Comprehensive Refurbishment of Buildings with Energy Services

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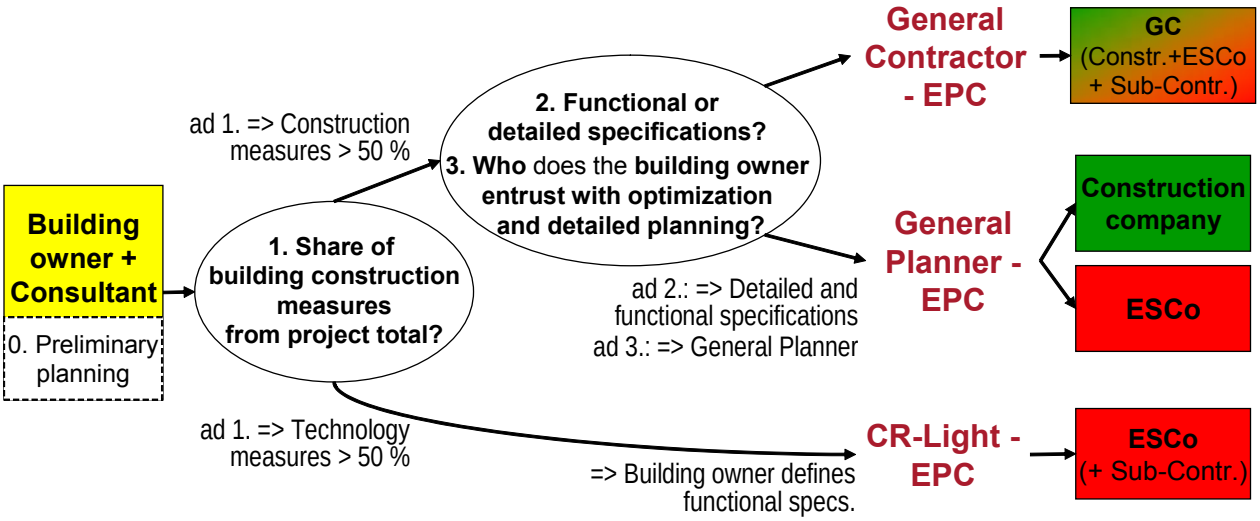
Abstract

Energy Performance Contracting (EPC) Projects, if implemented properly, have successfully delivered guaranteed savings since they were first established in Europe about 1995[1]. Consequently the new **EU Directive on Energy End-use Efficiency and Energy Services**[2] supports EPC and views it as an important instrument to implement energy efficiency based on market instruments.

EPC-projects realize demand reduction measures which typically encompass building technologies like HVAC, electrical applications and control systems. In most cases, building envelope refurbishment measures are excluded. As a consequence, large saving potentials are neglected in the refurbishment process and they are lost until the next comprehensive refurbishment cycle of the building some 30 years later. **Obstacles** like no integrated planning approach, too long pay back periods of the energy efficiency investment measures, procurement problems or a lack of knowledge on implementation models and various others are some of the reasons behind.

In this paper, we propose and describe **models how to integrate building refurbishment measures into EPC-models**, in order to achieve a comprehensive refurbishment (CR) of buildings as indicated above (**CR-EPC-models**). We propose three different basic models for the implementation of Comprehensive Refurbishment projects: a "**General Contractor**" (GC), a "**General Planner**" (GP) and a "**CR-Light**" **-EPC–model**. The decision for an implementation model can be taken after completion of preliminary project planning.

Factors for applicability of the models (especially for the public sector) are described out of which the most important ones are 1. share in building construction measures from project total, 2. whether functional or detailed specifications for the awarding of the CR-works and services are applied and 3. who the building owner wants to put in charge of detailed planning, overall optimization and supervision of the project: a GC or a GP?



Comprehensive Refurbishment-EP-Model selection flow chart

To sum up, the paper gives **conclusions and recommendations** for the implementation of CR-projects and a short **outlook** on future activities and research.

Motivation and Introduction

Energy Performance Contracting (EPC) projects, if implemented properly, have successfully delivered guaranteed savings since they were first established in Europe about 1995.[1,10, 11] Consequently the new EU Directive on Energy End-use Efficiency and Energy Services[2] (EE+ES-Directive) supports Energy Service concept and views it as an important instrument to implement energy efficiency based on market instruments.

EPC-projects realize demand reduction measures which typically encompass building technologies like heating, ventilation, air-conditioning (HVAC), electrical applications and control systems. In most cases, building construction measures[3] like building envelope refurbishment are excluded. As a consequence, large saving potentials are neglected in the refurbishment process and they can not be tapped until the next building refurbishment cycle comes some 30 years later.

Obstacles like no integrated planning approach, too long pay back periods of the energy efficiency investment measures, procurement problems or a lack of knowledge on implementation models are some of the reasons behind.

In many cases EE is not the driving force behind Comprehensive Refurbishment of buildings. Non-energetic benefits like building modernisation, increased comfort, external representation or income from rent may be more important to the building owner. Nevertheless minimum performance standards for thermal refurbishment or guarantees for maximum energy consumption should be written into the terms of reference. CR-EPC-models as promoted here are a good means to secure these goals and are also applicable to sale and lease back projects.

In this paper, we describe models how to **integrate building construction measures into EPC-models** in order to achieve a comprehensive refurbishment (CR) of buildings as indicated above. We propose to call these **Comprehensive Refurbishment-EPC-models** (**CR-EPC**)[4]. We propose three different basic models: a "**General Contractor**" (**GC**), a "**General Planner**" (**GP**) and a "**Comprehensive Refurbishment Light**" (**CR-Light**).

The following **main features** of the three basic models are described in more detail in this paper: **key actors, responsibilities** and **basic contractual relationships; (public) procurement implications; important requirements on the various project partners; contractual guarantees and quality assurance instruments** as well as **advantages** and **disadvantages** of the different models. We also give some comments on **financing options**. To sum up, the paper gives **conclusions** and **recommendations** for the implementation of CR-projects and a short **outlook** on future research and development activities.

Not covered in this paper are aspects such as payback periods of different CR-building measures, subsidy programmes or CR-model contracts. We assume that the selection of the implementation model has no direct impact on these aspects and leave these topics (and many others) to other elaborations.

Methodologically, the paper mainly builds on practical CR and EPC project experiences, developed and implemented by Graz Energy Agency, Austria. It is supplemented with EPC experiences from Berlin Energy Agency and the Austrian Energy Agency (former E.V.A.).

