Contracting and building renovation – does it work together?

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Abstract
The renovation or refurbishment[1] is an important point in the life cycle of a building that makes it possible to achieve both environmental and climate protection goals and a higher quality of living of the inhabitants. However, lack of money often leads to a renovation that covers only the basic requirements, whereas measures that are valuable in a long term perspective like energy saving measures are not realised. Energy performance contracting (EPC) is widely used as an instrument to reduce long term operating costs significantly by guaranteed energy savings. An energy service company (ESCo) implements saving technologies, especially in the field of heating, HVAC, lighting and plug loads, and in particular in public buildings. It is the aim of this paper to investigate the possibilities to incorporate construction measures like building envelope insulation into standard energy performance contracting.

For this purpose a qualitative survey is presented that was performed among experts and stakeholders in the business: ESCos, building owners and facility managers, representatives of construction companies and financing institutions were interviewed. The focus was on their experiences with such projects, on difficulties that arose or barriers that exist from their point of view and on the chances they perceived. This provides the basis for identifying restraints and supporting factors for the integration of contracting and constructional measures.

Three pilot projects that have been renovated in Austria are outlined subsequently. They are evaluated with respect to the contractual network between the project partners, types of guarantees and financing issues. Special emphasis is put on the assignment of tasks and the cash flow between the project partners. Various constellations of trades acted as energy service provider: a general contractor, an energy supply company, a consortium of a builder and a plumber. The projects reveal some differences to the standard energy performance contracting. First of all, pre-financing of the renovation measures out of savings was not within the scope of any pilot project. The construction measures outweighed the HVAC upgrading measures in volume by far and were financed by the building owner. The energy saving guarantee was considered the main advantage of EPC and the reason for negotiating the energy performance contract.

Introduction
Energy performance contracting (EPC) is a concept that is widely used in the public sector to implement energy efficiency for buildings and building systems. The energy service company (ESCo) performs a detailed feasibility study. The result is a package of recommended upgrading measures, their aggregated costs and their aggregated savings. In contrast to other outsourcing contracts EPC is a guarantee to achieve the energy savings. If the measures fail to produce savings, the ESCo pays a penalty. Since operation and maintenance are essential to realise the projected savings they are part of the contract, too. The term of a standard contract is often 5 to 10 years; investment

1. Renovation and refurbishment are used synonymously throughout this paper.

costs are re-financed from the energy savings within this time period. EPC for large buildings with high energy consumption and a high peak load is more cost effective allowing for shorter payback periods and contract terms.

In addition to the mentioned characteristics the advantages of EPC are:

- EPC is service-oriented, apart from operation and maintenance it may include information and motivation programmes, hot lines, etc.
- Capital cost and operation costs are optimised together, resulting in a best prize offer.
- The risk of non-performance of the measures is carried by the ESCo. This is especially valuable if innovative technologies are implemented and specialist skills are necessary for operation and maintenance.

EPC is working particularly well for upgrades of building systems (Heating, ventilation, cooling, air conditioning, lighting, etc.) and for control and management measures. Guaranteed savings range from 15 to 25 % of the previous energy consumption.

But what if the goal is more ambitious? This paper reports on an idea that was first[2] addressed by a project[3] within the program "Building of Tomorrow" of the Austrian Federal Ministry of Transport, Innovation and Technology. In the context of this program passive house standard is required as well as to take in ecological, economical and social concerns: use of sustainable raw materials, efficient use of materials, consideration of user needs, costs should be comparable with conventional building methods. The project should analyse whether such a comprehensive renovation of buildings could be achieved by EPC or what could be the contribution of EPC to a comprehensive renovation of the whole building. As a minimum construction measures like insulation of the building envelope would be required to further reduce the energy consumption towards the aim of a passive house standard.

A central task was a social study on the perception of construction-centred measures and EPC among important actors in the business. 22 interviews have been conducted among ESCos, customers, financiers and consultants. The findings of the study are presented in the following. The concepts were resumed by the "Eurocontract"-project[4] of the Graz Energy Agency within the EIE-program. J.W. Bleyl et al. elaborated the cooperation models and present them in another paper for the ECEEE 2007-conference with the title "Comprehensive refurbishment of buildings with energy services".

Three Austrian renovation projects managed by the Graz Energy Agency and the Austria Energy Agency, Vienna, which comprised comprehensive renovation measures serve as a further input to this paper. They are outlined with a description of the measures that were incorporated, the contractual relationship of the companies that were involved, the advantages for the clients, the financing of the projects, etc. Conclusions are drawn with respect to the topic of this paper.

Interviews with stakeholders on constructional measures and EPC

Although insulation of the building envelope is often in the list of EPC-adequate measures, there are only few realised projects or case studies. The majority show individual and rather simple measures, like e.g. low-e windows. Comprehensive renovations were seldom combined with EPC. An extended EPC-variant to include building renovation, still has the attractiveness of the standard[5] EPC and also shows the central criteria of EPC. In addition even more benefits can be anticipated: The incentive to provide high quality work and equipment is built-in, it leads to immediate improvements without the need to wait until appropriation of costly measures is concluded, healthier working and living conditions are established (compared to retrofitting of building systems).

