Grazer ENERGIEAgentur

IEA DSM TASK XVI

"Competitive Energy Services
(Energy Contracting, ESCo Services)"

Comprehensive Refurbishment of Buildings through Energy Performance Contracting

A Guide for Building Owners and ESCos including Good Practice Examples

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IEA DSM TASK XVI:
Competitive Energy Services (Energy Contracting, ESCo Services)

Comprehensive Refurbishment of Buildings through Energy Performance Contracting

A Guide for Building Owners and ESCos including Good Practice Examples
2nd Edition

This project is carried out within the framework of the IEA research cooperation on behalf of the Austrian Federal Ministry of Transport, Innovation and Technology.

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1 Abstract

Energy Performance Contracting (EPC) Projects, if implemented properly, have successfully delivered guaranteed savings since they were first established in Europe about 1995. Consequently the new **EU Directive on Energy End-use Efficiency and Energy Services** 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?

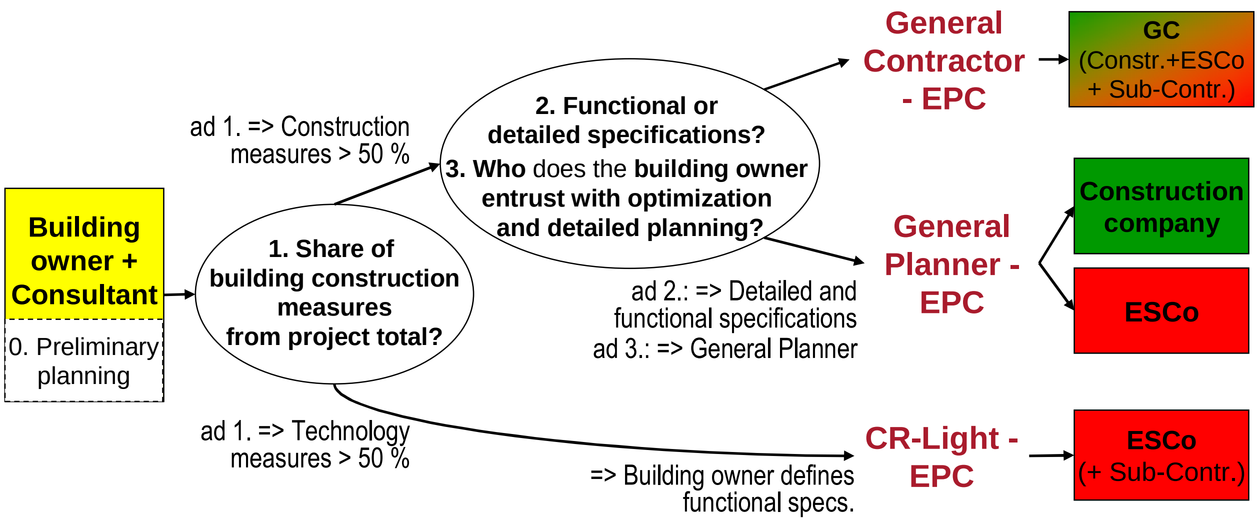

Figure 1 Comprehensive Refurbishment-EP-Model selection flow chart

For further illustration, **good practice examples** from Task XVI participating countries and others are provided.

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

2 Motivation and Introduction

Residential and commercial buildings are major consumers of final energy - and waste it at an alarming rate. 21 % of global green house gas emissions or 8.2 Giga tons of CO_{2eq} per year can be ascribed to the operation of the worldwide building stock – construction and disposal of the buildings not accounted for.[1] The share in electricity consumption is even more than double: 53 % of the worlds total electricity consumption is consumed in buildings, quoting the IEA World Energy Outlook 2006.[2]

While new building construction rates range between less than one percent in an average city to over ten percent in booming regions, only some new buildings benefit from model energy performance. The majority of saving potential must be realized in the vast and already existing building stock. It is here where a major effort in the urban energy transition process must be made.

Economic saving potential for building energy efficiency refurbishment measures are high: According to Vattenfall and McKinsey the green house gas abatement potential in the building sector is 3.7 Giga tons of CO_{2eq} per year by 2030 or 45 % across all building types with measures such as "improved building insulation, better heating and cooling efficiency, energy efficiency in lighting and appliances". And what it might cost? Quoting the same source the "marginal abatement cost curve is negative (-160 €/t CO_2)", which means, that implementation of the saving measures will result in a net positive cash flow over a term of 25 years.[3]

Countries and organs of the European Union (EU) and other regions of the world have embraced increasingly forceful measures and support programs, to aim at improving the performance of the existing building stock. In this context Energy-Contracting[4] is being promoted as an important implementation tool for energy Efficiency (EE).

In some European countries, Energy Performance Contracting (EPC) agreements between clients and contractors (ESCo's) are entered into, to implement building refurbishment projects with quantifiable savings and contractual long term guarantees. When implemented properly, they have successfully delivered guaranteed savings since they have been first established in Europe in the mid-1990s.[5]

The new European Union (EU) Directive on Energy End-use Efficiency and Energy Services[6] (EE+ES-Directive) supports the Energy-Contracting concept and views it

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[1] Vattenfall 2007, *Global Mapping of Green House Gas Abatement Opportunities up to 2030*

[2] World Energy Outlook 2006

[3] See footnote 1

[4] Also referred to as "ESCo or Energy Service". We prefer the term "Energy-Contracting" to emphasize the difference to a standard fuel supply or maintenance contract, which does not imply any outsourcing of risks or provision of guaranties for the overall system performance (see also figure 17.2)

[5] Some references to successful examples in public buildings in Austria and Germany: www.Grazer-ea.at, www.bundescontracting.at, www.contracting-offensive.de, www.berliner-e-agentur.de (partly in German)

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

as an important instrument to implement energy efficiency (also termed Energy End-use Efficiency) based on market instruments.

EPC-projects realize demand reduction measures that typically comprise building technologies like heating, ventilation, air-conditioning (HVAC), lighting, electrical applications and control systems. In most cases, building construction measures[7] such as building envelope refurbishment or passive solar shading measures are excluded. A comprehensive refurbishment (CR) approach to buildings - examining and treating all energy sensitive aspects - is frequently not aimed at. As a result, 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 such as the absence of full cost calculations, no integrated planning, too long payback periods of the energy efficiency investment measures, procurement problems or a lack of knowledge on implementation models are some of the reasons behind.

For many building refurbishment projects, improvements in energy efficiency are not the driving force. Non-energy goals and benefits like space use efficiency and expansion, increased access or ergonomic workplace comfort, external appearance or other ways of lifting income from rent may be more important to the building owner. Nevertheless minimum performance standards for thermal refurbishment and guarantees for maximum energy consumption should always be written into the terms of reference for any building refurbishment. CR-EPC models as described here are a good means to secure energy efficiency improvement goals. They are applicable to Public-Private Partnership like sale and lease back projects just as well.

In this publication, we describe models how to integrate building construction refurbishment measures into EPC models in order to achieve a comprehensive refurbishment of buildings as indicated above. We propose to call these "Comprehensive Refurbishment EPC" models (CR-EPC). Three basic CR-EPC models are introduced: a **"General Contractor"** (GC CR-EPC), a **"General Planner"** (GP CR-EPC) and a **Refurbishment "Light"** (CR "Light" EPC) model, the latter for a reduced scope of refurbishment measures.