The groundwork for this paper has been laid with a systematic **description of 6 existing and planned CR and EPC projects** and an evaluation of the experiences made.[5] Earlier basics for this work have been laid in the "CONZUK"-project[6], which have been summarized by Tritthart et al.[7]. The latter paper also documents three of the six CR-project examples mentioned before. Additionally talks with stake holders such as real estate owners, ESCo's and others have been conducted.

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[1] Reference to 2 successful examples (in German): www.contractingoffensive.at, http://www.berlin.de/sen/umwelt/klimaschutz/berlin_spart_energie/de/oeffentliche_einrichtungen/

[2] Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006

[3] By **building construction measures** we understand measures like refurbishment of facades, windows or passive shading, whereas standard Energy Service measures are **building technologies** like HVAC, lighting or controls

[4] In Austria and Germany CR-EPC models are also known as "Garantie"-Modelle (e.g. http://www.energyagency.at/(nopubl)/themen/thema_index.htm?thema_id=68 as of 070403)

[5] Bleyl, J.W.; Kuhn, V.; Schinnerl, D.: "Comprehensive refurbishment of buildings with energy services", preliminary EUROCONTRACT-manual (unpublished draft version), Graz/Berlin, January 2007.

[6] Bucar, G.; Baumgartner, B.; Tritthart, W.; Piber, H.; Supp, B.: „Contracting als Instrument für das Althaus der Zukunft", Graz, February 2004

[7] Tritthart, W., Bleyl, J.W., Bucar, G., Bruner-Lienhart, S.: "Contracting and Building Renovation – Does it Work Together?", to be published within the ECEEE Summer Study 2007 proceedings, paper id. 5,200

This paper has received **support** from a number of institutions and individuals. We thank for financial assistance from the Intelligent Energy - Europe Programme[8] and the Austrian "Lebensministerium"[9]. The EUROCONTRACT partners[10], especially Vollrad Kuhn, Berlin Energy Agency and Marton Varga, Austrian Energy Agency have given helpful comments. The work has been continued within Task XVI „Competitive Energy Services" run by the IEA (International Energy Agency) Demand Side Management Implementing Agreement (http://dsm.iea.org/).

The findings of this paper have to be considered as **work in progress**, due to the limited practical experiences collected so far. If you have **questions or remarks to this paper**, your feed back is highly welcomed. You can reach the authors at Grazer Energy Agency Ltd, attention to Jan W. Bleyl-Androschin (bleyl@grazer-ea.at).

Energy Services Combined with Comprehensive Refurbishment Measures

We focus on some **key elements** and **definitions** here, assuming that the reader has a basic knowledge on energy services. Some further references on EPC-projects can be found here (unfortunately in German only): www.bundescontracting.at, „Leitfaden Energiespar-Contracting" published by dena[11] or from the brochure „Die Energiesparpartnerschaft. Ein Berliner Erfolgsmodell"[12].

Generally any design approach should **first of all focus on all possible demand reduction opportunities** (including building envelope) and then supply the remaining demand as efficiently as possible (including renewable supply options). This requires an integrated planning concept. A good example for this approach is the reduction of all electrical and thermal cooling loads including solar shading options before assessing an air conditioning unit.

The energy service concept shifts the focus away from the sale of the units of 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 (=> useful energy). The Energy Service model (combined with the knowledge and experience of an ESCo) is used to provide useful energy at minimal lifecycle- or project cost to the end user.

The before mentioned EC Directive on "Energy End-use Efficiency and Energy Services" defines energy services as "**the physical benefit, utility or good** derived from a **combination of energy with energy efficient technology and/or with action**, which may include the **operations, maintenance and control** necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances **has proven to lead to verifiable** and **measurable or estimable energy efficiency improvement** and/or primary energy savings".

Furthermore the Directive also defines **"Energy service company" (ESCo)** as a company that "delivers energy services, energy efficiency programmes and other energy efficiency measures in a user's facility, and accepts some degree of technical and sometimes financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on meeting quality performance standards and/or energy efficiency improvements."

At **CR-EPC-projects, building refurbishment measures are integrated into standard EPC-Models in order to achieve a comprehensive refurbishment of the buildings.** Depending on the CR-EPC-model, a general contractor, a general planner or an ESCo will implement a service package encompassing project coordination, overall optimization, detailed planning, implementation of measures, operation & maintenance, subcontracting, fulfilment of energy savings-, comfort- and other guarantees and may also provide (or facilitate) financing and acquisition of subsidies.

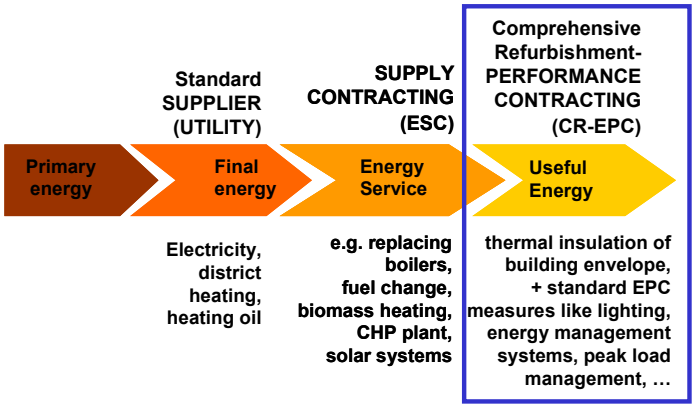
The difference of a CR-EPC to an in-house refurbishment is the long-term guarantee for the quality of the measures taken, which goes clearly beyond the implied warranty. If there are problems after the refurbishment (unexpectedly high energy consumption, problems with the formation of mould, etc.), remedying this devolves on the contractor (during the contract period). In case of in-house refurbishment, the building owner is responsible himself.

It is important to mention here, that problems like lack of quality assurance at the construction site or formation of mould have nothing to do with the Contracting-model itself. They occur, because more advanced building technologies (like more air-tight building shells) require different or more sophisticated operation and maintenance procedures (here: increased manual or mechanical ventilation). And they depend on the motivation of the construction company to deliver long term quality. A CR-contracting-model offers an instrument to incentivize "life- or project cycle" optimization including the operation phase of the building, because the ESCo is responsible

[8] http://ec.europa.eu/energy/intelligent/index_en.html
[9] http://umwelt.lebensministerium.at/
[10] www.eurocontract.net
[11] Deutsche Energie Agentur, 4. Auflage, Dezember 2004
[12] Senatsverwaltung für Stadtentwicklung des Landes Berlin, April 2002

not only for the construction but also for the operation and maintenance of the building. At a guaranteed price. Thus the ESCo has an inherent interest to take care of quality assurance at the construction site and perform proper maintenance.