Qualitative interviews with actors in the EPC business should be an adequate method to shed light on the fact why there are only few such projects despite of these incentives. The interviews were recorded and transcribed to provide the base for an analysis of perceived constraints and risks as well as of advantages and positive feedback. The focus of the detailed interviews with experts and stakeholders was on their experiences in case they have dealt already with such projects respectively on their opinion of this issue. The analysis showed how much thought they have given to this subject, what was most often put forward, where the roots of the stated barriers and opportunities are and in which phases of the building project these appear.

ESCO: "MIGHT BE TOO EXPENSIVE."

Eight representatives of ESCos were asked why there were so few contracting projects with construction measures, what their opinion was on such projects and what conditions could raise their willingness to accomplish such projects.

It is a common feature of standard EPC-projects that the ESCo´s costs are repaid by the generated savings. Minor insulation measures like to seal windows or to use mineral fibre-blankets or loose-fill materials in attics will not pose a problem. But as soon as a bunch of renovation measures are considered the energy savings even if aggregated for many years, will be outweighed by the capital costs. Contract terms would exceed the economic period for the contractor.

The core-competence of the ESCo is not the construction business. Whereas the complexity of the project and the coordination effort is raised his share does not hold with it. Moreover he has to take the risk for the whole project because he signs the energy performance contract. The construction company will not give any performance guarantees on the energy savings, has been quoted. ESCos would at least appreciate quality guarantees of construction companies that last for the contract duration. The cooperation of the ESCo with the construction

2. Another precursor in many respects was also the EU-LIFE-project "Neue Dienstleistungen zur umfassenden ökologischen Gebäudesanierung", see e.g. Tritthart, W., et al.: "Creating a regional service-market for the ecological refurbishment of buildings", ECEEE Summer Study 2001.

3. Bucar (2004)

4. Bleyl (2007)

5. As e.g. given by Seefeldt/Kuhn: Guidelines for Performance contracting in State buildings (Hessen guidelines), Ministry of the Environment Hessen, Germany

firm could be organised as a consortium or joint venture but this is also quite resource expensive.

In Austria the tender documents should already contain a quite detailed calculation of energy and cost savings. So a comprehensive construction project needs time-consuming pre-work without a reward for it. Costs and savings are probably quite difficult to define at this stage.

But ESCos also see several opportunities for this sort of energy performance contracting. All features that make up the attractiveness of EPC for customers are in excess realised: A whole building approach is built in, a one-stop-shop-offer is especially attractive in a complex project, a high-quality execution of the design and planning lies also in the motivation of the ESCo.

A stable cooperation either with a construction firm or with a finance partner would be profitable in the opinion of the ESCo. Once it has been settled the process can be stream-lined, the response on tendering is easier, especially the accounting for construction options and costs. But some ESCos also fear it could lead to dependency and reduced competitiveness. They prefer to use special construction systems or products with well-defined fields of application and attend to train their staff according to it. This could also be a chance for producers of innovative systems and products, if contacts could be facilitated.

BUILDING OWNERS AND CLIENTS: "HAVE NOT THOUGHT ON THIS YET."

Five persons have been interviewed; three of them were property developers and two persons were from public building administrations. Building renovation was one of the main tasks of all interviewees, but only the latter were acquainted with EPC.

The subjects of the interviews were: What features of EPC are or could be especially valuable for their projects?, What conditions hamper EPC with additional construction measures?, What are prerequisites on their behalf for projects (legal, financial, tendering, cooperation, etc.)? How could innovative building systems like renewable energy systems be promoted within their projects?

Persons that had not entered an EPC until then had a significant lack on how EPC could facilitate their renovation and energy improvement projects. Sometimes they even were wrong informed. All interviewees stated the minor importance of EPC for comprehensive renovation. The EPC experienced persons reckoned the contractors had too little know-how on construction issues to push through comprehensive renovation projects.

Investment costs are substantially higher, so the duration of an energy performance contract would be at least 20 years or even longer. Whereas this was mentioned as an obstacle on the part of the ESCo this poses no problem for the customer - with some exceptions: Staff of public building administration often is not allowed to sign such long-term contracts; Property developers who want to sell a renovated building have to find agreements on how and under which conditions to pass on the long-term commitments to the new owners.

Most promising was considered a pooling of similar buildings with similar construction and consequential renovation requirements, e.g. school buildings of the 1970ties. EPC could be the tool for improving the facilities and several buildings together within a short time. Renewable energy goals as well as climate change mitigation are also arguments that count for school buildings in specific. The ESCo should encourage such measures demanded the interviewees and referred to experiences with ESCOs that were anxious to restrain on simple technological system upgrades.