The following key features of the three basic models are described in more detail in this publication: Typical measures, key actors, responsibilities and basic contractual relationships; public and corporate 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.

For further illustration, **good practice examples** from Task XVI participating countries and others are provided. We also give some comments on financing options. To sum up, the publication gives conclusions and recommendations for the implementation of CR-projects and a short outlook on future research and development activities.

Not covered in this publication are payback periods of different CR-building measures, subsidy programmes or contractual details. We assume that these as-

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

pects have no direct impact on the basic selection of the implementation model and leave these topics (and many others) to further elaborations.

Methodologically, the publication mainly builds on practical Comprehensive Building Refurbishment and Energy Performance Contracting project experiences, developed and implemented by Graz Energy Agency Ltd, Austria. It is supplemented with EPC experiences from the Berlin Energy Agency and the Austrian Energy Agency (former E.V.A.).

The groundwork for this publication has been laid with a systematic description of six existing and planned CR-EPC projects and an evaluation of the experiences made.[8] Earlier basics for this work have been established in the "CONZUK"-project[9], which have been summarized by Tritthart et al.[10]. 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.

The work has been continued within Task XVI „Competitive Energy Services" run by the IEA (International Energy Agency) Demand Side Management Implementing Agreement (http://www.ieadsm.org). The authors wish to thank for financial support within the framework of the IEA research cooperation of the Austrian Federal Ministry of Transport, Innovation and Technology.

The findings of this publication have to be considered as work in progress, due to the limited practical experiences collected so far. The authors at the Graz Energy Agency Ltd expressly invite feedback and inquiries, attention to Jan W. Bleyl-Androschin (bleyl@grazer-ea.at,) and wish to cooperate with any interested stakeholders.

[8] Bleyl, Jan W; Kuhn, V; Schinnerl, D 2007, *Comprehensive Refurbishment of Buildings with Energy Performance Contracting*. EUROCONTRACT-manual. Graz Energy Agency

[9] Bucar, G; Baumgartner, B; Tritthart, W; Piber, H; Supp, B 2004, *Contracting als Instrument für das Althaus der Zukunft*. Graz Energy Agency

[10] Tritthart, W; Bleyl, Jan W; Bucar, G; Bruner-Lienhart, S 2007, *Contracting and Building Renovation – Does it Work Together?* In ECEEE Summer Study 2007 proceedings, paper id. 5.200

3 Energy-Contracting: Implementation Tool for Energy Efficiency and Renewables extended to Comprehensive Refurbishment of Buildings

We focus on some key elements and definitions here, assuming that the reader has a basic knowledge of the Energy-Contracting concept and building energy efficiency. Some further references can be found here: www.grazer-ea.at, www.contracting-portal.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 energy conservation by evaluating all possible demand reduction opportunities, including the building envelope. Only afterwards the remaining demand should be supplied 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 Performance Contracting (EPC) 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 total cost of keeping a room warm, air-conditioned or lit (=> useful energy). The EPC-model aims at providing useful energy at minimal project- or lifecycle cost to the end user. And it achieves environmental benefits due to the associated energy and emissions savings.

The EC Directive on "Energy End-use Efficiency and Energy Services" defines Energy Service 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".*

The Directive also defines an "Energy service company" (ESCo) as an organisation 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."*

[11] Deutsche Energie Agentur, 4. Auflage, Dezember 2004

[12] Senatsverwaltung für Stadtentwicklung des Landes Berlin, April 2002

At Energy -Contracting, facility owner and ESCo 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.

3.1 Central elements of a Contracting package

The central elements of an Energy-Contracting package are summarized in the following figure:

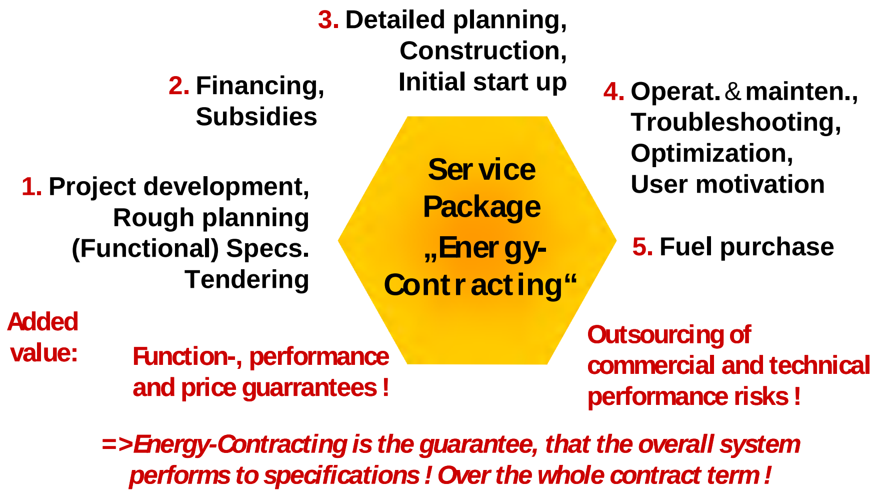

Figure 2 – Energy-Contracting: a modular energy service package with success guarantees and outsourcing of risks

As for Energy-Contracting, transfer of technical and commercial implementation and operating risk as well as takeover of function, performance and price guarantees by the ESCo play a crucial role. These elements create added value compared to in house solutions and are guaranteed in the 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.

Most projects are unique in one way or another and require an individual adaptation of the model. Energy-Contracting is a service package that can and must be arranged specifically to the needs of the building owner and thus quasi is a modular system. This means the client defines what components s/he wants to outsource and what components s/he carries out her/himself. For example, financing can be provided either by the ESCo or the building owner. Or with a (leasing) finance institution as third party. Critical to decision-making is which service provider can offer better financing conditions. This means the contracting package does not automatically include external financing.[13] Other partial tasks, such as ordinary operation

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

management or fault clearance, can readily be assumed by the building owner her/himself.

3.2 Added value chain for Energy-Contracting

The next figure illustrates an energy added value chain from primary to useful energy and energy savings with the respective business models and indications of typical measures carried out. The figure shows the two basic Energy-Contracting models: Energy Supply Contracting (ESC) and Energy Performance Contracting (EPC), the latter expanded to the Comprehensive Refurbishment (CR-EPC) concept:

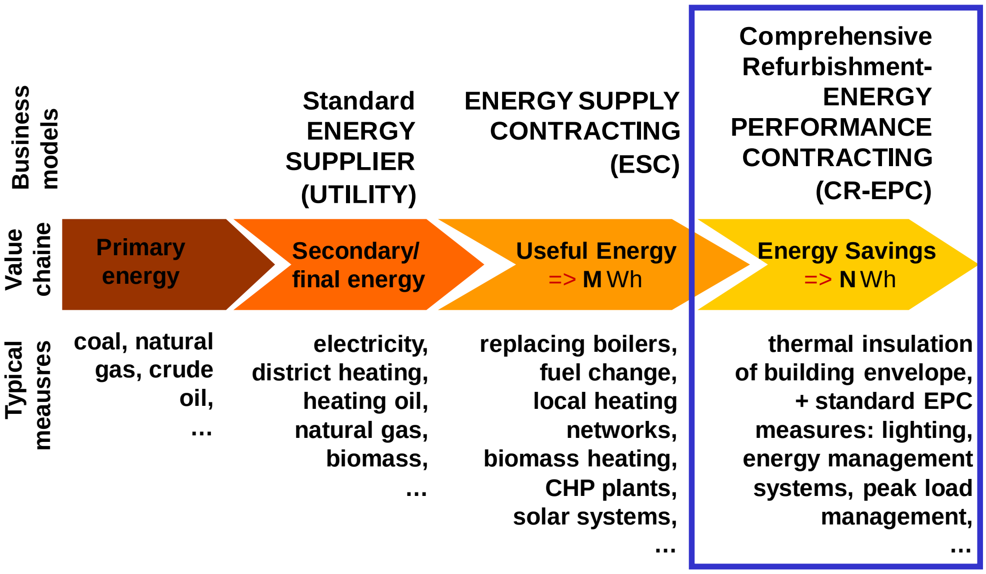

Figure 3 – Energy Service models, energy added value chain and typical efficiency measures

At Energy Supply Contracting efficient supply of useful energy such as heat, steam or compressed air is contracted and measured in Megawatt hours (MWh) delivered. The model includes purchasing of fuels and is comparable to district heating or co-generation supply contracts.