The next chart follows an energy added value chain gives an overview of classical energy supply and the two basic energy service models (energy supply contracting (ESC) and energy performance contracting (EPC)) and indicates typical measures:

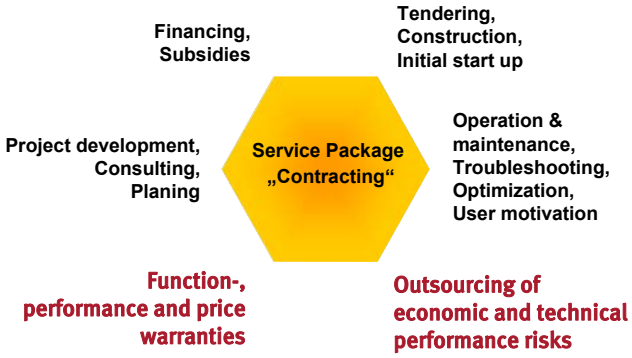


Overview Energy Service Models and typical measures

At supply contracting, efficient energy supply, including purchasing of final energy, is contracted (comparable to district heating). As for energy performance contracting, is on demand side measures in the building itself.

Energy performance contracting is a service package that can be arranged specifically to the needs of the building owner and thus quasi is a modular system. This means the client defines what components he wants to outsource and what components he carries out himself. For example, financing can be provided either by the ESCo or the building owner. What is decisive is who can provide better financing conditions. This means the contracting package in no way automatically includes external financing.[13] Other partial tasks, such as ordinary operation management or fault clearance, can be taken over by the building owner himself just as well.

The central elements of an energy service package are summarized in the following chart:



Energy Services: A modular package with success warranties

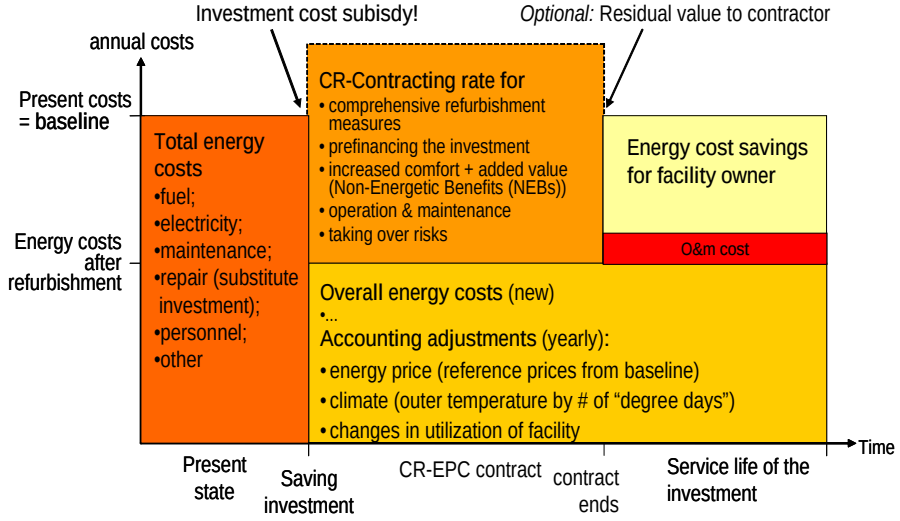
As for energy services, transfer of technical and economic implementation and operating risk as well as takeover of function, performance and price warranties by the ESCo play a crucial role. These elements create added value compared to in house solutions and are guaranteed in the CR-EPC-contract. In other words: 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.

At energy performance contracting, the building owner and energy service provider enter into a **long-term contractual relationship**. Short-term focusing on profit will not lead to success for either of the parties involved. The term “Energy Saving Partnership”, which has been given to the energy performance contracting campaign of the Berlin Senate mentioned above, expresses this well.

[13] This topic has been elaborated more: Bleyl, Jan W.; Suer, Mark: Comparison of Different Finance Options for Energy Services. In: light+building. International Trade Fair for Architecture and Technology. Frankfurt 2006.

Building technology measures can mostly be re**financed** from the future energy cost savings within a project period of 10 years. This is not true for building construction measures, such as building envelope insulation, with today's energy prices. Therefore, the building owner has to participate in financing the building measures e.g. by means of a building cost allowance, (which may, e.g., also be taken from maintenance reserve funds or subsidies), and/or paying a residual value at the end of the contract (see figure "business model …"). CR-EPC models can also be implemented with a leasing finance partner.

The CR-EPC business model is shown in the following chart:



Business Model of Comprehensive Refurbishment Energy Performance Contracting (CR-EPC)

In summary, the key features of the EPC-model are:

- A CR-EPC-partner plans and realizes energy efficiency measures including building construction measures and is responsible for their operation and maintenance throughout the contract term.
- Depending on the implementation model, the contracting partner to implement the measures is either a general contractor (GC), a general planner (GP) or an Energy Service Company (ESCo).
- The ESCo has to guarantee energy cost savings compared to a present state energy cost baseline. Further guarantees and quality assurance instruments can be included such as comfort, operation & maintenance or emission reduction guarantees[14].
- Typical EPC contract terms amount to 10 years. Investments for CR-EPC projects – depending on their magnitude - can be refinanced only partially from future energy cost savings. The building owner has to directly pay part of the investments, e.g. with a building cost allowance. Another option is extended contract periods of 15 – 25 years. Also leasing finance can be an option and should be considered. After termination of the contract, the entire savings will benefit the client.
- The ESCo's remuneration is the contracting rate and depends on the savings achieved. In case of underperformance the ESCo has to cover the short fall. Additional savings are shared between the partners.

Based on the previous remarks, we define Comprehensive Refurbishment Energy Performance Contracting (CR-EPC) as:

A comprehensive energy service package including building construction measures aiming at the guaranteed improvement of energy performance and cost efficiency of real estate objects. A general contractor, a general planner or an Energy Service Company (ESCo) implements a customized package of refurbishment measures and services (planning, building, operation & maintenance, (pre-)financing, user motivation, …) and takes over technical and economical performance risks and guarantees for the project. The measures are partially repaid out of guaranteed future energy cost savings, but with (substantial) contributions by the facility owner.[15]

[14] Basics for possible "Quality assurance Instruments / Guarantees for Energy Services" have been compiled in a unpublished EUROCONTRACT manual by Graz Energy Agency 2007

[15] Following Seefeldt, Leutgöb (2003) "Energy Performance Contracting – Success in Austria and Germany, Dead End for Europe?" eceee paper id #5158.