Anyway, interviewees that could drawn on experiences with EPC wanted to carry on with it. An extension to construction measures – may be with alternative financing like leasing – was favoured.

ENGINEERS AND ARCHITECTS: "NO EXPERIENCES."

Only three interviews could be conducted; with an architect, an electrical and home automation engineer and a HVAC engineer. Several engineers were asked but did not want to spend time on a subject they had no professional interest in or had no clear impression of. Although non of the interview partners had been involved in a EPC project they already had heard of energy performance contracting and they were interested in.

As expected there was a lack of information on how to rate a project with respect to its energy saving potential, expectation on the benefits were rather diffuse and the working sequence when participating as a designer in an EPC project was unknown. None of the interviewed persons wanted to act as ESCo, they thought of a cooperation, but they had not made contacts with a ESCo until then. It might be difficult to survive as a designer who passes on the responsibility for energy savings to someone else; the energy performance contractor is partly a rival in business.

But on the other hand the architect or the engineer is often the person who is consulted first by the building owner and he might suggest to call upon a contractor for guaranteed energy savings and for pre-financing.

BUILDERS AND GENERAL CONTRACTORS: "CONTRACT TERMS ARE TOO LONG."

Five representatives of medium sized building companies were asked on their experiences and their perception on the following groups of questions: What are the chances of EPC from the point of view of their customers? What are the barriers? What are the conditions that could move their company further towards EPC? All interviewed persons had already participated in EPC more or less: either they had been sub-contracted, or they had been involved in the bidding. Contracting projects still are handled as pilot projects.

Networking and informal business networks are distinctive features of the construction trade. Building companies have their partners and sub-contractors to form a trusting business relationship over many years. Contacts of the interviewees to the ESCo were not as pronounced and mostly in its early stages. Building companies have not compared the range of competencies of different ESCos, they do not feel to "be already married" to a contractor.

Guaranties of energy savings and the risk associated with it is a matter of concern for building companies. Companies that have performed only one or no EPC project were more cautious. One company had contacted an ESCo who would not take the energy saving risk and who proposed to share the risk. As for guarantees concerning the construction measures (performance and longevity) the representatives of the companies thought the existing regulations would be sufficient. The

could not anticipate the objections the ESCos had raised. After enquiring possible solutions they could envisage some sort of insurance, e.g. for corrosive wear.

Functional specifications commonly used in the EPC tendering are (among other issues) outlining the objectives of the project and the scope of the work. Whereas the tender documents in the construction trade are usually very detailed, containing a description of products to be used and work to be accomplished. Building companies are able to handle this sort of tendering, nevertheless it causes additional work. Significant costs are anticipated for small enterprises that also have to seek and buy legal expertise that is not available in-house. Functional specifications redound to the advantage of the customer.

Prefinancing of the building improvement measures was not popular with the interviewed persons. It puts a strain on liquidity of the company that has to buy the raw materials. On the other hand they complained that incorporating financing institutions into the team results in less flexibility. Large enterprises are sometimes forced to long-term commitments/obligations when realising big investor projects: they become an associate instead of getting the total construction costs rewarded.

The predominant motivation is to be present where construction is required. Other incentives are only minor important and are expressed casually. Thus it can be concluded that contracting is not on the companies´ agenda concerning public relations. None of the building companies takes into consideration to built up a new business area "Contracting". But they are eager to be the first who takes the opportunity to position themselves on a future market "renovation".

In the interviews it was always asked whether contracting projects could profit from the built-in incentive of the ESCo to maintain and operate the facility to maximise energy savings. All interview partners negate any similar incentives for the construction measures. All orders are executed carefully and accurately because of warranty reasons. This statement neglects that there are specific requirements for low-e buildings and passive houses (e.g. air tightness).

FINANCE INSTITUTIONS AND BANKS: "VERY PROMISING."

Representatives from three banks that also provide leasing financing were interviewed on the possibility to integrate additional criteria like energy saving in various financing options, on the integration of construction measures in contracting projects and on the organisation of the cooperation in this case. All interview partners had some experiences in EPC, one of the companies was leading on the market.

Barriers to extend the scope of EPC towards ecology or construction measures were perceived in the growing complexity of the tendering requirements. If they are too detailed they leave no flexibility and require legal expertise on contractual terms. Procurement regulations often hamper the provision for life-cycle-costs. The interview partners were in favour of a comprehensive renovation and complained the low awareness of the advantages.

Prefinancing and transferring of risks were mentioned as main advantages for the customer. The passing out of risk factors could promote the diffusion of innovative technologies. The interview partners also identified a wide range of future target groups for extended EPC: Industry, hospitals, chemical laboratories, and so on. Contracting could also extend to cover the risk of process failures.

