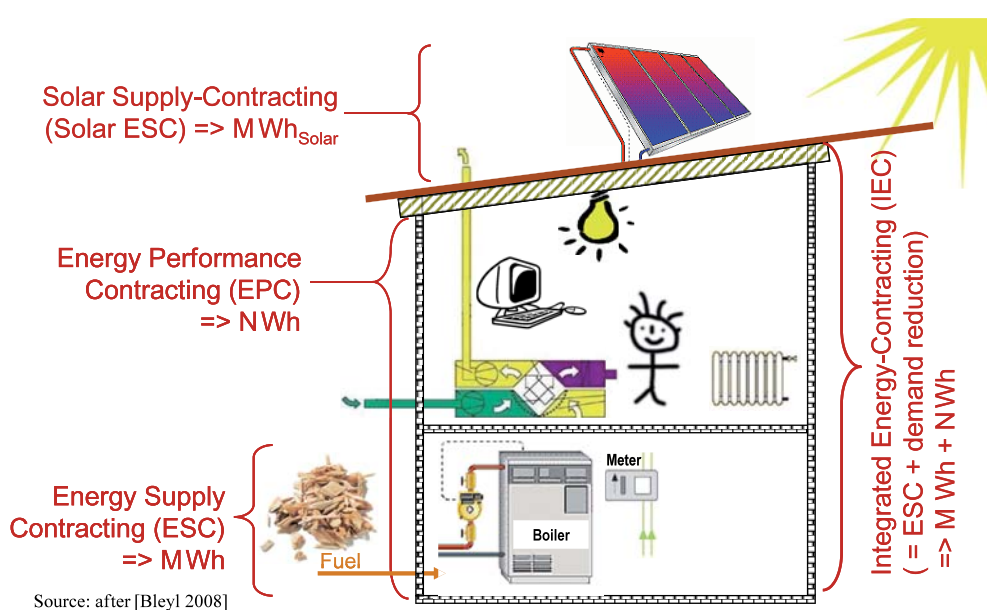


Figure 2. Scope of measures of different Energy-Contracting models

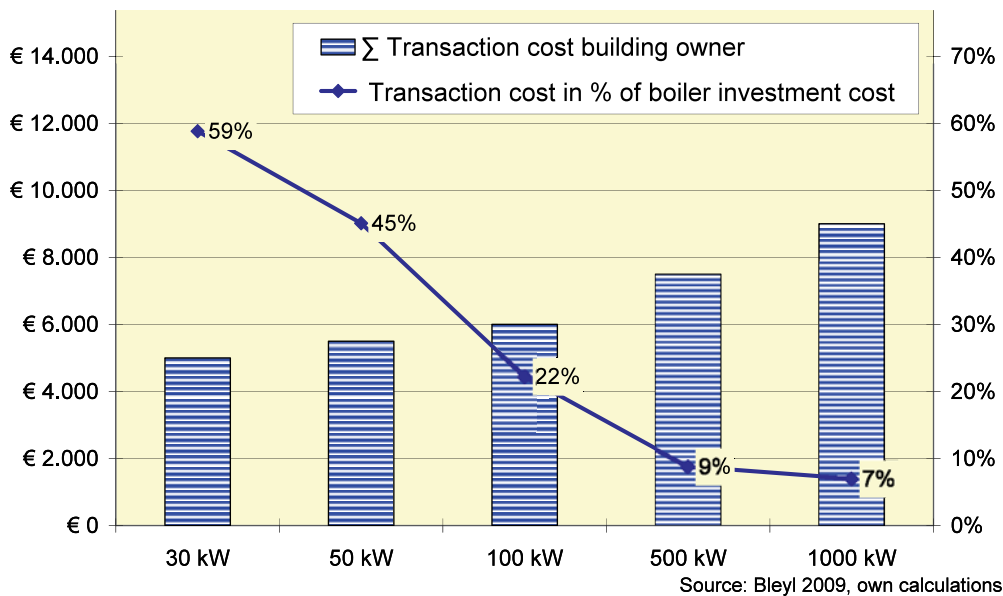


Figure 3. Transaction cost: absolute and relative to investment cost for ESC projects

scope of services outlined below, depend on the size and complexity of the project off course.

In this context, transaction cost denotes the cost accruing to the contracting customer – usually the owner of the building – and the ESCo to conclude an energy service contract. The main items on the buyer's side are project preparation and data preparation, writing the (functional) service specifications, establishing and reviewing the contract as well as tendering and awarding of the energy services. And off course the ESCos costs for tender preparation and negotiation must not be forgotten.

Heat supply contracting projects in the residential sector are comparably simple by their technological nature and can be standardized well. Depending on the know-how and resources of the building owner, these services will, in many cases, be provided by an independent consulting company like energy agencies. The transaction cost on the side of the building owner

are estimated to be between 5,000- 9,000 Euro depending on the size of the facility. These figures are given on the basis of market prices of independent consulting companies as well as numerous own projects carried out. In this estimate, standardization of the project steps and tools is assumed.

Additional transaction cost between 60% and 7% – depending on the size of the heat supply – in relation to the boiler investment cost accrue. These additional cost constitute a significant additional investment expenditure and thus a substantial impediment for the market penetration of Energy Contracting as a tool for the implementation of energy efficiency in the residential sector.