Three Basic Models to Implement Comprehensive Refurbishment Measures with Energy Services

The decision for an implementation model requires accomplishment of preliminary project planning. For an overview of the three models and the model selection criteria, please refer to the graph on page 1.

General Contractor EPC-Model (GC-EPC)

Main Features are:

- **Share of building construction measures:** more than 50 % of total project volume[16]
- **Project specifications:** detailed specification for 0 – 50 % of project volume possible
- **Overall project management, responsibility for optimization, planning:** GC
- **Execution of measures:** General contractor (individual company or consortium)
- **Financing:** Combination of EPC-savings guarantee + investment cost allowance from building owner + third party financing from financing institute (or ESCo) + subsidy programmes

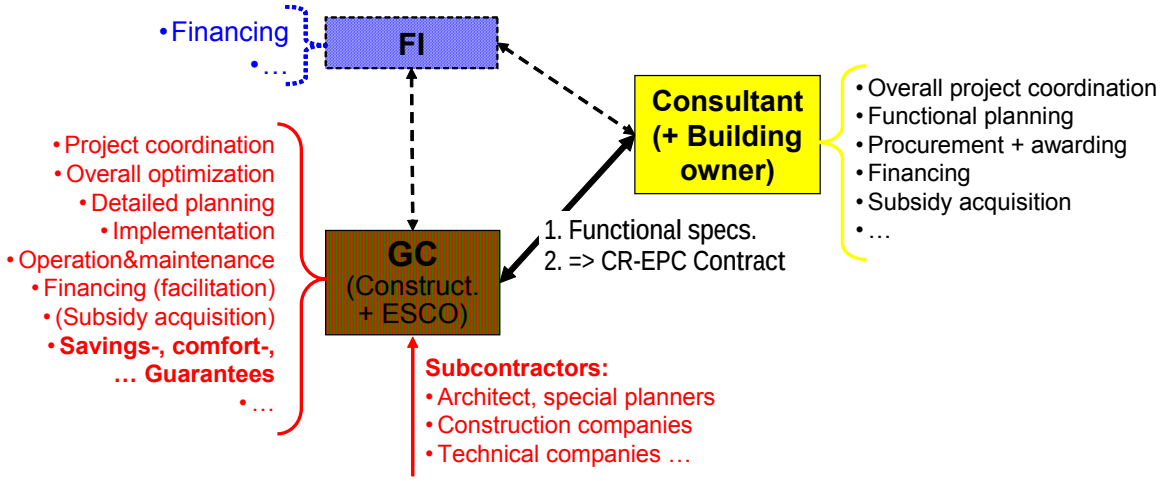
In this model, the majority of the CR-works and services are not described with detailed specifications. Instead the building owner provides functional specification defining the project's technical, financial, organizational, legal and economic performance requirements and the framework conditions for implementation of the measures.

All services, ranging from overall optimization, detailed planning, construction through operation & maintenance and user motivation, and compliance with the energy service quality guarantees over the contract term are contracted to a general contractor (GC, which can be one company or a consortium).

Key Actors, Responsibilities and Contractual Relationships

In this case, the building owner is not committed or does not have the expertise to plan, optimize and coordinate the overall project in detail. An internal project coordinator or external consultant[17] provides advice and coordinates preliminary project planning, the tendering process, and acceptance and validation of the deliverables. This coordinator in effect represents the interests of the building owner. Once the groundwork (-> functional specification) has been laid for the project, the coordinator initiates a negotiated tendering procedure and selects a suitable **general contractor**.

The following diagram illustrates the contractual relationships for the GC-EPC-Model:



General Contractor EPC-Model: Key actors, responsibilities and contractual relationships

The GC is responsible for project coordination, overall optimization, detailed planning, implementation of measures, operation & maintenance, subcontracting, fulfilment of energy savings, comfort and other guarantees and may also provide (or facilitate) financing or acquisition of subsidies.

The GC can be a standard **construction company** or a standard **energy service company**. Often, a **consortium**[18]

[16] > 50 % building construction measures applies for most full scale comprehensive refurbishment projects
[17] Some energy agencies have specialized in offering this kind of consultancy, e.g. Graz Energy Agency Ltd.
[18] A consortium is a project-partnership with the objective of pooling resources to fulfill a contract, whereby each company is jointly and severally liable for the whole project. One company acts as liaison and represents the consortium externally. An internal partnership agreement governs the relationship between the companies.

acts as GC. Most such consortiums comprise a construction company and ESCo and supply the contractual services conjointly. Often, the contractual relationship between the two parties is dissolved after all measures have been implemented, and one of the companies then assumes the remaining contractual rights and obligations.

The GC can hire other project partners such as architects, specialized planners, construction companies or technical companies as **subcontractors**. Since the building owner concludes only one GC-contract, he has only one project partner to deal with and thus reduces the number of interfaces for him.

Financing services are displayed separately in the diagram, because experience has shown, that for most energy services it makes sense to differentiate between financing, technical and economic services. "ESCo's are experts in technical, economic, and organisational matters of energy services, which is what they should be commissioned for. Financing is not necessarily their core business. ESCo's can be considered as a vehicle and facilitator for financing. In many cases including a financing institution (FI) as a third party to take over financing matters and risks makes good sense."[19] This holds true for all three models introduced here.

Procurement Implications (especially for Public Sector Clients)

In praxis most EPC-projects are tendered with a negotiated procedure. Nevertheless, a remark with regard to prerequisites for the **applicability of negotiated procurement procedures** is appropriate here. The procurement law states, that the execution of a negotiated procedure is the exception and not the rule. This exception is subject to prerequisites defined in the public procurement laws. For energy services the following prerequisite has to be fulfilled: "A prior and global pricing is not possible, because of the nature or because of the risks associated with the delivery of the services."[20]

This translates into procurement praxis as follows:

1. The bidder must be allowed **sufficient freedom of scope in formulating his proposal** (e.g. selection of EE-measures to be implemented). "Sufficient freedom of scope" requires that a minimum of 50 % of the project cost must be subject to negotiations.[21]
2. In order to provide sufficient freedom of scope, the tender documents must be **formulated as functional specifications** (as opposed to detailed specs.), defining the project's technical, financial, organizational, legal and economic performance requirements and framework conditions for the implementation of the measures.
3. The negotiated procurement procedure must actually **allow negotiations both for the bidder and the contracting authority**.