As for Energy Performance Contracting, which is the basis for our models, the focus is on reducing final energy consumption through energy efficiency measures as indicated in Figure 3. The business model (see Figure 4) is based on a savings guarantee compared to a predefined baseline[14], also labelled as Negawatt hours (NWh).

3.3 Extension of Energy-Contracting to Comprehensive Refurbishment-EPC

At Comprehensive Refurbishment-EPC (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 encom-

[14] In case of new buildings, to account for increased comfort levels or Non-Energy-Benefits, calculatory baselines can be used as long as agreed upon beforehand

passing 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 CR-EPC business model is shown in the following figure:

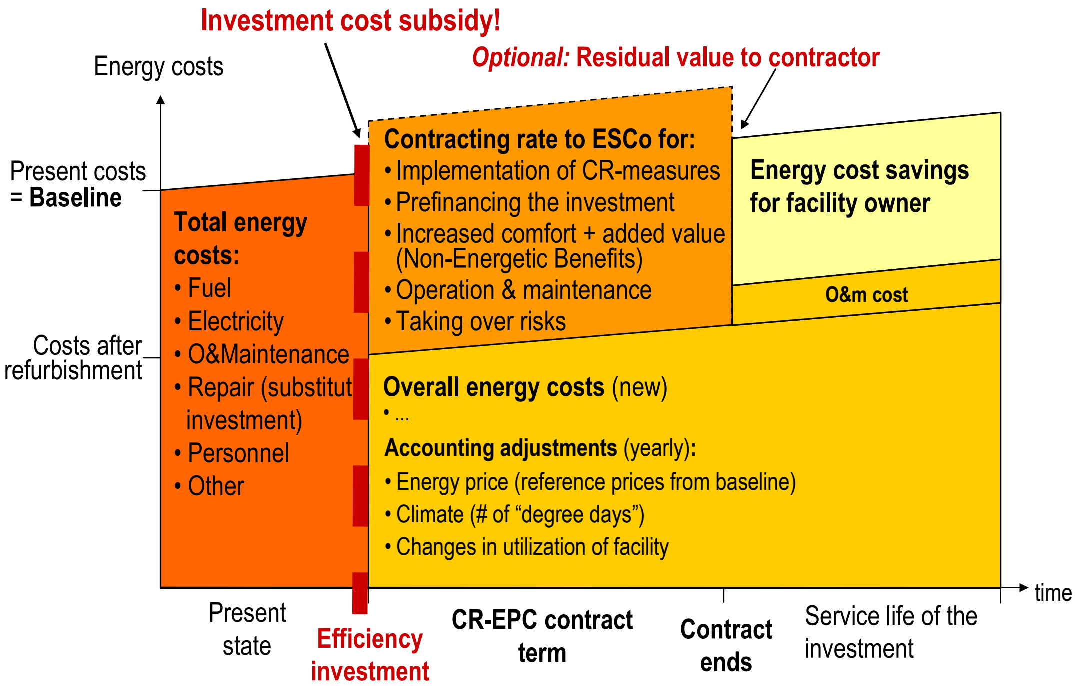

Figure 4 – Business model of Comprehensive Refurbishment Energy Performance Contracting (CR-EPC)

Energy-Contracting models can not decrease pay-back times of energy efficiency investments. Building technology measures can mostly be refinanced from the future energy cost savings within a project period of 10 years. This is generally not true for building construction measures, such as building envelope insulation, with today's energy prices. Therefore, the building owner has to co-financing the building measures e.g. by means of a building cost allowance (which may, e.g., be taken from maintenance reserve funds or subsidies) and/or paying a residual value at the end of the contract (see Figure 4). Another option is longer contract terms of 20 to 25 years, as is common for Public-Private-Partnership contracts.

An important difference of a CR-EPC-model to an in-house refurbishment is the long-term guarantee for the results and quality of the measures taken, which goes clearly beyond the standard legal liability or implied warranty. If there are problems after the refurbishment, such as unexpectedly high energy consumption levels or problems with the formation of mould, the responsibility for remedying these is devolved to the contractor during the contract period. In case of an in-house refurbishment, the building owner is responsible himself.

It is important to mention here, that problems such as lack of quality assurance at the construction site are not related to the Contracting model itself. Quality requires controlling and depends on the motivation of the construction company to deliver long term quality. The same is true for problems with formation of mildew. It occurs, because more advanced building technologies, such as better sealed building shell; for example, require different or more sophisticated operation and maintenance procedures, which means in this context increased manual or mechanical ventilation.

A CR-contracting model offers an instrument to provide incentives to optimise life- or project cycle performance, including the operation phase of the building, because the ESCo is not only responsible 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.

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

- A CR-EPC-partner plans and realizes energy efficiency measures including building construction measures and is responsible for their performance, 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 thermal comfort conditions, operation & maintenance or emission reduction guarantees.[15]
- 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.

[15] For more details see Bleyl, Jan W; Baumgartner, B; Varga, M 2007,*Quality Assurance Instruments for Energy Services* have been compiled in a EUROCONTRACT-manual. Graz Energy Agency

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 energy efficiency and refurbishment measures and services such as planning, building, operation & maintenance, (pre-)financing or user motivation and takes over technical and commercial 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.*[16]

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

4 Three Basic Models to Implement Comprehensive Refurbishment Measures through Energy Performance Contracting

4.1 Overview

Energy-Contracting and comprehensive refurbishment activities can be combined in a number of ways, depending among other factors on the scope of the building construction measures, if functional or detailed planning is applied and on public entities procurement obligations as contracting authorities (see Figure 5). We present three different approaches to integrate comprehensive refurbishment measures into the standard EPC model. They can be applied in both the private and the public sector.

The three approaches can be summarized as follows:

1. **General Contractor Model (GC CR-EPC)**
   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-Contracting quality guarantees over the contract term are contracted to a general contractor (GC, which can be one company or a consortium).
2. **General Planner Model (GP CR-EPC)**
   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-Contracting services are tendered with functional specifications. Hence building construction works 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.
3. **Comprehensive Refurbishment „Light"-EPC Model (CR "Light"-EPC)**
   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 construction works, the building owner can define detailed specifications for these for the tendering process. An ESCo is awarded an ES-contract and realizes overall optimization, detailed planning, and operation & maintenance and provides all guarantees. The main difference to the GC 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"-EPC model (CR "Light"-EPC).

In any case, as a first step, a preliminary planning of the CR-EPC-project is necessary. For the selection of a suitable implementation model the flowchart below can be used as a guide.