Constraints and prospects within the EPC procedure, further results

The approach of customers to EPC is slightly different depending on their starting point: Building owners who decided to renovate their building and might, secondly, be interested in additional or high-grade measures that pay for themselves by the savings. On the other hand there are building owners interested in energy saving and/or contracting and they could take into consideration to commission renovation measures, too, causing the contract to run for 20 to 30 years in contrast to 5 to 10 years as for typical EPC. This difference was not explicitly differentiated in the interviews neither by the interviewer nor the interviewee, but the predominant perception was the latter case: The customer primarily wants to reduce energy consumption; he could increase savings by comprehensive renovation measures. This is in contrast to the pilot projects were renovation was put in the first place and the clients were prepared to spent money on the renovation.

The interviews with experts and stakeholders were assessed concerning their perception of constraints and prospects in the course of an EPC project. Most private building owners or property developers lack the information on the possibility and on the advantages of energy performance contracting in general, in contrast to employees of public administrations[6] which may have a profound knowledge on EPC but usually do not link it with comprehensive renovation. Two of the pilot projects given in the next chapter of this paper demonstrate that even residential buildings offer opportunities for an extended EPC.

Energy agencies serve as project developers and facilitators to give advice in the tendering and the awarding procedure of an EPC project. Municipal and local authorities which have no or little experiences with EPC often refer to the professional help of energy agencies, just as social housing associations do. Public authorities have to comply to special requirements regarding the procurement procedures.

Compared to a standard EPC an invitation for tender comprising comprehensive renovation works is quite complex to deal with. It depends very much on the quality of the tendering documents of the client how many bidders show interest. Construction companies do not take the lead to submit a bid, not even if construction dominates. ESCos on the other hand are missing construction related expertise to easily complete the tender in this regard. A stable partnership seems to be a prerequisite especially for "new-comer" companies – as well ESCo and builders - to answer a call for EPC with a high proportion of construction works. But in the interviews there has been no evidence that it has been established somewhere.

Problems with extended guarantees are also expressed by the interviewees as problems of the other business: ESCos assume that construction related guarantees are posing problems because they are expensive to repair while builders see no problem since they are subject to warranty anyway.

6. In Austria the management and maintenance of most of the public buildings is outsourced to the BIG (Bundesimmobiliengesellschaft).

To prove successful comprehensive renovation projects that are realised as EPC always need a "whole building approach", this means a mutual optimisation of all components by an integrated design process. The interviewees however stressed the effort for coordination during the construction phase which is suspected to be very high. But the willingness of ESCos to achieve know-how in construction respectively of builders to do so in HVAC is rarely existent.

Bundling of various goals and different technologies into the projects to achieve an optimum with respect to energy and ecology criteria is always a demanding task. It normally leads to the necessity to form a team of specialists to access skills and expertise from various construction trades. Thus another part of the project[7] within the "Building of Tomorrow" was an analysis of the Austrian legal situation, in specific of the trade law, with respect to (joint) contract offers comprising construction and HVAC measures of a single company as well as of two or more companies. Addressing the perceived restraints and supporting factors the actors gave in their statements, three models were drafted on how the main actors in a renovation project could cooperate to achieve the outlined goals. The models were already further elaborated and are presented in more detail in the ECEEE 07-paper 5,039 of J.W. Bleyl et al.

Pilot projects on EPC with comprehensive renovation measures

An internet survey on concurrent initiatives and similar activities has shown that the Graz Energy Agency (GEA) is certainly one of the leading institutions to address the integration of renovation measures in energy performance contracting (EPC). GEA has been involved into some projects in this context already; most of them served as case studies or as pilot projects, too. The three pilot projects given are dating from the years 2002 and 2003 and thus are realised after the social study in the former chapter.

A difference to standard EPC-projects is the fact that the construction works cost significantly more than the technical system investment costs, e.g. six times of the latter in the first example. Therefore the contractual issues are sophisticated in comparison to the standard EPC-contract. Financing is always tailored to each client and to the financing and funding conditions applicable to the project. In the following examples no ESCo was pre-financing, but the client paid the cost either by loans, by his budgetary means or by subsidies.

PILOT PROJECT 1: JOANNEUM RESEARCH BUILDING STEYRERGASSE, GRAZ/AUSTRIA

Client: Joanneum Research Forschungsgesellschaft mbH

ESCo: MCE Building & Infrastructure Solution GmbH [technical building services and automation]

EPC-Project management: Graz Energy Agency, Kampits & Gamerith architects; thermal renovation design was the first task, building upon this, tender specifications for its construction were developed

Figure 1: Picures of the building after renovation (above) and during renovation (below).