If these requirements cannot be met, public sector clients are required to realise the project with the GP or CR-Light model.

Important Project Partner Requirements

- The GC bears the responsibility for the entire project from overall optimization, detailed planning and implementation to operation & maintenance and the coordination of subcontractors. He has to give performance guarantees for the results of the project as a whole and may also have to facilitate financing and subsidy acquisition. This requires specialized know how, experience and a good interdisciplinary understanding of the various project elements and a solid financial background.
- EPC-projects with comprehensive refurbishment measures typically have pay-back times of more than 10 years and require either a co-financing from the building owner through a partial payment of the investment cost or extended contract terms of up to 25 years.
- A GC-consortium is a viable solution especially if its constituent companies have worked together successfully in the past.
- The GC must have the statutory permits and authorizations that are required for the project activities. In Austria, for example, the GC must have a builder's license in order to carry out extensive construction activities, and must have a heating/ventilation or gas/plumbing technician's license to install and service building energy systems.

[19] Bleyl, Jan W.; Suer, Mark: Comparison of Different Finance Options for Energy Services. In: light+building. International Trade Fair for Architecture and Technology. Frankfurt 2006

[20] BVergG 2006 § 30 (2) Austrian public procurement law (translation by authors)

[21] Project costs are calculated on the bases of preliminary planning. For formula see chapter CR-Light-EPC-model

Contractual Guarantees and Quality Assurance Instruments

The GC takes over technical and commercial implementation and operating risks (among others) and gives performance guarantees for the results of the entire project over the contract term. Typically, guarantees are given for:

- Energy cost savings in relation to a reference baseline. As a result, it is in the GC very own interest, to operate the facility's heating, ventilation and other technical systems efficiently.
- Comfort standards (e.g. room temperatures or humidity) will be maintained
- Malfunctions will be corrected within a guaranteed period of time
- investment costs
- Materials and equipment installed will meet the specified quality and performance requirements
- Consortia by their legal nature have to warrant that they will meet all deliverables and guarantees collectively, irrespective of their individual spheres of responsibility. Their relationships within the consortium are regulated by the consortium's bylaws.
- Companies involved outside the GC-contract have a liability which is limited to the legally mandatory (implied) warranties

Advantages of the Model

The GC-EPC-model offers the following advantages (in addition to the known advantages of energy services):

- "One stop shop": The GC assumes the coordination and provides guarantees for the entire CR-EPC-project including all interfaces and the overall performance. Performance can easily be judged by fulfilment of guarantees and remuneration is performance based (bonus-penalty-system).
- Financing can be individually arranged from a combination of EPC-savings guarantee, investment cost allowance by the building owner, third party financing from a financing institute (or ESCo) and subsidy programmes.
- For the building owner, interface problems are reduced since the GC is the sole project partner for the realization and operation of all measures.
- In the case of a consortium only one consort acts as the external contact partner for the building owner, but all corporation partners are responsible (joint and several liability) for providing all deliverables.
- Sharing risks by two or more partners within a consortium enables these partners to offer the building owner more extensive guarantees than one individual company could offer.

Disadvantages of the Model

The GC-EPC-model has the following potential disadvantages (in addition to known disadvantages of ES):

- Deliverables with detailed specifications (typically building construction measures) must account for less than 50 percent of the total project value.
- The building owner is highly dependent on the GC. Detailed controlling and management options during the project planning and implementation phase are limited. This means that the building owner must have sufficient confidence in the GC's capabilities.
- Additional GC-surcharge for "general services" (coordination and responsibilities for overall project).
- Qualified General Contractors (bidders) are rare (market actors may have to be familiarized with the GC-concept and functional procurement procedure first).
- Project acquisition and long-term contract fulfilment is often with the ESCo- and not the construction-partner of the consortium, although construction volume exceeds energy service volume.
- Possible conflicts of interest regarding implementation quality between GC and subcontractors or consortium partners (GC is focussed on meeting the long-term contractual performance guarantees and to minimize project cycle cost, whereas the subcontractor's horizon is limited to the acceptance directly after construction period).
- Typically, pricing pressure from general contractors is higher for subcontractors compared to a direct contract with the building owner.
- The GC-model favours bigger companies (GC's) and may be disadvantageous to SME's or regional companies.

General Planner EPC-Model (GP-EPC)

The Main Features are:

- **Share of building construction measures:** more than 50 % of the total project volume
- **Project specifications:** detailed specification for 0 – 100 % of project volume possible
- **Overall project management, responsibility for optimization and planning:** general planner
- **Execution of measures:** Construction company and ESCo
- **Financing:** Combination of EPC-savings guarantee + investment cost allowance from building owner + third party financing from financing institute (or ESCo) + subsidy programmes

In this model the building owner can specify detailed solutions of the CR-measures (e.g. design of the facade). The building owner commissions a general planner who is responsible for overall project optimization, detailed planning, specifications, supervision and quality assurance. Typically, the GP tenders building construction measures (e.g. building envelope) on the basis of detailed specifications; whereas energy services are tendered with functional specifications. Hence building construction measures and ESCo services are awarded in separate contracts. This model is basically a combination of a standard construction procedure (Independent planner + Construction Company) combined with the ES-concept.

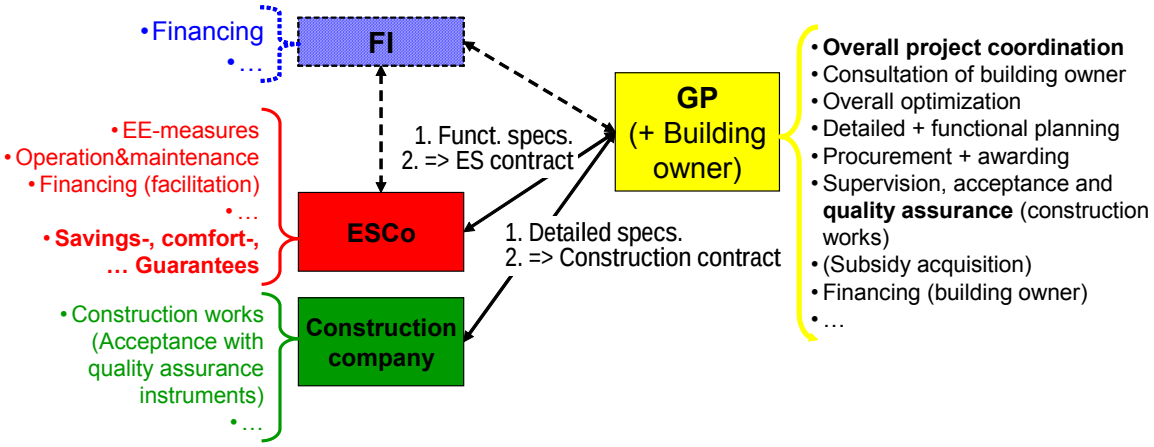
Key Actors, Responsibilities and Contractual Relationships

In this case, the building owner wishes to provide detailed specifications for the majority of the refurbishment measures. In praxis this is typically a detailed planning for the building envelope refurbishment. A second reason to choose the GP-EPC-model may be that the building owner prefers to put an independent planner in charge of the overall optimization, detailed planning and supervision of the refurbishment measures.