The ESCos expenditure are estimated to be 4 to 6 days, translated into 2,000 to 3,000 Euro per project. These figures are based on own experiences and information from different ESCos. If these cost are added, the total transaction cost amount

Thermal load of boiler installation	kW	30	50	100	500	1,000
Annual heat consumption	MWh	61	102	204	1,020	2,040
Gasprice (HHV) In-house	cent/kWh	4,7	4,5	4,3	4,1	4,0
Price advantage ESCo	%	10,0%	10,0%	10,0%	7,5%	5,0%
Gasprice (HHV) ESCo	cent/kWh	4,2	4,1	3,9	3,8	3,8
Base- + metering price	€/month	6	8	12	25	30
Annual efficiency In-house	%	91%	91%	91%	91%	91%
ESCo average efficiency increase	%	4%	4%	4%	4%	4%
Annual efficiency ESCo	%	95%	95%	95%	95%	95%

Figure 4. Life cycle cost (LCC) comparison: Input data fuel cost

to over 80% for 30 kW- and almost 10% for a 1 MW-installation in relation to the boiler investment.

The estimated transaction cost – independently from the exact amount – show that standardization and quality assurance of the product Energy Contracting is a condition necessary for reducing the transaction cost and thus an increased market penetration. And to make it a standard off-the-shelf-product, especially for small installations.

In a first approximation, a minimum size for heat supply projects of approx. 100 kW_{therm} can be derived by taking 20% additional investment cost for the building owner as a limit⁵. Small projects are burdened additionally by the fact that the annual cost for operation, maintenance and controlling is largely independent of the project size. This fix cost block is another reason for an economic minimum size of heat supply projects to be outsourced to ESCOs, without being able to give exact quantifications here.

LIFE CYCLE COST COMPARISON ENERGY-CONTRACTING VS. IN-HOUSE IMPLEMENTATION

The economic comparison is performed between in-house and energy contracting implementation on the assumption of both new heat supply facilities.^{6 7}

Methodologically, the in-house calculation is done with a life cycle cost (LCC) calculation, that is the sum of capital, operation and consumption related cost over the project term and discounted to a net present value.

The ESCo calculation is performed by using a sophisticated tool for ESCo offers, which has been used in a comparable manner to participate in numerous ESCo calls for proposals⁸. Based on the entered capital, operation and consumption related cost over the project term, energy and service prices are calculated, requiring a return on investment (ROI) of 10% of the project cash flow.

The total investment cost for the considered boiler facilities, with a range between 30 and 1.000 kW_{therm}, is between 8,500 Euro and 130,000 Euro. This includes all investment costs apart from measures relating to building and underground construction, disposal of the old installation and all the investments in the secondary network of the building outside the boiler room.

Figure 4 lists the most important input data for the comparison of the consumption related cost, since these are the most sensitive for outcome of the total cost comparison, in particular the ESCo's average efficiency increase (see Figure 4).

The by far biggest share of the life cycle cost of heat supply systems accrues from the consumption related (fuel) cost, which amount to approx. 80%. This underlines the sensitivity of the efficiency of the heating system and the fuel cost. For heat loads below 500 kW_{therm}, the share of the cost which is not consumption related increases slightly. This cost structure is comparable for in-house implementation and outsourcing to an ESCo.

The microeconomic life cycle cost comparison reveals no significant cost advantage for the EC or in-house implementation model. The cost differences are in the range of +/- 5%, so that comparability of cost relating to accuracy can be stated⁹. The ESCo's cost advantages, most notably with the fuel cost, are basically equalled by its entrepreneurial mark up (calculatory target: 10% return on investment).

However a slight trend can be observed: Below 50 kW_{therm} in-house comes out to be 5% cheaper. Taking transaction cost into account the cost advantage rises to 11%. Above 100 kW_{therm} Energy contracting starts gaining a slight cost advantage, which amounts to about 5% for the 1,000 kW_{therm} installation.

The Chart in Figure 5 summarizes the results of the microeconomic comparison.

When comparing in-house to ESCo implementation, special attention should be paid to the outsourcing of technical and commercial implementation and operating risks as well as takeover of function, performance and price guarantees by the ESCo. These features constitute an added value compared to in house solutions and must be guaranteed in the EC-contract. In other words: Energy-Contracting is more than putting together individual components. The contracting concept incorporates incentives and guarantees, that – throughout the contract term – the entire system performs according to specifications.

5. 100 kW roughly equals 1,000 to 1,500 m² or 12 to 20 apartment units

6. In contrast to this, the ESCo industry could argue, that EC accelerates the modernization of heating facilities (Vorzieungseffekt), i.e. that the comparison of efficiency (capacity factor) should be made between the existing and a new facility, at least for part of the life cycle. In this case the typical gain in annual boiler capacity factor comes out between 10 and 20%. In all cases of accelerated modernization effects through and ESCo, EC can be rated as a well suited and advantageous implementation tool for energy efficiency.

7. The technical-economic assumptions and framework conditions of both calculations are as follows: Calculation term 15 years, interest and discount rate 6%, annual price increase 1,5% for all cost categories

8. Bleyl 1994-2002, ESCo department of Berlin Energy Agency Ltd.

9. The small cost differences apply likewise to the comparison of net present value as well as non-discounted total cost. For easier traceability we have you used the non-discounted values in Figure 5.