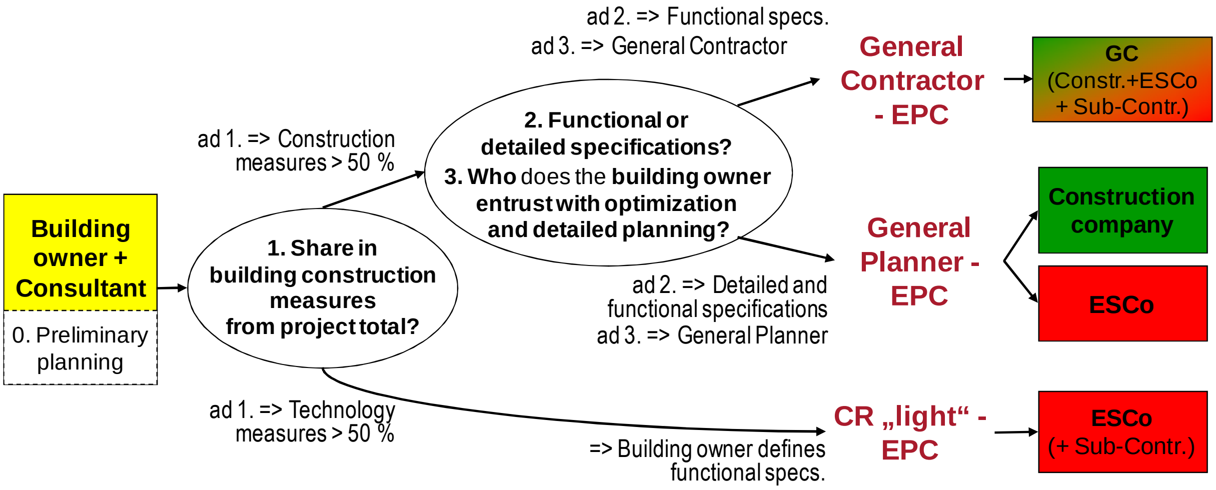

Figure 5 – Comprehensive Refurbishment-EPC model selection flow chart

If the project predominantly is comprised of building technology measures, the Comprehensive Refurbishment "Light" model can be used. However, if the project mainly involves construction works, as is the case in most full scale refurbishment projects, the "general planner" or the "general contractor" model must be applied. The "General Planner" model should be used, if the building owner wishes to specify detailed solutions. Otherwise the building owner must decide, whom he wishes to entrust with the optimization and detailed planning: GC or GP?

The following aspects and implications of the three basic models are described in more detail in the following chapters:

- Key features of the models (summary)
- Key actors, responsibilities and contractual relationships
- Procurement implications (especially for public sector clients)
- Contractual guarantees and quality assurance instruments
- Advantages and disadvantages of the different models

Not covered here are aspects such as financing options[17], subsidy schemes, pay back periods of different building efficiency measures, details on contractual guarantees and quality assurance instruments[18] or CR model contracts.

Off course each project requires an adaptation of the implementation model and contract to the individual project conditions (compare Figure 2).[19]

[17] see footnote 13
[18] For more details on QAI's see footnote 15
[19] Some energy agencies and independent consultants have specialized in offering this kind of consultancy, e.g. Graz Energy Agency Ltd and other Eurocontract partners.

4.2 General Contractor CR-EPC model (GC CR-EPC)

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-Contracting quality guarantees over the contract term are contracted to a general contractor, which can be one company or a consortium.

Key Features	General Contractor CR-EPC model
Example measures:	***CR building refurbishment, e.g. in conjunction with sale & lease back*** (Public-Private-Partnership) ***projects***
Share of building construction measures:	more than 50 % of total project volume[20]
Project specifications and tendering:	functional specification > 50 % of project volume => negotiated procedure
Overall optimization and detailed project planning:	General Contractor (individual company or consortium)
Execution of measures:	General contractor (individual company or consortium)
Financing:	Individual combination of EPC-savings guarantee + investment cost allowance + third party financing + subsidy programmes

Table 1 – Key features of General Contractor CR-EPC model

4.2.1 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 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 and initiates a negotiated tendering procedure on the basis of functional specifications and selects a suitable general contractor.

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

[20] > 50 % building construction measures applies for most full scale comprehensive refurbishment projects

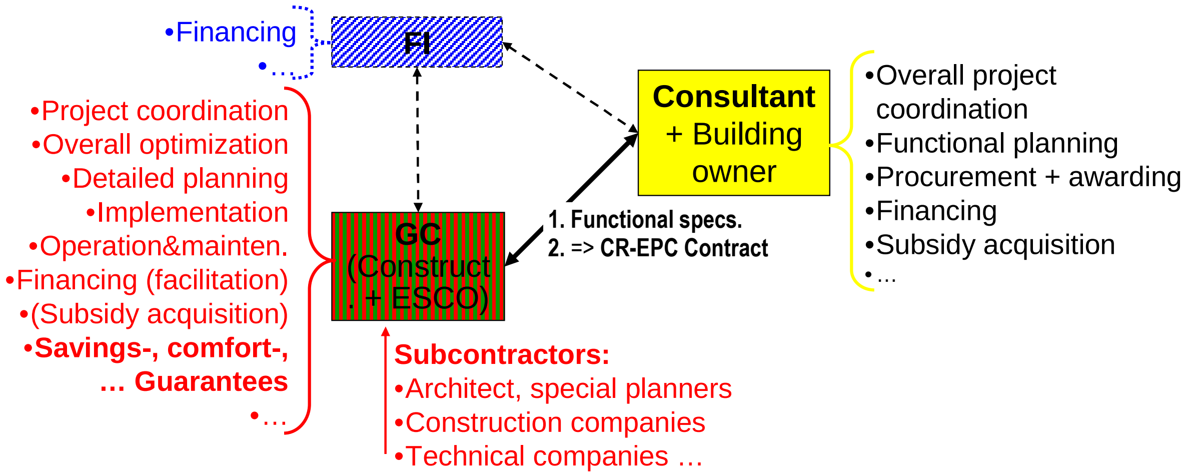

Figure 6 – General Contractor CR-EPC model: key actors, responsibilities and contractual relationships

The general contractor bears the responsibility for the entire project outcome from overall optimization, detailed planning and implementation to operation & maintenance and the coordination of subcontractors. He has to provide energy savings, comfort and other 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.

The General Contractor can be a standard construction company or a standard ESCo. Often, a consortium[21] 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. A GC-consortium is a viable solution especially if its constituent companies have worked together successfully in the past.

The general contractor must have the statutory permits and authorizations that are required for the project activities. In Austria, for example, the general contractor 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.

The general contractor 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-Contracting projects it makes sense to differentiate between financing and energy services. "ESCo's are experts in technical, economic,

[21] A consortium is a project-partnership with the objective of pooling resources to fulfil 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.

and organisational matters of Energy-Contracting, 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."[22] This holds true for all three models introduced here.

CR-EPC-projects with comprehensive refurbishment measures typically have payback 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.

4.2.2 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-Contracting 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."[23]

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. Project costs are calculated on the basis of preliminary planning (For formula see chapter CR "Light"-EPC model, Figure 9).
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 general planner or CR "Light" model.

4.2.3 Contractual guarantees and quality assurance instruments

The general contractor takes over technical and commercial implementation and operating risks and gives performance guarantees for the results of the entire project over the contract term.