The general planner (e.g. a civil or industrial engineer or an architect) represents the interests of the building owner. He is responsible for consulting the building owner, overall project optimization, detailed and functional planning, procurement and awarding, supervision, acceptance and quality assurance of construction measures and last but not least overall project coordination. This agenda may be expanded to subsidy acquisition or other tasks.

It is the GP's task to plan and meet building performance criteria (e.g. air tightness or max. heat demand < 30 kWh/m^2/a) **on which the ESCo can base its performance guarantees.**

The following diagram illustrates the contractual relationships for the GP-EPC-model:



General Planner EPC-Model: Key actors, responsibilities and contractual relationships

After completion of the planning, building construction measures and energy services are awarded in separate contracts:

- **Building construction measures** are typically planned in detail and awarded to a construction company on the bases of detailed specifications. Special attention must be given to the definition and control of performance criteria. For quality assurance, the contract should include mandatory QAI's into the specifications such as thermo graphic pictures, blower door tests, operation manuals and expert's reports or extended liabilities. The contract is concluded between building owner and Construction Company.
- **Energy Services** are typically awarded with a negotiated procedure on the basis of functional specifications. These must also include detailed (performance) data of the building construction measures, which are implemented by other partners, so the ESCo can calculate performance guarantees for the complete

refurbishment project. **The ESCo takes over operation & maintenance for the entire refurbishment measures**. The EPC-contract is concluded between the building owner and the ESCo.

Procurement Implications (Especially for Public Sector Clients)

- For this model, the selection of the GP is of special importance, taking his scope of responsibilities into account. For the commissioning of the GP-contract, it is possible to define quantitative and qualitative awarding criteria. With the help of a cost-benefit-analyses, the qualitative (e.g. consultation fees) and quantitative criteria (e.g. draft concepts or references) can be combined, weighed and evaluated.[22]
- Building construction contracts are typically awarded with an open tendering procedure

In addition, the implications stated in the GC-model apply here as well.

Important Project Partner Requirements (in addition to GC/ESCo-requirements)

- The GP must possess interdisciplinary competencies and experiences in the overall optimization, realization and coordination of CR- and ES-projects. Comprehensive refurbishment requires an integrated planning approach, which takes reciprocating effects of the different building technologies into account.
- EPC-projects with comprehensive refurbishment measures typically have pay-back times of more than 10 years and require either a co-financing from a finance institute or the building owner through a partial payment of the investment cost or extended contract terms of up to 25 years.
- All partners involved must have the statutory permits and authorizations that are required for the project activities (the licenses required for Austria are described in the GC-EPC-model as an example).

Contractual Guarantees and Quality Assurance Instruments

The main responsibility for the entire project is shared between GP and ESCo:

- The general planner is responsible for overall coordination, optimization and planning of the project. He is contractually obligated to the building owner to meet agreed standards and performance criteria. Hence, it is recommended to include success criteria into the GP contract. In principle, the GP's planning services must be covered by liability insurance.
- The quality of the building construction measures has to be controlled and assured by the GP. He has to provide evidence to the ESCo, e.g. by performing calculations, thermo graphic inspections, blower door tests, expert's reports and similar measures.
- The ESCo gives performance guarantees for the entire building measures (maximum energy consumption, comfort standards, …) based on the energy service as well as the building construction measures.
- To secure project cycle optimization and implementation quality it is recommended to integrate the ESCo at an early stage into the project and to allow the ESCo a comment and control status.
- The construction company warrants that the materials deployed and methods used to install them meet the quality requirements (typically limited to the legally implied warranty).

Advantages of the Model

The General Planner-EPC-model offers the following advantages (in addition to the known advantages of ES):

- This model is closest to the established standard construction procedure.
- The building owner (via the GP) has more control over the detailed planning and implementation steps of the project.
- Financing can be individually arranged from a combination of EPC-savings guarantee, investment cost allowance by the building owner, third party financing from a financing institute (or ESCo) and subsidy programmes.
- Project measures are implemented by companies that specialize in specific project elements
- Project coordination costs are likely to be lower than with the GC-model (no GC surcharge)
- The standard tendering process with detailed specifications is advantages for construction companies in that it is easier for them to offer clearly defined building measures, if they are not used to functional call for tenders.

Disadvantages of the Model

The General Planner-model has the following potential disadvantages (in addition to known disadvantages of ES):

[22] See Bleyl, Jan W.: Evaluation of tenders with a cost-benefit analysis. Eurocontract Training Session. Berlin 2006.

- The building owner is highly dependent on the quality general planner, who in return is not responsible for the long term results and the operation of the building (as compared to the GC or ESCo).
- There are more interfaces with potential problems than in the GC-model, e.g. in transitioning from the construction to the operational phase. Especially the ESCo assuming guarantees for the overall building performance including the building construction measures may be critical.
- Only ESCo performance can easily be judged by fulfilment of guarantees and remuneration is performance based (bonus-penalty-system).
- Fewer incentives for innovative solutions, because detailed specifications leave less room for innovative competition between ESCo's. Innovation is mostly dependant the background of the GP.