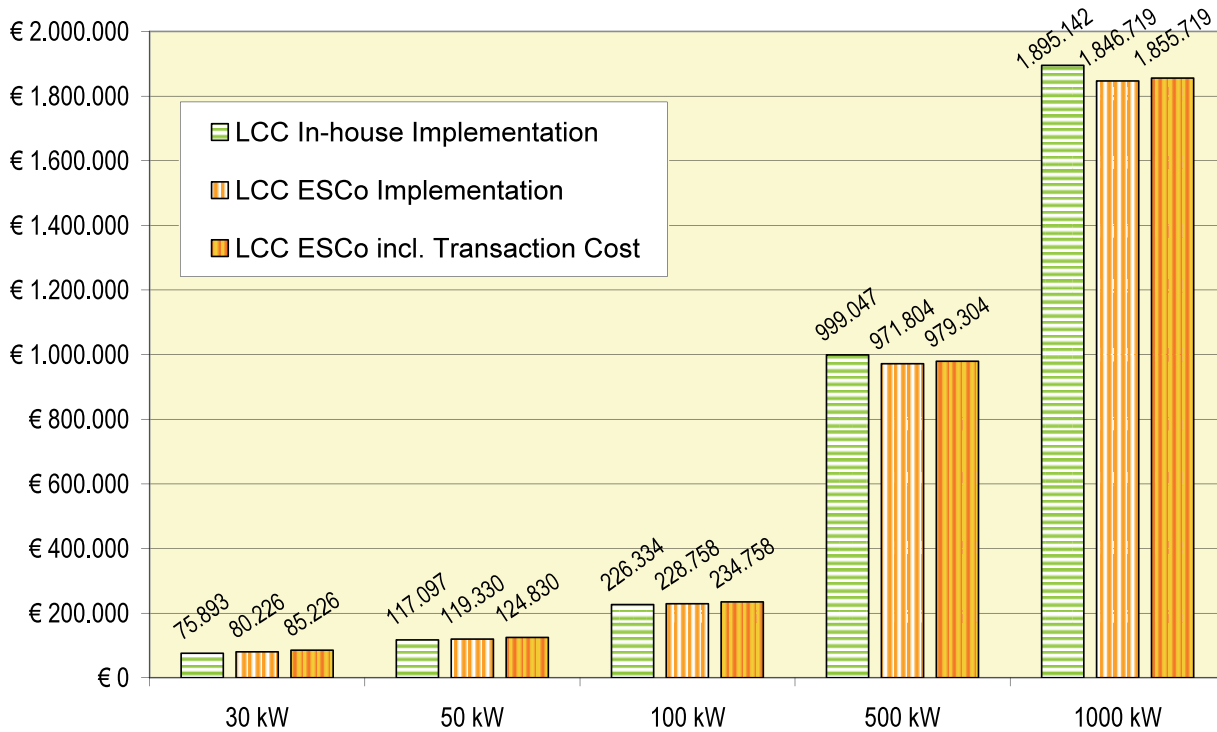


Figure 5. Life cycle cost (LCC) comparison between in-house and ESCo implementation over thermal load

Residential ESCO Market in Germany: Market Survey

ESCO MARKET IN GERMANY: DESIGN OF THE MARKET QUERY

The main objective of the market survey was to learn about active market participants, their typical products, their efficiency and the market penetration. To this end a large market survey has been carried out by Prognos. The design of the query targeted the supply side, addressing more than 380 companies with kind support of all relevant ESCO associations in Germany (VfW Verband für Wärmelieferung, AGFW Arbeitsgemeinschaft Fernwärme, ESCo Forum im ZVEI Zentralverband der elektrotechnischen Industrie). A standardised query asked for information to the following five main topics in more than a hundred items:

- Company: main company activities, branch, regional focus, turnover, staff, general market situation
- Portfolio of products & services: products in residential sector, innovative products & services, installed heat capacity, installed power capacity, annual investment, typical project size, typical contract duration,
- Realised technologies and implemented services: technical facilities and measures, realised annual efficiency, employed fuel including Renewables (oil, natural gas, biomass, solar etc.),
- Market barriers: informational, motivational, structural, organisational, economical, legal and financial barriers.

The feedback of the query was around 30% and was hence in an usual range for standardised market queries.

RESULTS OF THE MARKET QUERY: MARKET PARTICIPANTS

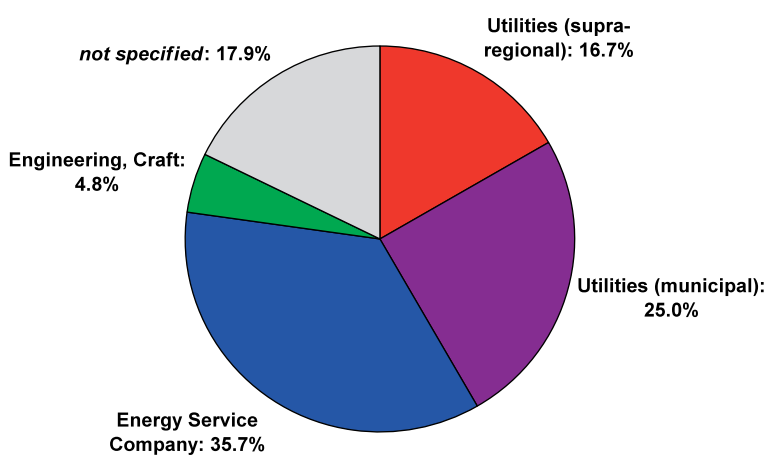
It could be observed that the number of active companies might have been overestimated in past studies: *not all* companies which claim to be an Energy Service Company are regularly and professionally providing Energy Service Projects. We identified more than 380 potential companies, but learned that not all companies are *active*. Some of the companies used to offer energy contracting but stopped, some are just thinking about it. Using a conservative approach, it can be estimated that there are currently 250 active ESCOs. The turnover of all active companies (with Energy Service Schemes) are around 2 billion Euro/a. This represents approximately an employment number of some 4,000 full time equivalents.