Building data: Construction in 1962, extension in 1965 and 1974, utilisation as research centre, total floor space 6,543 m², district heating supply

Initial situation, baseline costs: High energy costs and water consumption (fresh water was used for cooling of the scientific equipment), comprehensive refurbishment necessary for the whole building; baseline 123,300 € per year (42,700 € heating, 56,000 € electricity, 24,600 € fresh and waste water)

Measures:

- Building envelope measures: insulation of outer walls, replacement of windows
- HVAC measures: improvement of boiler settings and controls, installation of thermostat valves in the heating water circulation, cooling of the laboratory appliances (electron microscopes, vacuum pumps) by a closed-cycle chiller and a heat exchanger for the room heating, building energy management system
- Organisational measures: concept for getting the staff involved

Investment costs: 1.3 Mio € for refurbishment and 200,000 € for technical equipment (design and EPC management not included). Apart from app. 180,000 € which was a grant of the Kommunalkredit Austria AG, the complete investment costs were financed by the building owner.

Savings: 35,900 €/a or 29 % (guaranteed), 7,400 m³/a of fresh water

Contract period: 15 years (September 2003 – August 2018)

7. Bucar (2004)

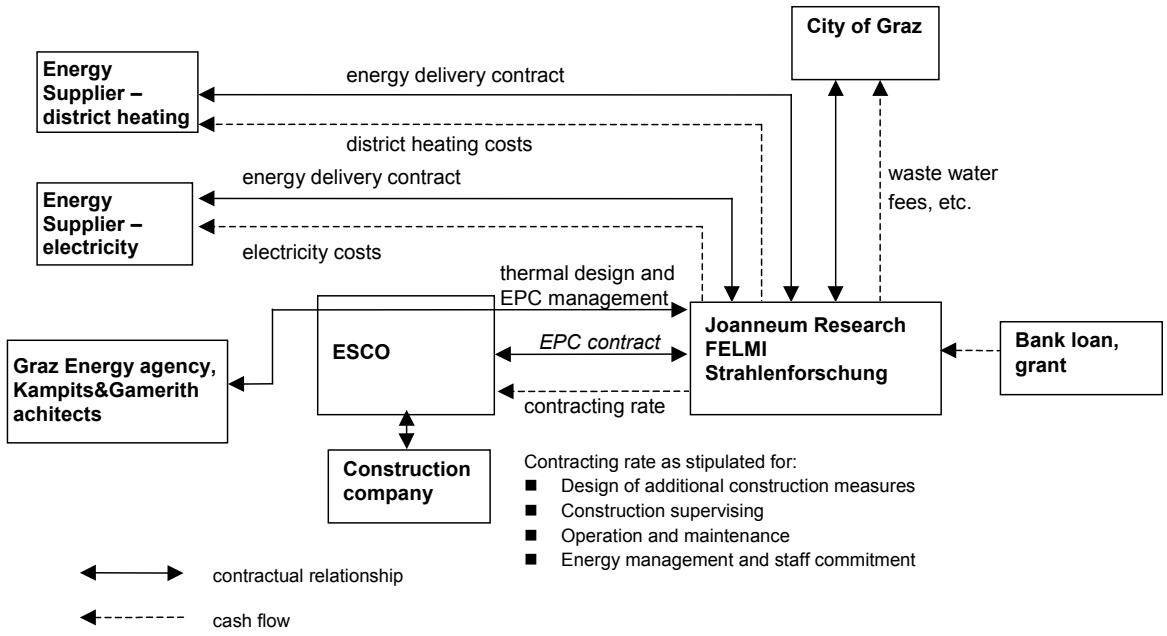

Figure 2: EPC implementation graph

Figure 3: Pictures of the building before renovation (left), after renovation (right), detail of insulation application (middle)

EPC model:
The client commissioned GEA and Kampits & Gamerith to design the building envelop insulation and to prepare a tender for EPC and for the renovation of the building envelop. The ESCo had to accept this tender for the renovation measures. The guarantee of the ESCo comprised not only the energy savings but also the correct functioning of the laboratory equipment. The ESCo was also in charge of supervising the HVAC and the construction work that were thus carefully checked during the construction phase and after commissioning by means of thermography.

Success: The guarantee could be reached with no problems, although there is still a potential optimization (the old cooling system was activated several times, because the new chilled water circulation produced jumps in the chilled water temperature that damaged the laboratory equipment.).

PILOT PROJECT 2: MULTI-STOREY RESIDENTIAL BUILDING OSTMARKGASSE, VIENNA/AUSTRIA

Client: BUWOG – Bauen und Wohnen GmbH

ESCo: Consortium „Bietergemeinschaft Gros/Sedlak/Paldauf" [Gros/Sedlak is a construction company, Paldauf is a plumbing trade company]

EPC-Project management: Austrian Energy Agency, Vienna, together with BUWOG

Building data: Construction 1968 – 70, total floor space 10,537 m², two five-storey buildings with a total of 145dwellings

Initial situation, baseline costs: High heating energy consumption (specific heat consumption 94 kWh/m²a) and costs, facades of the buildings had not been insulated and were showing construction defects. The whole site is heated by a district heating system whereas the hot water is generated decentralised with electric storage units.