„Comprehensive Refurbishment Light" EPC-Model (CR-Light-EPC)

Main features:

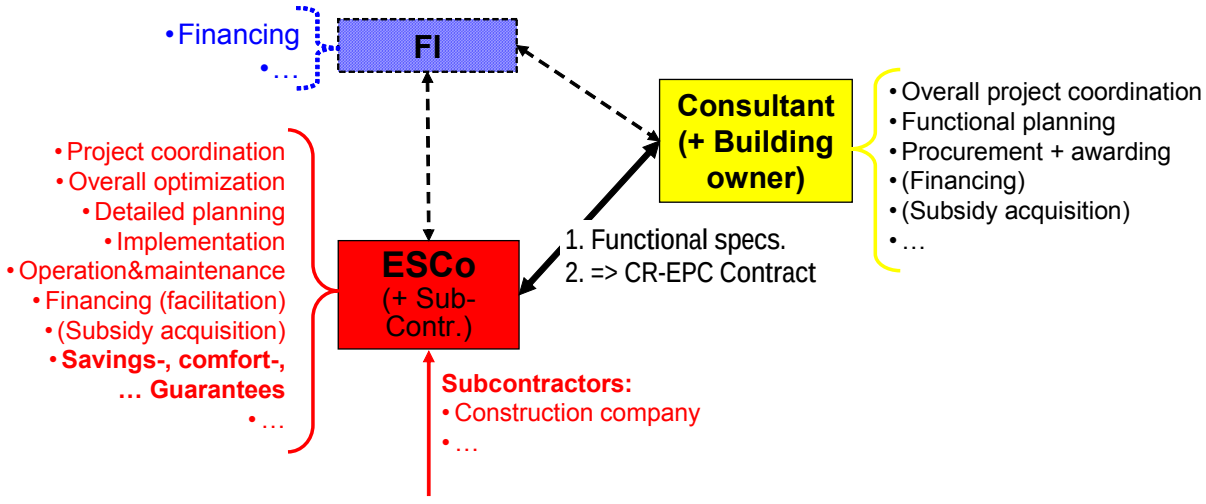
- **Share of building construction measures:** less than 50 % of the total project volume
- **Project specifications:** detailed specification for 0 – 49 % of project value possible
- **Responsibility for optimization and planning:** ESCo
- **Project implementation:** ESCo
- **Financing:** Combination of EPC-savings guarantee + subsidy programmes (+ investment cost allowance from building owner or third party financing from financing institute or ESCo)

Within this model, individual building construction measures (such as top floor ceiling insulation) can be realized with a standard EPC contract. If less than half of the total project cost can be attributed to building construction measures, the building owner can define detailed specifications for these for the tendering process. An energy services company is awarded an ES-contract on the bases of functional specifications and realizes overall optimization, detailed planning, and operation & maintenance and provides performance guarantees. The main difference to the GC-EPC-model lies in the smaller extent of building construction measures. Because only simple building construction measures are involved, we propose to call this the **"Comprehensive Refurbishment Light"** model (CR-light-EPC).

Key Actors, Responsibilities and Contractual Relationships

The responsibilities and contractual relationships are to a large extent similar to the GC-EPC-model. Main differences are the extent of the building construction measures. The role of the GC is taken over by a standard ESCo, which may hire a construction company for the building construction measures.

The contractual relationships in the CR-Light-EPC-model are as follows:



CR-Light EPC-Model: Key actors, responsibilities and contractual relationships

The ESCo is responsible for project coordination, overall optimization, detailed planning, implementation of measures, operation & maintenance, subcontracting, fulfilment of energy savings, comfort and other guarantees and may also provide (facilitation of) financing or acquisition of subsidies.

Procurement Implications (Especially for Public Sector Clients)

An EPC-Light contract can only be awarded with a negotiated procedure if the legal procurement prerequisites - as described in the GC-model - are met. The consultant must ensure that **more than 50 % of the deliverables are tendered with functional specifications**, which provide sufficient freedom of scope in formulating proposals. In reality, functional specifications are typically provided for the building technology measures/energy services (> 50 %) and detailed specifications for the building construction measures.

In order to **calculate the value of the measures that allow for negotiations**, the value of the building construction and other measures described in detail must be subtracted from the total project value (over the duration of the project). This is done using the following formula:

+ ∑ Contracting rates (over project term, excl. interest) + Co-financing by building owner + Third party financing by finance institute (excl. interest) + Subsidies		+ Demolition work + Building and roof construction + Doors and windows + Thermal and acoustic insulation + Plastering and painting + Miscellaneous + ... (other detailed specs.)
∑ total project value	**–**	**∑ detailed specifications**

= ∑ negotiable measures (described with functional specifications)

Calculation formula for value of negotiable measures

The total cost of works and services tendered with functional specifications must account for more than half of the total project value, to meet the legal requirements for a negotiated tendering procedure. The calculation is done on the basis of the preliminary planning results.

Important Project Partner Requirements

- In this case, the ESCo bears the responsibility for the entire project as described in the GC-model.
- EPC-projects with individual building construction measures typically have pay-back times of 10-15 years and may require some co-financing from the building owner through a partial payment of the investment cost.
- The ESCo must have the statutory permits and authorizations that are required for the project activities. Depending on the amount of construction activities, a heating/ventilation or gas/plumbing technician's license to install and service building energy systems may be sufficient.

Contractual Guarantees and Quality Assurance Instruments

The ESCo takes over technical and commercial implementation and operating risks (among others) and gives performance guarantees (as described in the GC-model) for the results of the entire project over the contract term.

Advantages of the Model

The „Comprehensive Refurbishment Light" EPC-Model offers the following advantages (in addition to the known advantages of energy service models):

- (Individual) building refurbishment measures can be realized within a standard EPC-model in the same manner as standard building technology EPC-measures
- Standard-ESCo's gain access to projects including building construction measures in which their energy services expertise can be integrated which may provide access to a potentially lucrative new market for ESCo's.
- "One stop shop": The ESCo assumes the coordination and provides guarantees for the entire EPC-project including all interfaces and the overall performance. . Performance can easily be judged by fulfilment of guarantees and remuneration is performance based (bonus-penalty-system).
- Financing can be individually arranged from a combination of EPC-savings guarantee, investment cost allowance by the building owner, third party financing from a financing institute (or ESCo) and subsidy programmes.
- An integrated solution is provided by an expert partner that has at his disposal all the requisite competencies and can call upon other specialist subcontractors as needed.
- For the building owner, interface problems are reduced since the ESCo is the sole project partner for the realization and operation of all measures.