In the last 20 years, the last majority of the organisations were established. These organisations, which partly were established as subsidiaries of larger ESCOs or real-estate providers, show a considerable growth. The data about sales figures and the number of employees prove that and show an average robust growth of approx. 10%/a – after considering the M&A effects (Mergers & Acquisitions). However, ten per cent of the interviewees also say sales volumes and numbers of employees have receded in the last three years.

RESULTS OF THE MARKET QUERY: MARKET SEGMENTS, PRODUCTS AND PROJECT SIZES

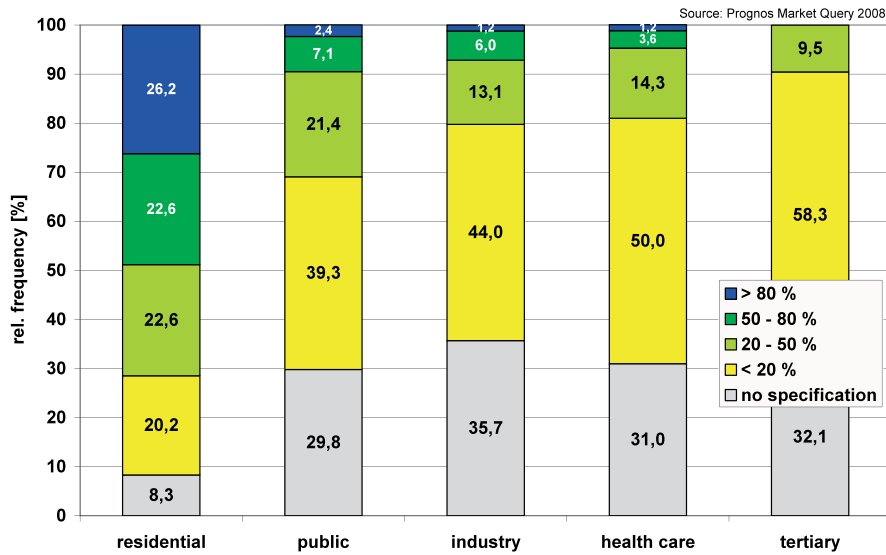
Residential building is the by far largest market segment of the German ESCo market. Approximately half of the contractors achieve more than 60% of the sales volume in this segment. For all segments of the contracting market, an increasing growth is largely expected. It is also in this context that the expectation for the segment of residential building is most distinct.

The by far most important product is energy supply contracting (cp. Figure). Almost two thirds of the interviewees stated



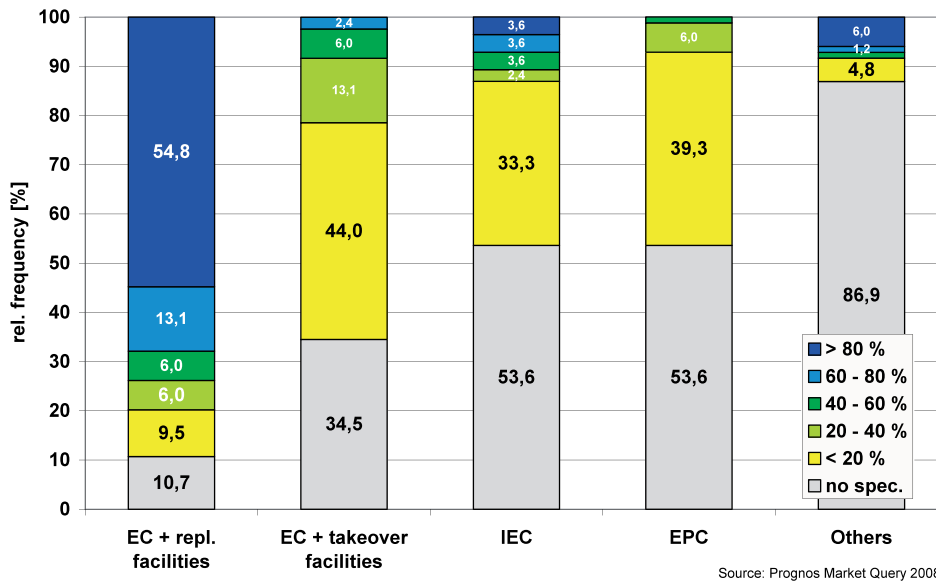
Source: Prognos Market Query 2008

Figure 6. Affiliated branch of industry & trade of ESCOs in Germany



Source: Prognos Market Query 2008

Figure 7. Market focus of ESCOs in Germany by market segments (sales volume)



Source: Prognos Market Query 2008

Figure 8. Market products of ESCOs in Germany (sales volume) [EC incl. replacement of facilities, EC with takeover of existing facilities, EC with integration of different efficiency measures (IEC), Energy Performance Contracting (EPC)]