Measures:

- Thermal improvement of the building envelope (insulation of the outer wall, insulation of the top and bottom floors, removal of the thermal bridges)
- Adjustment of the district heating network delivery (reduction of the temperature level and reduction of the mass flow rate, correct calibration of the network pumps)
- Adaptation of the return-valves of the heating circulation and installation of thermostat-valves

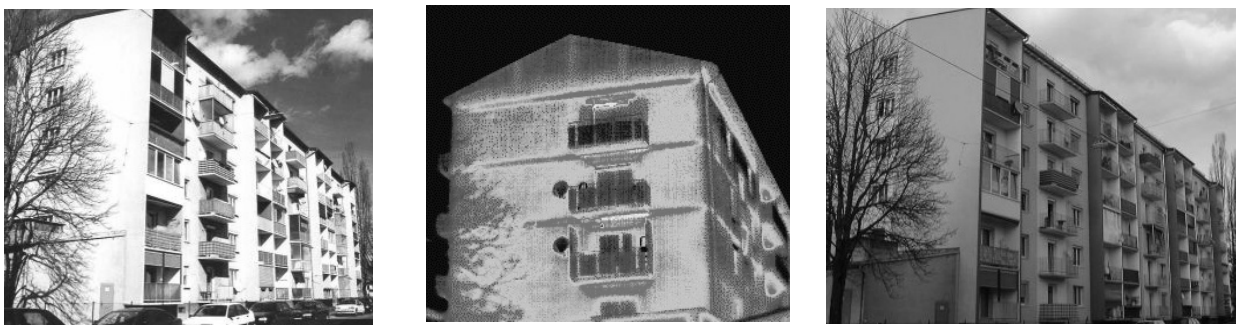

Figure 4: Before renovation (left), Thermography before renovation (middle), renovated building (right)

- Tenant information and commitment on energy saving practices
- Operation and maintenance of all devices installed by the ESCO
- Implementation of an energy management system

Investment costs: 1,123 Mio € (partly financed by a subsidy of 35 €/m² from the Municipality of Vienna THEWOSAN program)

Savings: 60 % of the heat costs (old energy indicator 94 kWh/(m²a) heating demand; after renovation: 39 kWh/(m²a) heating demand)

EPC model:

The ESCo guarantees that the maximum energy costs per year (after adjustments for price, climate and utilization levels) will not exceed a specific level during the contract period. If this fails, the contractor's fees for operation and maintenance will be reduced by the amount of the excess costs. The measures were financed by a subsidy and by a bank loan that is paid back with a raise in the preservation fee[8] (which is a part of the rent) of the tenants. But energy cost savings offset most of its increase.

The construction company was sub-contracted by the ESCo. The ESCo was supervising the construction works in order to obtain a high quality construction.

Contract period: 10 years (2003 – August 2013)

PILOT PROJECT 3: THREE RESIDENTIAL BUILDINGS DAUN-GASSE-ASPERNGASSE, GRAZ/AUSTRIA

Client: Gemeinnützige Grazer Wohnungsgenossenschaft, GGW [a social housing association]

ESCo: Steirische Gas-Wärme GmbH, StGW [the styrian gas provider]

EPC-Project management: Graz Energy Agency

Building data: Construction in 1959, total floor space 7,485 m², 150 dwellings

Initial situation, baseline costs: High heating energy consumption and costs; facades of the buildings had not been insulated and were showing signs of construction defects; heating with single stoves (coal) in each room; electrical hot water heating in each dwelling. The inhabitants are tenants with a rather small income.

Measures:

- Building envelope measures: thermal insulation of the external walls of the buildings, insulation of the top floor ceilings / cellar ceilings, replacement of windows
- Technical and other measures: installation of a new gas fired central heating and hot-water supply system (including the distribution system) combined with solar collectors (app. 83 m²); establishment of an energy management system; elevator construction; renewal of the electrical installations of the shared building sections.
- Organisational measures: Operation and maintenance lies within the responsibility of the ESCO; tenant involvement: the inhabitants with the largest energy consumption are invited to an energy saving information event.

Investment costs: 2,18 Mio € (financed by a very cheap governmental loan[9] and by the savings)

Savings: 45 % of the heating costs (old building energy indicator: 120 kWh/(m²a) for heating, after renovation: 53 kWh/(m²a) for heating)

EPC model:

GEA and GGW (the client) were designing the construction renovation measures. The client issued the tender specifications and contracted the construction company. The ESCo did the design of the heating and hot water systems as well as the supervision of the construction works.

The contractor guarantees a maximum limit for all investment costs (fixed price), for the annual heating costs for all three buildings (climate- and use-adjusted, without hot-water supply, no guarantee for the individual flats but for the tenants altogether) as well as the energy prices for hot-water supply during the contract period (with index adaptation on the basis of the energy price index). There is also a guaranteed reaction time in case of technical problems.

If the contractor cannot meet the guarantee specifications, the contractor's fees for routine services (operation, maintenance inspection and repair) will be reduced by the degree of non-fulfilment of the guarantee.