Typically, the core guarantee is given for the energy cost savings in relation to a reference baseline. At the same time comfort standards such as minima and maxima for room temperatures and humidity are defined and have to be maintained. As

[22] 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

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

a result, it is in the general contractor's very own interest, to design and operate the facility's heating, ventilation and other technical systems efficiently, because his remuneration depends on the fulfilment of the savings guarantee given.

Other guarantees are typically defined for investment costs, for reaction times in case of malfunctions or for quality and (eco-) performance requirements of materials and equipment installed.

In principle, the extent and details of the guarantees in an Energy-Contracting service package can be agreed individually for each project. The goal is to outsource commercial and technical performance risks to the ESCo and demand measurable guarantees as described above (see also Figure 2).

Consortia by their legal nature have to warrant that they will meet all deliverables and warrantees 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.

4.2.4 Advantages of the model

The GC CR-EPC model offers the following advantages in addition to the known advantages of Energy-Contracting in general, which are not particularly stated here:

+ "One stop shop": The general contractor assumes the coordination and provides guarantees for the entire CR-EPC-project including all interfaces and the overall performance. An integrated solution is provided by an expert partner that has at his disposal all the required competencies and can call upon specialized subcontractors as needed.
+ The general contractor's performance can easily be judged by evaluating the guarantees agreed in the CR-EPC contract. In addition the general contractor's remuneration is partly performance based with a bonus-penalty-system in case of under or over performance.
+ 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 general contractor is the sole project partner for the realization and operation of all refurbishment 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.

4.2.5 Disadvantages of the model

The GC CR-EPC model has the following potential disadvantages in addition to known disadvantages of the Energy-Contracting model:

- Refurbishment measures with detailed specifications, which are typically building construction measures like facades, are limited to less than 50 percent of the total project value.

- The building owner is highly dependent on the general contractor. 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 general contractor’s capabilities and in addition apply adequate quality assurance instruments. One solution is to require second opinion reports from independent consultants for critical project steps.
- The general contractor usually calculates an additional general contractor surcharge for coordinating and taking responsibility of the overall project. At the same time, pricing pressure for subcontractors is higher compared to a direct contract with the building owner. Generally, the general contractor model favours bigger companies and may be disadvantageous to small and medium sized enterprises (SME’s) or regional companies.
- In the case of a general contractor consortium, project acquisition and long-term contract fulfilment is often with the ESCo- and not the construction partner of the consortium, although construction volume exceeds ESCo contract volume.
- Possible conflicts of interest regarding implementation quality may arise between general contractor and subcontractors or consortium partners, because the general contractor 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 number of qualified comprehensive refurbishment general contractors, which are familiar with the Energy-Contracting concept is limited in most markets. Market development activities to familiarize market actors with the CR-EPC concept and with the functional procurement procedure may be necessary.

Applicability and evaluation of the advantages and disadvantages described must be determined on an individual project basis and may need to be adapted to different countries and regions.

4.3 General Planner CR-EPC model (GP CR-EPC)

In this model the building owner can specify detailed solutions of the construction measures, such as the detailed design of a building envelope refurbishment. The building owner commissions a general planner who is responsible for overall project optimization, detailed planning, specifications, tendering, supervision and quality assurance.

Typically, the general planner tenders building construction measures on the basis of detailed specifications; whereas ESCo services are tendered with functional specifications. Hence building construction measures and ESCo services are awarded in separate contracts.

This model is basically a praxis oriented combination of a standard construction procedure with the Energy-Contracting concept.

Key Features	General Planner CR-EPC Model
Example measures:	CR building refurbishment including facade and building technology

Share of building construction measures:	More than 50 % of the total project volume
Project specifications and tendering:	Construction: Detailed specs. => standard procurement ESCo: Functional specs. => negotiated procedure
Overall optimization and detailed project planning:	General Planner
Execution of measures:	Construction company and ESCo
Financing:	Individual combination of EPC-savings guarantee + investment cost allowance + third party financing + subsidy programmes

Table 2 – Key features of General Planner CR-EPC model

From the procurement law perspective, a negotiated procedure can only be applied for the ESCo services, not for the construction measures (please refer to 4.2.2).

The other implications outlined in the GC CR-EPC model with regard to procurement, financing, pay back times and statutory permits for the actors apply here as well.

4.3.1 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 CR-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.

The general planner must possess interdisciplinary competencies and experiences in the overall optimization, realization and coordination of CR- and Energy-Contracting projects. Comprehensive refurbishment requires an integrated planning approach, which takes reciprocating effects of the different building technologies into account.

It is the general planner’s task to plan and ensure building performance criteria such as air tightness or maximum 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 CR-EPC model:

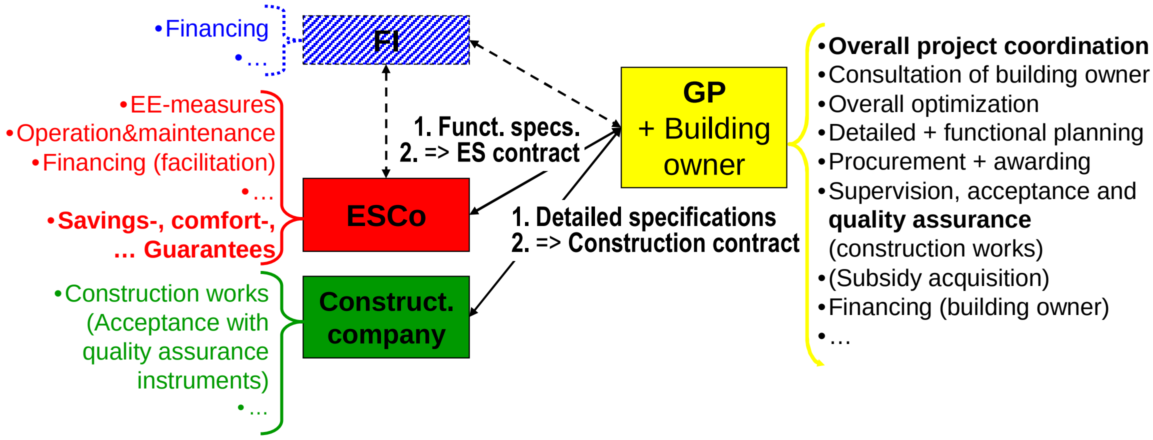

Figure 7 – General Planner CR-EPC model: key actors, responsibilities and contractual relationships

After completion of the planning, building construction measures and Energy-Contracting are awarded in separate contracts. The Building construction measures are typically planned in detail and awarded to a construction company on the basis of detailed specifications.

Special attention must be given to the definition and control of performance criteria and quality assurance instruments (QAI). The contract must include mandatory QAI's such as thermo graphic pictures, blower door tests, operation manuals and expert's reports or extended liabilities (See 4.2.3).

ESCo 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 CR-EPC-contract is concluded between the building owner and the ESCo.

For this model, the selection of the general planner is of special importance, taking his scope of responsibilities into account. For the commissioning of the general planner 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.[24]

4.3.2 Contractual warrantees and quality assurance instruments

The responsibility for the entire project is shared between general planner 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

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

measurable success criteria into the general planner contract. As a minimum, the general planner's services must be covered by liability insurance.

The quality of the building construction measures has to be controlled and assured by the general planner. He has to provide evidence of the implementation quality of building construction measures to the ESCo, e.g. by providing thermo graphic inspections, blower door tests, expert's reports, simulations and similar quality assurance instruments.[25]

The ESCo has to provide performance warrantees for the entire building measures as described in the general contractor model, based on the ESCo as well as the building construction measures.