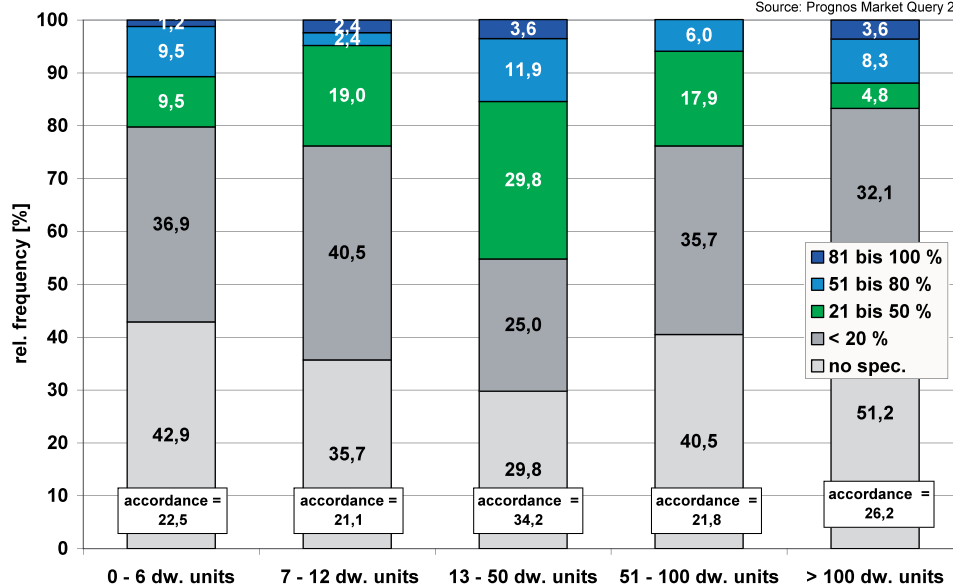


Figure 9. Realized project size according to ESCOs in Germany

they achieved more than 80% of the sales volume due to the delivery of energy (EC) while substituting old technical facilities. As for all the other products, clearly indifferent answers prevail (less than 20% or no statement). Perhaps this may be interpreted by considering the fact that other ways of contracting also come into the question but are not the rule.

The contractors were also asked to give the realised project size in terms of dwellings per unit. Although there is a wide range of answers, the highest accordance is in the range of 13-50 dwelling per unit. The mean value of all the mentions sees a minimum project size of 13 dwelling units, (which corresponds to a dwelling area of little less than 1,000 m²). Due to the heterogeneous answers, such a value should rather be seen as rough orientation than a value verified according to scientific methods. However, the mean value does correspond to the estimates of the associations, which were made in the course of the workshop (1,000-1,500 m² dwelling area) as well as to the results of the studies of current common market practice, which show a priority for projects between 13 and 50 dwelling units. However, the figures are low for small buildings. Therefore, it is, above all, the mean value that provides an important orientation aid for estimating the potential and opportunities in the following Chapter. Figure 9 shows the results.

RESULTS OF THE MARKET QUERY: ANNUAL EFFICIENCY

An important motivation for the market survey was the question, whether ESCOs (as a specialized branch with an ascribed high technical competence) achieve systematically better results in terms of annual efficiency of the heating boiler (annual efficiency: overall ratio of delivered heat to the fuel used).

Our question aimed at the achieved difference by the ESCO compared to the standard in-house operation mode both at the start and over the whole life span of the energy service contract compared to the in-house operation of the boiler. As Figure 10 shows, the advantage at the beginning is not expected to be considerable high (majority expects some 0-5% plus) but is expected to increase to 6% to 10% over the whole life span.

Two things have to be kept in mind: a) there is a considerable bandwidth of the answers, b) even for ESCOs who (surprisingly often) know exactly about their own annual efficiency, it is still a kind of guess, how much worse it had been the annual efficiency in case of in-house operation mode. The latter figure highly depends on the degree of professionalism that is assumed for the comparative group relating to in-house implementation.

Further results of our query show that there are mainly operational and technical reasons, why ESCOs manage to avoid the successive drop of annual efficiency and to keep it near the initial or budgeted value (*while guaranteeing optimal dimensioning and parameterization of the facilities*). All ESCOs report about differentiated operational and technical measures for securing annual efficiency. These measures credibly show the optimized management of facilities and operations. Taking all this into account, an average value to the amount of 5-10% (corrected sample) seems to be quite realistic. What seems to be less credible to the authors is the assumption that annual efficiency can, on the average, be improved by about 6-7% (corrected sample) once a new facility is put into operation.

Among other things, innovative and technological aspects were inquired. As Figure 11 shows, ESCOs are motivated to employ systematically innovative technologies such as CHP and renewable energies. Although no very clear majorities are evident, it seems clear, that many ESCOs have specialized in technologically complex solutions. After all, one fourth of the interviewees state they achieve the major part of the sales volumes by means of CHP solutions (Combined Heat and Power). Almost one sixth of the providers systematically implement biomass facilities (e.g. wood chip or pellet heating). The answers relating to other solutions, such as solar heating, biogas or other innovative supply variants, are rather indifferent and suggest these products are not offered systematically. The frequency can be seen in Figure 12.