Contract period: 15 years (2002 – August 2017)

Success: The target was reached easily. Though the guarantee is given for the sum of all tenant's energy consumption, it is me-

8. The preservation fee is a levy to save money for maintenance and improvement measures of the building. It is defined by law ("Erhaltungs- und Verbesserungsbeitrag").

9. This loan with an interest rate of 0.5 % is granted for renovations of social housing companies that result in a comfort rise (central heating, elevator, etc.

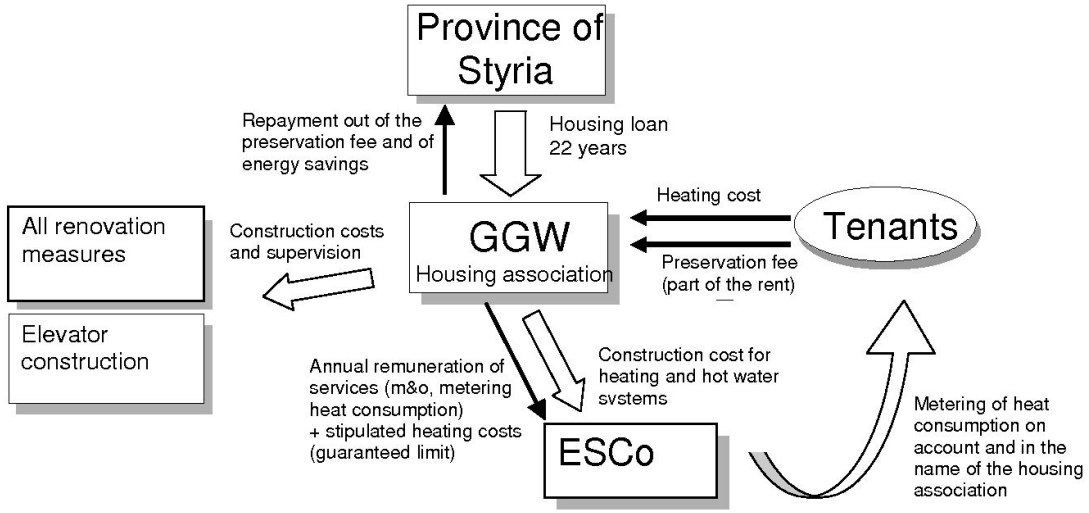

Figure 5: EPC implementation graph

tered for each flat; seven tenants with the highest contributions are informed on energy saving possibilities each year.

EVALUATION OF THE PILOT PROJECTS

The pilot projects were evaluated with respect to the contractual network between the project partners, types of guarantees and financing issues. Only in one example (no. 3) the ESCo was also the energy supplier and thus the client concluded a heat delivery contract with it. The heat supplier (ESCo) installed the heating system for the housing association and received full remuneration for the installation. In all pilot projects the thermal renovation was designed by the energy agency (GEA, resp. AEA, partly with the client or with a building physics engineer), with the aim to fulfil the requirements of subsidies that are granted for comprehensive renovation projects in Styria as well as in Vienna. The ESCo's business was the design development, subcontracting of all companies of the construction trade, the organisation of an optimal construction process with all involved companies, the supervising of the construction works and to furnish the documents that verified the high quality of the renovation (thermography images).

In two pilot projects (no. 1 and no. 3) the ESCo sub-contracted the complete construction work. The construction companies were not included in the performance contracting itself; the ESCos were content with the legal instruments to assure workmanship (statutory warranty, claim for damages). This minimises conflict points between business partners because it has a strict inherent hierarchy: The ESCo is the leader of the construction team. The consortium of pilot project no. 2 already acted as general contractor before they decided to submit the EPC offer.

The focus of the described EPC projects was on the saving guarantee. During the contract period the ESCo guaranteed an upper level of heating costs. It was calculated taking into consideration the actual climate conditions (heating degree days of this year), the actual end energy prices and any changes of the inhabitants´ consumption relevant behaviour. In all pilot projects the projected guaranteed savings could be reached.

In residential buildings of social housing associations in Austria it is possible to prolong the former payment for energy for the contract period although energy costs are reduced after renovation. A share of the rent exactly corresponding to the energy saving was thus allotted for the repayment of the investment costs. If the saving guarantee is not upheld, the contractor's fees for operation and maintenance would be reduced by the amount of the excess costs. No unforeseen excess expenditures could occur for inhabitants.

Comprehensive renovation projects are in general characterised by a complex design and construction process which is mainly due to the fact that several trades have to be organised and sometimes have to work hand in hand. Moreover guaranteed savings rely on a whole building optimisation comprising the construction works as well as the HVAC systems. So this adds much complexity to an EPC project; besides the standard EPC is often only a small part of the investment costs of a comprehensive renovation project. Also the client favours a single contract that allows him to outsource every inconvenience to get an integrated optimisation process on the way. In all pilot projects the EPC comprised a total optimisation of the building envelope, the heating system and other energy technical units. This implies that an integrated optimisation of the building took place and the supervising of the construction is accurate.