To secure project cycle optimization and implementation quality it is recommended to integrate the ESCo into the project at an early stage 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. Guarantees are typically limited to the legally implied warranty.

4.3.3 Advantages of the model

This model is closest to the established standard planning and implementation procedure for building refurbishment measures. In comparison to the general contractor model, the GP CR-EPC model offers the following advantages:

+ The building owner himself or via the general planner has more control over the detailed planning and implementation steps of the project.
+ Project coordination costs are likely to be lower in comparison to the GC CR-EPC model because there is no general contractor surcharge. On the other hand, costs for the general planner have to be accounted for.
+ The standard tendering process with detailed specifications is advantageous for construction companies in that it is easier for them to bid for clearly defined building measures, especially if they are not used to functional call for tenders. In addition, it is easier to contract subtasks to specialized companies for individual or specialized measures.

As with the other CR-EPC models, 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.

4.3.4 Disadvantages of the model

The general planner CR-EPC model has the following potential disadvantages, in comparison to the general contractor model:

- The building owner is highly dependent on the quality and creativity of the general planner, who in return is not responsible for the long term results and the operation of the building as compared to the general contractor or ESCo. Only

[25] Additional quality assurance instruments may be derived from the IPMVP protocols, which can be downloaded from www.evo-world.org/

the ESCo's performance can easily be judged by fulfilment of guarantees and remuneration is performance based with a bonus-penalty-system.

- There are more interfaces with potential problems than in the GC CR-EPC 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.
- Warrantees for the building construction measures are typically limited to the legally implied warranty as opposed to long term guarantees in a CR-EPC contract over the complete project term.
- In general, there are fewer incentives for innovative solutions, because detailed specifications leave less room for competition of ideas between bidders. Innovation is mostly dependant on the initiative of the general planner.
- The number of qualified comprehensive refurbishment general planners, which are familiar with the Energy-Contracting concept is limited in most markets.

Applicability and evaluation of the advantages and disadvantages described must be determined on an individual project basis and may need to be adapted in different countries and regions.

4.4 Comprehensive Refurbishment "Light"-EPC model (CR "Light"-EPC)

With this model, individual or smaller building construction measures such as top floor ceiling insulation can be realized within 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 ESCo is awarded an Energy-Contracting contract on the basis of functional specifications and realizes overall optimization, detailed planning, and operation & maintenance and provides performance guarantees.

The main difference to the GC CR-EPC model lies in the smaller extent of the building construction measures. Because only simple or "lightweight" building construction measures are involved, we propose to call this the comprehensive refurbishment "light"-EPC model (CR "Light"-EPC).

Key Features	**Comprehensive Refurbishment „Light"-EPC Model**
Example measures:	Building efficiency technologies + top ceiling insulation, window repair …
Share of building construction measures:	Less than 50 % of the total project volume
Project specifications and tendering:	functional specification > 50 % of project volume => negotiated procedure

Overall project management, optimization and planning:	Energy Service Company (ESCo)
Execution of measures:	Energy Service Company (ESCo)
Financing	EPC-savings guarantee + subsidy programmes. (investment cost allowance + third party financing on demand)

Table 3 – Key features of Comprehensive Refurbishment "Light"-EPC model

4.4.1 Key actors, responsibilities and contractual relationships

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

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

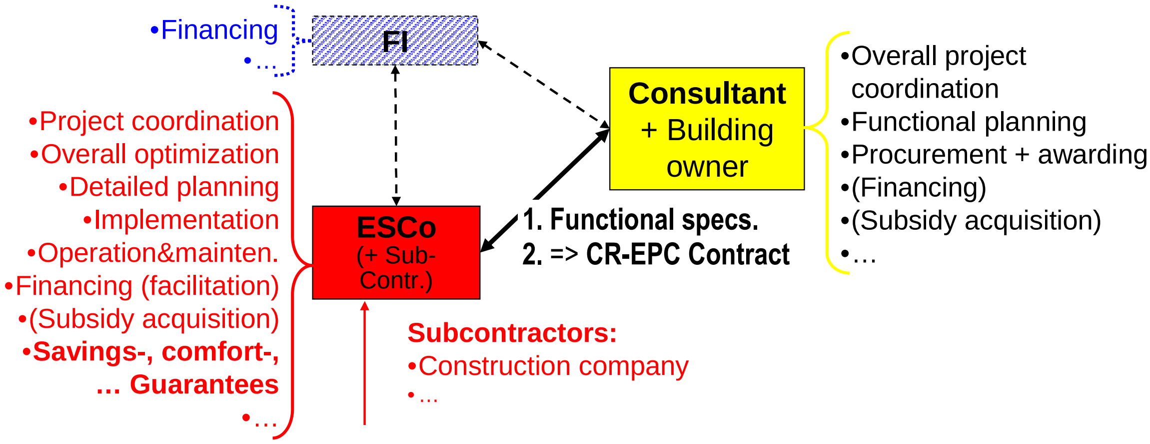

Figure 8 – Comprehensive Refurbishment "Light"-EPC model: key actors, responsibilities and contractual relationships

The ESCo is responsible for 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.

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.

CR-EPC-projects with individual building construction measures typically have payback times of 10 years and may require some co-financing from the building owner through a partial payment of the investment cost.

4.4.2 Procurement implications (especially for public sector clients)

A CR "Light"-EPC contract can only be awarded with a negotiated procedure if the legal procurement prerequisites - as described in the GC CR-EPC 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)	– Demolition work
+ Co-financing by building owner	– Building and roof construction
+ Third party financing by finance institute (excl. interest)	– Doors and windows
+ Subsidies	– Thermal and acoustic insulation
	– Plastering and painting
	– Miscellaneous
	– All other detailed specifications
∑ Total project value	**– ∑ Detailed specifications**

= ∑ Value of negotiable measures
(described with functional specifications)

Figure 9 – 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.

4.4.3 Contractual warrantees 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 CR-EPC model) for the results of the entire project over the contract term.

4.4.4 Advantages and disadvantages of the model

The comprehensive refurbishment "light"-EPC model offers some advantages, in comparison to the other two CR-EPC models as well as the standard basic EPC model: Individual building construction measures can be realized within a standard EPC model in the same manner as standard building technology EPC-measures.

In addition, the model offers standard-ESCo's access to building refurbishment projects including building construction measures in which their energy service expertise can be integrated. This may facilitate access to new and potentially lucrative building refurbishment markets for ESCo's.

As a disadvantage of this model, all refurbishment measures with detailed specifications must account for less than 50 percent of the total project value. Other important advantages and disadvantages are similar to the GC CR-EPC model.

As for the other models, applicability and evaluation of the advantages and disadvantages must be determined on an individual project basis and may need to be adapted in different countries and regions.

5 Conclusions, Recommendations and Outlook

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

1. The proposed CR-EPC models can facilitate customized packages of building construction and building technology measures combined with the known guarantees of standard EPC models and outsourcing of technical and commercial risks to ESCos.
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 high cooling loads of more than 40 W/m^2.
4. We propose three different models for the implementation of comprehensive refurbishment through Energy-Contracting: a General Contractor-, a General Planner- and a CR "Light"-EPC model. All three CR-EPC models presented allow combining (comprehensive) refurbishment measures of buildings with the advantages and long term guarantees of Energy-Contracting models.
5. 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 energy efficiency measures are desired. And 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 planner or a general contractor.