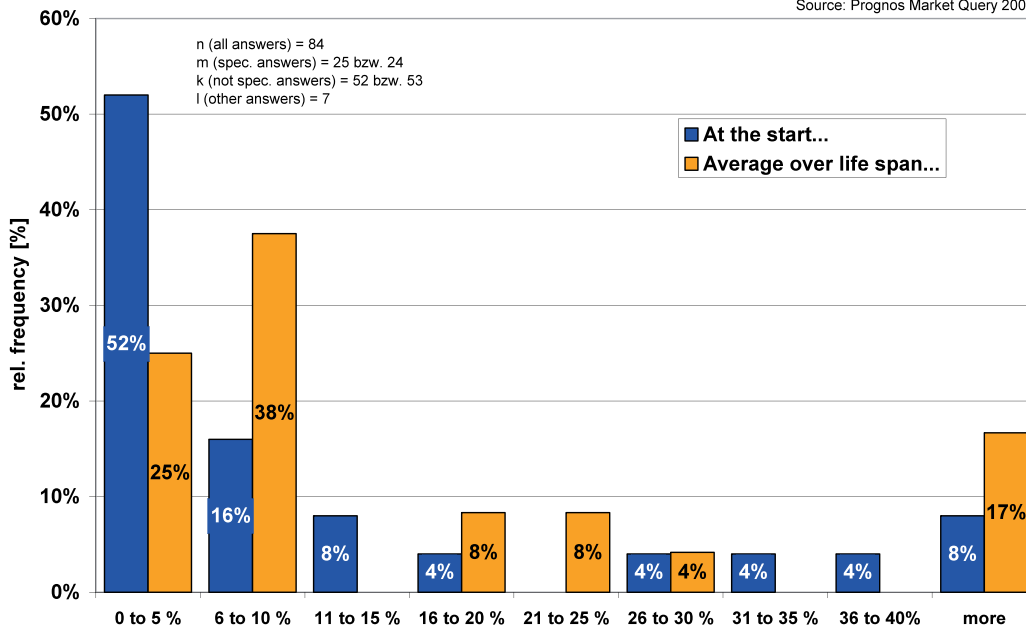


Figure 10. Advantage of annual efficiency according to ESCOs in Germany compared to in-house operation

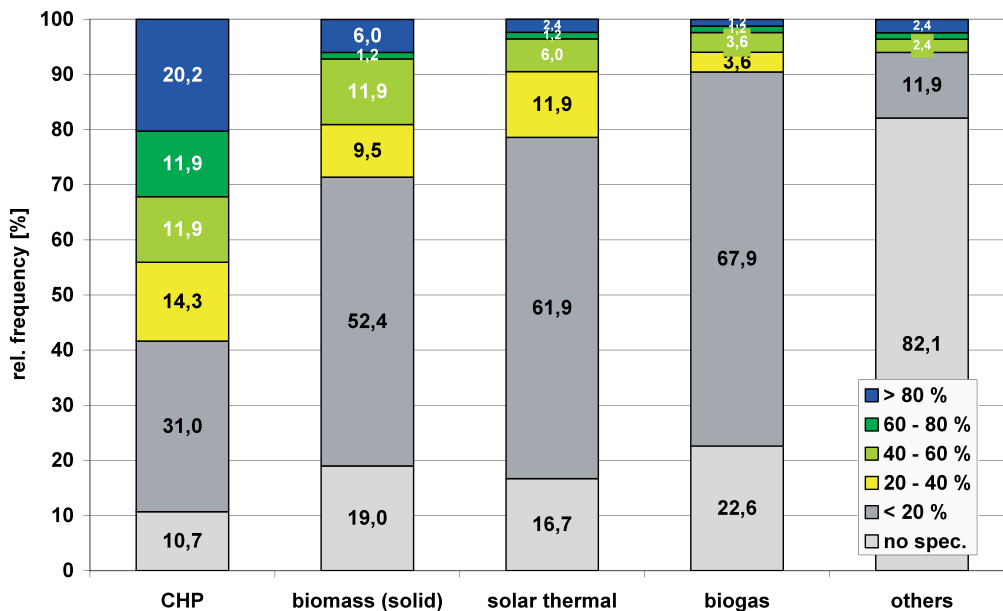


Figure 11. Employed technologies according to ESCOs in Germany

RESULTS OF THE MARKET QUERY: SUMMARY

Although earlier market surveys implied a larger number of market participants in the German ESCo market, there are more than 250 market participants performing in a professional and energy efficient way. In a succinct summary, the typical contracting project addresses existing residential buildings with at least 13 dwelling units (approx. 1,000 m² floor space) and has a contractual period of 10-15 years. As a rule, the old facility will be replaced while taking some minor measures for optimizing and maintaining optimal operation of the facility (see below). It is true that innovative products, such as integrated energy contracting or energy performance contracting,

do occur as niche products. Nevertheless, they clearly are not the case today.

On the whole, the results confirm the thesis according to which the market of the existing rented flats is the by far largest segment on the contracting market. It is true the relevant figures do not allow any direct computational conclusion. Nevertheless, it can be estimated that more than a half of the overall market fall to this segment.