Another advantage for the client is a risk transfer to the ESCo: In pilot project no. 1 the ESCo guaranteed not only the savings, but the problem free operation of the laboratory equipment, too. The ESCo was also responsible for maintenance, energy controlling, reporting and inhabitant information and motivation, there was the contact person in case of any defects of the HVAC systems as well as of the refurbishment works, or if any damages occured. There was also a guaranteed reaction time in this case.

In all pilot projects the ESCos were also asked to provide a financing scheme. It is one distinct result of the implementation phase that their pre-financing offers were not so attractive for the clients. All chose their own financing institutions and schemes instead.

Much resources of the EPC management of the Energy Agencies was invested to develop applicable tender procedures for the thermal refurbishment measures that are partly functional with performance specifications or a defined minimum standard. It became obvious that housing companies need expert support e.g. of an energy agency for the implementation of EPC extended with comprehensive renovation measures. There are specific legal requirements for building owners like public authorities and social housing associations.

Conclusions and further recommendations for the establishment of EPC with comprehensive building renovation

Energy performance contracting (EPC) is a vehicle to accomplish energy efficiency and energy conservation. EPC can also extend to cover construction measures. The **study** on hand has shown that **stakeholders and experts** are actively engaged if there is a forum to discuss the problems and the chances that might occur. The interviews have shown that EPC containing comprehensive construction measures was especially favoured by those participants that had not performed an EPC project until then. Whereas EPC-experienced persons primarily addressed potential problems.

To sum up the following **barriers** have been identified:

- lack of experience with long-term EPC comprising improvements that exceed upgrading of HVAC systems,
- additional efforts to provide the tendering documents,
- there needs to be a trustfully and stable basis for cooperation in case extended guarantees are assured,
- no insight in the work and knowledge of a potential EPC partner from the other trade,
- pay-back periods are drastically extended,
- the risks are higher for EPC incorporating comprehensive construction measures.

Positive feedback was on:

- integrated design and (extended) services are encouraged,
- ecology criteria as well can become awarded,
- comprehensive renovation is a window of opportunity to address e.g. architectural aspects like modifications of the floor plan,
- (extended) guarantees are in any case attractive.

The pilot projects were implemented during and after the social study had been conducted. In all pilot projects comprehensive renovation measures were realised. Various constellations of trades acted as ESCo: a general contractor, an energy supply company, a consortium of a builder and a plumber. The projects revealed some differences to the standard EPC:

- There was always an **integrated design** process necessary to take into account the trade-offs, e.g. between economy, comfort and reduction of energy usage. This is at any rate true if renewable energy technologies like solar hot water are to be implemented.
- **ESCo-prefinancing took a "back seat"**: it was not within the scope of any pilot project. The contract period was set to about 10 years; the construction measures by far outweighed the HVAC upgrading measures in volume. They were financed by the building owner.
- The energy **saving guarantee was outstanding attractive** for the clients. Therefore they wanted to implement their buildings renovated as EPC projects although it added a premium on top of the normal fees to include the services of the energy agency and the general contractor.
- In two pilot projects in addition "**guarantees of functioning**" were accepted: The proper functioning of the laboratory equipment that had to be cooled and the solar collectors that were realised for domestic hot water.

The energy agencies helped to issue **the tender.** The tender contained functional specifications – as is preferable for EPC – but for the thermal renovation some measures were mandatory. The energy agency always performed a quite detailed energy audit first. Building on that prioritised energy reduction measures were developed. The remaining demand was to be supplied as efficiently as possible. The energy agency also assisted the client in assembling the optimum package of services and measures the ESCo should be commissioned with.

The ESCos typically were in charge of **supervising the construction works**. That posed no problem – the ESCos had the needed expertise in-house or it was covered in the consortium. Even concerning the installation of the solar collector the ESCo didn't reject to guarantee. In two of the pilot projects the ESCo performed a thermography to prove the quality of the renovation and to exclude thermal bridges. The projected guaranteed savings were reached in all pilot projects.

The establishment of EPC plus comprehensive renovation measures could help to take us further towards the aim of sustainability, towards low energy consumption and passive house standard. But **substantial efforts** are still necessary to improve the standard EPC procedure to incorporate comprehensive renovation measures as well as to facilitate the current renovation practice with EPC elements:

- A detailed analysis of the strengths, opportunities, weaknesses and threats of extended EPC on the market and among various target-groups should be performed as a basis for promotion activities.
- Innovative financing options and guarantees might still turn out to be attractive e.g. for private building owners. The private owner community might in specific appreciate the sound calculation of the investment costs versus the aggregated savings that is part of EPC.
- Potential elements of the market development could be centred on qualification programs for the construction trade and on EPC-know-how transfer to business communities like engineers and builders.

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