   The details and implications as well as advantages and disadvantages of each model are described in the main section of this publication. Naturally, each project requires an adaptation of the implementation model and contract to the individual project conditions.
6. All three models proposed can be applied both in the public and the private sector.
7. Energy-Contracting models as energy efficiency tools will be successful, if the added values can be communicated. From the perspective of the building owner, the following main advantages of the apply:
   - Guarantees for the results, e.g. for energy cost savings, indoor comfort standards, operation & maintenance, service reaction times …. and that the overall system performs to specifications. Over the whole contract term.

- The ESCo' remuneration (contracting rate) is performance based with a bonus-penalty-system and is depending on the fulfilment of energy savings guarantees.
- Possibility to save investment costs through part-repayment from future energy cost savings and third-party financing.
- Shifting technical and commercial implementation and operation risks to the General Contractor, the general planner or the ESCo.
- One contact person for all energy matters included in the CR-EPC contract ("One stop shop").
- Increasing comfort and value of the building, resulting in long-term increase in the revenue from the property.
- Focusing on the own key business.
- The objective is to create a win-win-win situation for all parties involved. The environment and the building owner's image included.

8. Energy-Contracting models can not decrease pay-back times of energy efficiency investments. At current energy prices, the typical guaranteed energy cost savings of a CR-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, as is common for Public-Private-Partnership contracts.
9. Financing must be individually arranged from a combination of CR-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 energy services on the other. ESCo's are experts in technical, economic, and organisational matters of Energy-Contracting, 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 as a third party to take over financing matters and risks makes good sense.[26]
10. Comprehensive refurbishment (CR) of buildings is a demanding task in terms of integrating and optimizing all building construction measures and building technologies involved. It requires experienced partners and an integrated planning process taking reciprocating effects of the different EE-measures 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.
11. The necessity for quality assurance at the construction site is not related to the Contracting model itself. Quality requires controlling and depends on the motivation of the construction company to deliver long term quality. Energy-Contracting models offer an instrument to provide incentives to optimise

[26] Please refer to footnote 22

life- or project cycle performance, including the operation phase of the building, because the ESCo is not only responsible for the construction but also for the operation and maintenance of the building. Thus the ESCo has an inherent interest to take care of quality assurance at the construction site and perform proper maintenance.

12. In many cases EE is not the driving force behind comprehensive refurbishment of buildings. Nevertheless minimum performance standards for any thermal refurbishment and 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 Public-Private Partnership models like sale and lease back projects.

Outlook

Implementing an Energy-Contracting projects always requires dedicated project developers. A future challenge will be standardisation and spreading the concept, initiating further projects and collecting more experiences. Our theses, that the comprehensive refurbishment models introduced are a good instrument to implement building energy efficiency measures, still needs more good practice.

To our knowledge, practical experiences with the implementation of CR-EPC-Models are limited to Austria so far.[27] We would like to learn more about other experiences collected with comprehensive refurbishment of buildings in conjunction with Energy-Contracting or other models and welcome any feed back. Also cooperation models with the facility management community would be of great interest.

Last but not least, the CR-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.[28]

The latter problems are not encountered with the Energy Supply Contracting (ESC) model, because for the business model no baseline is needed to measure guaranteed savings. We will carry out research and work on model projects for possible advancements of the ESC model with the objective of integrating demand side measures and energy saving incentives into the model.[29]

For the future we propose, that any energy supply should be coupled with efficiency measures on the demand side. Otherwise our CO_2- and emission reduction goals will not be achievable.

[27] Berlin Energy Agency has prepared some projects but not yet reached the implementation phase

[28] Energy cost and climate adjustments are easy to handle with the yearly final invoice

[29] Task XVI „Competitive Energy Services‟ of the IEA (International Energy Agency) Demand Side Management Implementing Agreement (http://dsm.iea.org/) has recently started research on this topic.

6 Appendix: Good Practice Examples

This chapter demonstrates practical experiences in the implementation of the 3 different models as well as in-house implementation, which could also be extended to different Energy-Contracting implementation models. The following good practice examples are reflected:

General Contractor CR-EPC examples:

- Three Multi-Storey Residential Buildings in Graz (Austria)
- Comprehensive Refurbishment and Enlargement of Kindergarten incl. Savings Guarantee (Austria)

General Planer CR-EPC examples:

- Refurbishment of a research facility (Austria)

CR-Light examples

- Utility based ESCO: Ground coupled heat pump technology for residential consumers – Integrated Energy Contracting (Spain)
- Integrated Energy Contracting - "CR-Light" and Energy Supply Contracting for a Conference Centre and Guest House (Austria)

Building Refurbishment – In-house implementation examples

- CR of low income dwellings, ECOLISH-Pilotproject Vrieheide (Netherlands)
- Reduction of Cooling (and Heating) Loads with Window Films – a Chance for Energy Contracting (Belgium)

Each examples-description mentions the contact-details of the "reporter", so that questions can be submitted directly to the person, who is familiar with.

6.1 General Contractor CR-EPC examples

6.1.1 Three Multi-Storey Residential Buildings in Graz (Austria)

Reported by: Jan W. Bleyl-Androschin, bleyl@grazer-ea.at
Daniel Schinnerl, schinnerl@grazer-ea.at
Grazer Energieagentur GmbH, Austria

Facility:

- 3 multi-storey buildings
- Construction 1959
- 150 dwelling units

Initial situation:

1. High heating energy consumption 120 kWh/m²
2. Dwellings heated by single stoves

3. Hot water supply decentral in dewellings
4. Facades not insulated with defects


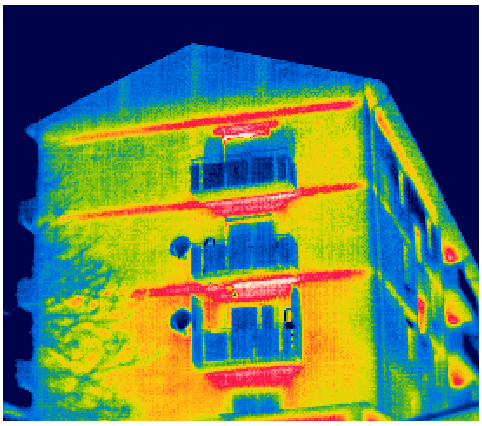

Figure 10– Multi-Storey Residential Buildings in Graz – before refurbishment

Goals:

1. Comprehensive refurbishment to raise living quality and quality of building structure
2. Reduction of energy consumption and greenhouse gases
3. Highest quality benchmarks at construction and economic criteria

Measures:

1. Thermal insulation of building envelope and exchange of windows
2. Gas fired central heating and hot-water supply and solar thermal system
3. Energy management and controlling system
4. Lift installation, renewal of electronic installations
5. O&M of ESCo and user motivation actions

Business Model

- A general contractor afford this comprehensive refurbishment guarantee model
  - All measures tendered as one package (from planning to o&m)
- Guaranteed investment sum 2.18 million €
  - Financing through state loan and savings
- Guaranteed savings
  - 24,500 €/a heating costs (- 45%)
  - 474 MWh/a heating energy (- 45%)
  - 405 t_{CO2}/a (- 69%)
- Project duration 15 years