Disadvantages of the Model

The CR-Light-EPC-model has the following potential disadvantages (in addition to known disadvantages of ES):

- Deliverables with detailed specifications (typically building construction measures) can only account for less than 50 percent of the total project value.
- The building owner is highly dependent on the ESCo. Detailed controlling and management options during the project planning and implementation phase are limited. This means that the building owner must have sufficient confidence in the ESCo's capabilities.
- Possible conflicts of interest regarding implementation quality between GC and subcontractors or consortium partners (GC is focussed on meeting the long-term contractual performance guarantees and to minimize project cycle cost, whereas the subcontractor's horizon is limited to the acceptance directly after construction period).
- The building owner has limited project steering options and is highly dependent on the ESCo's capabilities). This means that the building owner must have a great deal of faith in the ESCo's capabilities.
- Possible conflicts of interest regarding implementation quality between ESCo and subcontractors (ESCo is focussed on meeting the long-term contractual performance guarantees and to minimize project cycle cost, whereas the subcontractor's horizon is limited to the acceptance directly after construction period).

Conclusions, Recommendations and Outlook

Based on the previous chapters, the following conclusions and recommendations can be given:

1. Comprehensive Refurbishment (CR) of buildings is a demanding task in order to successfully coordinate and optimize all building construction measures and building technologies involved. It **requires an integrated planning process**, which takes reciprocating effects of the different building technologies into account. A good example for this approach is the reduction of all electrical and thermal cooling loads including solar shading options before assessing an air conditioning unit.
2. Generally, any building design approach should **first of all focus on all possible demand reduction potentials** (including the building envelope). Only as a second step, the remaining demand should be supplied as efficiently as possible.
3. An integrated energy efficient planning process is especially necessary, if **renewable energy sources** are to be applied. E.g. solar cooling will hardly be feasible with cooling high loads of more than 50 W/m^2.
4. In many cases EE is not the driving force behind Comprehensive Refurbishment of buildings. Nevertheless minimum performance standards for thermal refurbishment or guarantees for maximum energy consumption should be written into the terms of reference. CR-EPC-models as promoted here are a good means to secure these goals and are also applicable to sale and lease back projects.
5. We propose three different models for the implementation of Comprehensive Refurbishment in conjunction with energy services: a General Contractor-, a General Planner- and a CR-Light EPC-Model. All three EPC-models presented allow to **combine (comprehensive) refurbishment measures of buildings with the advantages and long term guarantees of energy services/contracting models.**
6. The **choice of the implementation model** (especially for public sector building owners) mainly depends on three factors:
   - The **share of building construction vs. building technology measures** in relation to the total project volume (over the contract period). This has implications mainly on the procurement law, if applicable.
   - Whether **functional or detailed specifications** for the contracting of the CR-works and services are applied or rather are applicable from a procurement law perspective.
   - **Who the building owner wants to entrust** with the detailed planning, overall optimization and supervision of the project: a General Contractor or a General Planner.

   The details and implications as well as advantages and disadvantages of each model are described in the main chapter of the paper.
7. All three models can be applied both in the **public** and **the private sector**.
8. The proposed CR-EPC-models can facilitate customized packages of building construction and building technology measures combined with the known **guarantees** and **outsourcing of technical and economical risks** of an EPC model. From the perspective of the building owner, the following main advantages of the Energy Service model apply:

- Guarantees for the results, e.g. guarantees for energy cost savings, indoor comfort standards, operation & maintenance, service reaction times, …
- The ESCo' remuneration (contracting rate) is performance based (bonus-penalty-system) depending on fulfilment of guarantees
- Possibility to save investment costs through third-party financing
- Part-repayment from future energy cost savings
- Shifting technical and economical implementation and operation risks to the General Contractor, the General Planner or the ESCo
- Focusing on the own key business
- One contact person for all energy matters included in the ES-contract ("One stop shop")
- Rectification of deficiencies and increasing comfort and value of the building
- Long-term increase in the revenue from the property

The objective is to create a win-win-win situation for all parties involved. The environment and the building owner's image included.

9. **Financing** must be individually arranged from a combination of EPC-savings guarantee, investment cost allowance by the building owner, third party financing from a financing institute (or ESCo) and subsidy programmes. We recommend differentiating **between financing** on the one hand side **and technical economic services** on the other**.** ESCo's are experts in technical, economic, and organisational matters of energy services, which is what they should be commissioned for. Financing is not necessarily their core business. ESCo's can be considered as a vehicle and facilitator for financing. In many cases including a financing institution (FI) as a third party to take over financing matters and risks makes good sense.[23]
10. **CR-EPC-models can not decrease pay-back times** of energy efficiency investments. At current energy prices, the typical guaranteed energy cost savings of an EPC-contract can not repay comprehensive building measures like a complete building envelope refurbishment within 10 years. The building owner has to Co-finance the investment by way of a building cost allowance (or a residual value payment at the end of the contract). Another option is longer contract terms of 20 to 25 years.
11. **Quality assurance problems** (e.g. formation of mould) **have nothing to do with the Contracting-model.** They occur, if the builders do not consider that advanced building technologies (like more air-tight building shells) require different or more sophisticated operation and maintenance procedures (in this case increased manual or mechanical ventilation). Moreover, a CR-contracting-model offers an instrument to incentivize "lifecycle" optimization including the operation phase of the building, because the ESCo is responsible not only for the construction but also for the operation & maintenance of the building at a guaranteed price.

Outlook

Implementing an EPC-project always requires dedicated project developers. A future challenge will be to spread the concept, initiate further CR-projects and collect more experiences. Our theses, that the Comprehensive Refurbishment Models proposed are a good instrument to implement building energy efficiency measures and thus support the implementation of the EE+ES-Directive, still needs more verification.

To our knowledge, practical experiences with the implementation of Comprehensive Refurbishment Models are limited to Austria so far.[24] We would like to learn about other experiences collected with comprehensive refurbishment of buildings in conjunction with energy services and welcome any feed back.

In addition, the EPC-model itself imposes obstacles from a methodological point of view, especially if the cost baseline is difficult to determine or if frequent adjustments of the baseline are necessary due to changes in utilization of the building.[25] The latter problems are not encountered with the Energy Supply Contracting (ESC) Model, because no baseline is needed to measure guaranteed savings. We would like to carry out future research work on possible advancements of the ESC-model with the objective of integrating demand side measures and energy saving incentives into the model.[26] Especially the GP-model is likely to profit from this new approach.

[23] Please refer to footnote 19
[24] Berlin Energy Agency has prepared some projects but not yet reached the implementation phase
[25] Energy cost and climate adjustments are easy to handle with the yearly final invoice
[26] Task XVI „Competitive Energy Services" of the IEA (International Energy Agency) Demand Side Managment Implementing Agreements (http://dsm.iea.org/) has recently started research on this topic.