Type of building	1 AU	2 AU	3-6 AU	7-12 AU	13-20 AU	21+ AU		
Year of construction	[GWh/a]						Total	Share
until 1918	4,535	10,291	12,602	7,976	1,884	362	37,649	17.2%
1919 - 1948	4,269	8,484	11,296	7,752	1,051	311	33,163	15.2%
1949 - 1978	9,746	21,070	34,428	31,218	5,195	9,089	110,746	50.6%
1979 - 1990	2,194	4,663	4,306	6,068	1,532	1,788	20,550	9.4%
1991 - 1995	899	1,376	1,954	1,710	362	198	6,499	3.0%
1996 - 2000	1,284	1,409	2,294	1,855	420	288	7,551	3.5%
2001 - 2004	458	563	557	374	114	69	2,135	1.0%
2005 - 2006	101	166	132	85	23	8	514	0.2%
Total	23,487	48,021	67,569	57,038	10,579	12,113	218,806	100.0%
Share	10.7%	21.9%	30.9%	26.1%	4.8%	5.5%	100.0%	

Figure 12. Specific useful heat demand in rental accommodation units in Germany in 2006

Statistical Market Potential of the Residential Sector in Germany

Investigating the market potential in this section is based, on a detailed analysis of the useful heat demand in the rental apartments sector. Quantity structures resulting from this analysis will be used to estimate the quantitative level of market potentials under consideration of suitable suppositions. Of central importance doing so will be a report of the “Statistisches Bundesamt” [StatBA, 2008].

Useful heat demand was investigated subdividing the size and time of construction of buildings into 6 and 8 categories, respectively. Both the specific demand [kWh/m² a] concerning “old” and “new” federal states and respective assets of rental accommodation units (AU) and the heated living area were determined using this method.

About 59% of all AU in Germany are rental accommodation units, totalling 21.1 million in number. More than 60% of them are situated in medium-sized buildings that usually comprise 3-12 AU. About half of all AU considered are found in buildings that had been constructed between years 1949 and 1978. As a consequence of low standards for thermal insulation at that time, the specific useful heat demand in these buildings is high compared to the situation in new buildings. Adjusted to climate, useful heat demand of investigated AU totals 218.8 TWh/a, 195.7 TWh/a of which for space heating and 23.1 TWh/a of which for domestic hot water. Figure 12 details specific demands considering building size and age.

Employed energy sources are dominated by natural gasoline (49.7%), oil (26.0%) and district or long-distance heating (15.7%). The remainder (8.7%) is supplied by electricity, wood, coal or solar thermal.

The demand will be categorized with respect to its suitability for Contracting in the market place:

1. Preferentially suitable,
2. Conditionally suitable,
3. Not suitable.

Evaluation of these three levels of suitability will be based on the characteristics **building size, energy sources and year of**

building construction (if related directly to the age of installed heating systems).

During the evaluation process priority is given to the size of buildings, since both heating systems and energy sources are more likely to be changed over time. Cost effective analyses (cf. Chapter Economic Analyses) demonstrate that a capacity of 100 kW_{th} appears to represent the quantitative minimum threshold for an economic justifiable contracting project, such that buildings comprising 13 or more AU are considered a “preferentially suitable” potential (10.4% of the total useful heat demand). This is concurrent with statements by the contracting and industry and housing association. Medium-sized (comprising 3-12 AU, 57.0%) are rated “conditionally suitable” and small buildings (comprising < 3 AU, 32.7%) “not suitable”.

75.6% of the useful heat demand is currently covered by natural gas or oil, the exclusive energy source in virtually all buildings supplied by contractors. Therefore only in a small market share other currently used energy sources can limit the market potential. Regarding buildings that use electricity and coal for energy supply, sources must be shifted and technical modifications enforced. Consequently, such buildings are rated “conditionally suitable” for contracting. Community (district, long-distance) heating and renewable energy sources are likely to remain unchanged, which is why this situation in buildings is considered “not suitable”.

Evaluating effects of building age on market potentials, we consider likely that installation dates of heating systems in the newest buildings meet their respective construction years (concerning year-classes 2001-2004 and 2005-2006). This, in turn, probably means that modifications and technical upgrades of installed heating systems will take place firstly in some years distance. The market potential of the newest buildings (1.2%) is deemed “conditionally suitable” for this reason. Older buildings of construction year-classes < 2001 are considered “preferentially suitable” in comparison, since an installation of new heating systems in these buildings is likely to occur much sooner. In Figure 13 evaluation criteria and suitability are summarized.

The following final assessment of market potentials takes into account all previous outcomes, thereby prioritizing the “poorest”. In other words, only those quantities that do not feature (are not subject to) any restrictions in one of the three evaluation categories are rated “preferentially suitable”:

Criteria	Preferentially suitable	Conditionally suitable	Not suitable
Building size	> 13 AU	3 - 12 AU	1 + 2 AU
Energy sources	natural gas, oil	electricity, coal	district heating, renewable energies
Year of building construction	< 2001	2001 - 2006	-

Figure 13. Evaluation criteria and suitability

- A useful heat demand of 12.3 TWh/a in the rental apartments sector – corresponding to a share of 5.6% of the total demand – is considered “preferentially suitable” for contracting. Buildings comprising 21 or more AU and covering a living area of about 1.200 m² reveal a particularly interesting potential (5.9 TWh/a).
- A “conditionally suitable” potential for contracting is set equal to 102.0 TWh/a. This is more than 8 times above the preferred level and corresponds to 46.6% of the total useful heat demand.
- A share of 47.7% (104.4 TWh/a), which is almost half of the total useful heat demand, must be considered “not suitable” for contracting in the near future.

How much can Energy Contracting contribute to EE?

DISCUSSION AND SUMMARY OF RESULTS

1. A cost effective market implementation of an Energy Contracting project, requires a minimum project size. This can be derived from the transaction cost accrued to implement EC projects. And from the life cycle cost comparison between in-house and outsourcing implementation:

- Energy Contracting (EC) still has to be considered as innovative and complex product. Transaction cost for a building owner to set up a project and conclude a contract are estimated between 5.000 and 9.000 Euro. This accounts for an additional investment of as much as 60% for small 30 kW_{therm} projects and down to 7% for a 1,000 kW installations. Taking 20% additional investment cost as a limit, a minimum projects size of approx. 100 kW_{therm} can be derived.
- The life cycle cost comparison reveals no significant cost advantage for an Energy Supply Contracting (ESC) or an in-house implementation model, comparing new installations in both cases. However a slight trend can be observed: below 50 kW_{therm} in-house comes out to be 5% cheaper. Taking transaction cost into account the cost advantage rises to 11%. Above 100 kW_{therm} Energy contracting starts gaining a slight cost advantage, which amounts to about 5% for the 1.000 kW_{therm} installation. This indicates that larger installations are better suited for EC implementation.

These results are also confirmed by the market query.

2. Earlier market surveys implied a larger number of market participants in the German ESCo market. We found that

there are around 250 market participants performing in a professional and energy efficient way. The residential sector is their most important market. Although there are various differentiated products in the market, standard Energy Supply Contracting is clearly the dominating product. Although there is still a lack of market data, it can be implicitly derived from results of our query and other market data that the actual market coverage for EC in the residential sector is between 10 to and 20%.

3. Based on their specialized know how the following advantages are on the side of competent ESCos:
 - ESCos achieve and maintain higher annual efficiencies of the heating facilities. The ESCos achieve an average advantage of around 5% efficiency gain. They keep the annual efficiency high over the life span by employing different operational and technical measures like remote controlling, energy balancing and continuous optimization.
 - Competent ESCos are more likely to install innovative high efficient and renewable technologies, as combined heat and power systems, solar thermal, local heating networks or renewable fuels compared to standard in-house solutions by building owners, whose core agenda is apart from complex technical solutions.
4. The statistical market potential analysis reveals the following results for Germany:
 - A useful heat demand of 12.3 TWh/a in the rental apartments sector – corresponding to a share of 5.6% of the total demand – is considered “preferentially suitable” for contracting. Buildings comprising 21 or more AU and covering a living area of about 1.200 m² reveal a particularly interesting potential (5.9 TWh/a).
 - A “conditionally suitable” potential for contracting is set equal to 102.0 TWh/a. This is more than 8 times above the preferentially suited level and corresponds to 46.6% of the total useful heat demand, mainly confined by the small size of the buildings (< 13 units).
 - A share of 47.7% (104.4 TWh/a), which is almost half of the total useful heat demand, must be considered “not suitable” for contracting in the near future.

Energy Contracting is not per se cheaper or better than in-house implementation. But it can lift obstacles to energy efficiency and contribute to the market implementation in the residential sector.

CONCLUSIONS AND OUTLOOK

Energy Supply Contracting has become a standard product for larger buildings in the residential sector. It is provided by a significant number of market participants in Germany, who systematically use professional operational and technical measures to maintain a high degree of annual efficiency. However, with ESC as the market prevailing model, the scope of achievable energy efficiency potentials is confined by two constraints:

- Mainly due to transaction costs, ESC is restricted to projects $> 100 \text{ kW}_{\text{therm}}$ in the residential sector.
- With ESC, efficiency gains are restricted to the boiler room and thus limited to around 20% compared to existing or 5% compared to new in-house installations.

To access higher efficiency potentials by energy service models, three developments are needed:

1. Smaller projects need more standardisation to reduce transaction cost, e.g. through information campaigns, facilitating agents and model contracts, confirmed by residential business associations. Data mining should be eased by technical means (e.g. smart metering), transaction costs could be (partially) subsidised by state funding or carried out by facilitating agents (partially funded by the state and/or ESCos). This is a precondition necessary to significantly move to smaller projects in mid term. The long term target could be the development of an Energy Service Scheme for single-family-houses.
2. Additional efficiency potentials of typically 20-50% can only be tapped, if building technologies, building envelope (building insulation, improved glazing) and targeting user behaviour are integrated into energy service schemes. This could be achieved either by in-house implementation and/or innovative energy service models such as the Integrated Energy Contracting model. First experiences show promising results of 40% final energy savings and 70% CO₂ reductions. Subject to further experiences this might be a solution which is more widely applicable to deliver comprehensive energy efficiency potentials.
3. The case for EC can not be built on cheaper cost primarily. Advantages of Energy Contracting can rather be found in the field of outsourcing of technical and commercial im-

plementation and operating risks to the ESCo as well as takeover of function, performance and price guarantees by the ESCo. And if innovative technologies are on demand. Only if these features are perceived as added value by the customers, more EC-products will be able to penetrate the market.

This development requires “educated” customers to demand qualified energy services in the market. Residential building owners or more likely independent facilitators need to learn how to procure ESCo services with guaranteed results. And there is a need to finance this project development process through public money or energy efficiency funds.

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