Figure 11– Multi-Storey Residential Buildings in Graz – after refurbishment

Contracts and Cash Flows

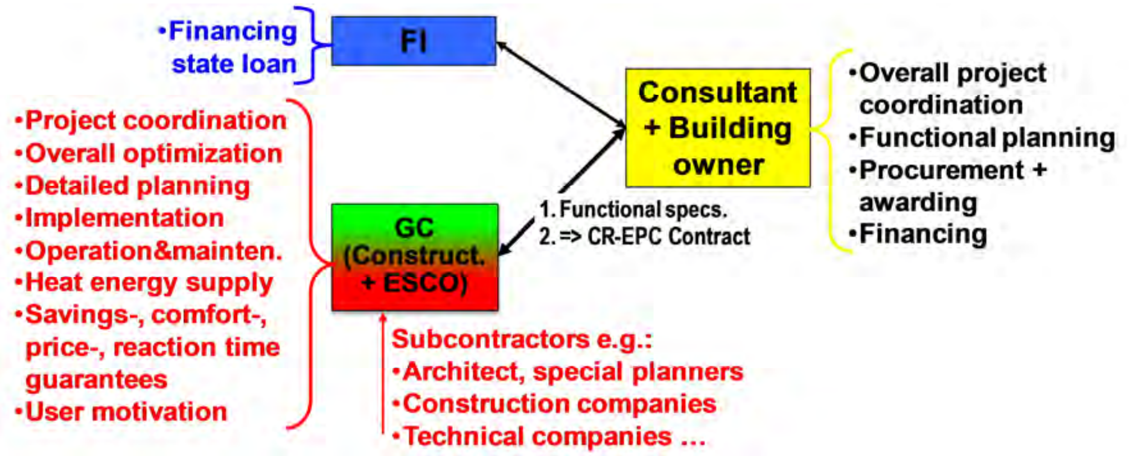

Figure 12– Implementation model of Multi-Storey Residential Buildings in Graz

Lessons Learned, Innovations and Client's Advantages

- ✓ Risk transfer to general contractor – complete service package
- ✓ Sustainability of measures with living quality and building construction improvement
- ✓ Most applicable are larger residential buildings (transaction costs)
- ✓ Adequate procurement process is important → partly functional specifications with performance spec.
- ✓ Guaranteed reaction time for technical breakdowns and comfort standards
- ✓ Tenants benefit from favourable financing conditions → running costs remain at same level

6.1.2 Comprehensive Refurbishment and Enlargement of Kindergarten incl. Savings Guarantee (Austria)

Reported by: Wolfgang Weber, **wolfgang.weber@eq-energie.at**
EQ Energie & Bau GmbH

Facility:

- Kindergarten at ground level
- 2 dwellings at upper level
- Year of construction 1970s
- Total 992 m² gross floor-space

Initial situation:

1. Very high energy consumption: 180 kWh/m² for heating
2. No insulation at all
3. Condition of structure according to age of building

Figure 13– CR and Enlargement at Kindergarten, indoor and outdoor picture

Goals:

1. Comprehensive refurbishment to raise living quality and quality of building structure + building enlargement
2. Reduction of energy consumption and greenhouse gases
3. Highest quality benchmarks at construction and economic criteria

Measures:

1. Thermal insulation of building envelope and exchange of windows
2. Gas fired central heating and hot-water supply, isolation of heat pipes
3. Energy management and controlling system
4. Furnishing of the whole building (110,000 Euro)

5. Total project volume: 900,000 Euro
6. ESCO guarantees energy savings of 52%

Business model:

1. Public procurement for general contractor:
   - ⇨ Financing, building technologies, construction, savings guarantee, … (one-stop-shop)
   - ⇨ 100 % functional specifications
2. Awarding criteria to award best bitter:
   - ⇨ Sum of Contracting-Rates over contract duration
   - ⇨ Energy savings guarantee
   - ⇨ Meeting technical minimum standards

Figure 14– Facade of Kindergarten after CR

Contractual relationships:

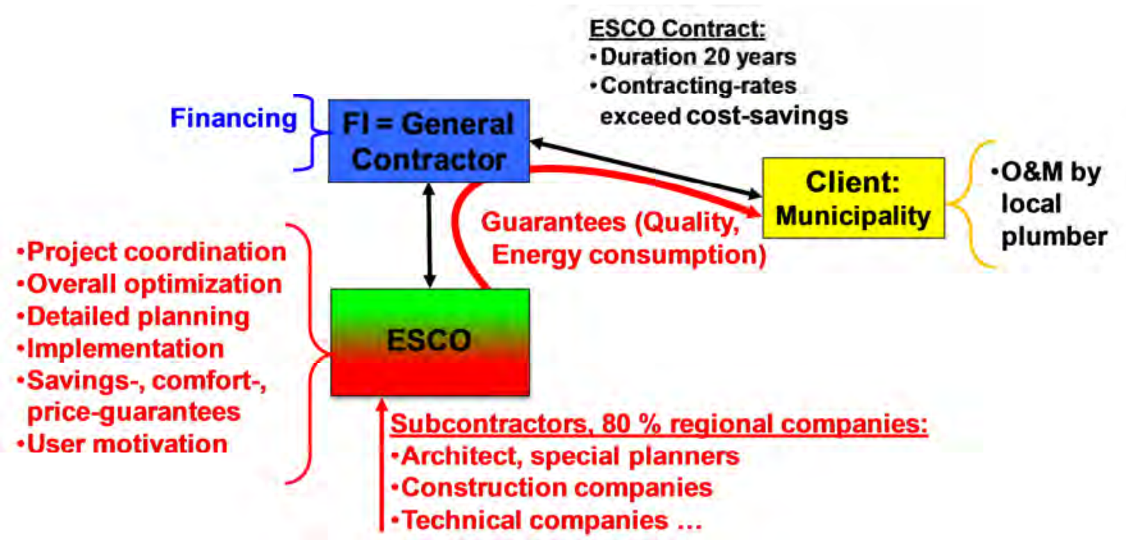

Figure 15– Contractual relationships of GC CR-EPC Kindergarten

Lessons learned, innovations and client's advantages:

- ✓ **Risk transfer to general contractor** – costs, future energy consumption, time schedule
- ✓ Sustainability of measures with **living quality and building construction improvement**; **comfort guarantees** according to legal standards (temperature)
- ✓ Adequate procurement process is important → at least **50% functional specifications with minimum standards**

- ✓ **Reduction of energy consumption: > 70%**

Figure 16– Building envelope of Kindergarten after refurbishment

6.2 General Planer CR-EPC examples

6.2.1 Refurbishment of a research facility (Austria)

Client: Joanneum Research Forschungsgesellschaft mbH

Contractor: MCE Building & Infrastructure Solution GmbH

General planer: GEA, Kampits & Gamerith architects in charge for project management and development

Building data: construction 1962, extension 1965 and 1974, utilisation as research centre, total floor space 6.543 m3, district heating supply


Figure 17– CR of research facility "Joanneum Research", pictures

Initial situation, main aims

- High energy costs, comprehensive refurbishment necessary for the whole building; baseline 123.300 € (heating, electricity, fresh and waste water)
- Main aims were guaranteed savings (at least 29 % of Baseline costs), reduction of CO_2 emissions and specific energy consumption, compliance with comfort standards and refurbishment measures, that means total optimisation of the building envelope, the heating system and other energy technical units.

Measures

- Envelope measures: insulation of outer walls, exchange of windows
- HVAC measures: optimisation of heating regulation system, installation of thermostat valves, cooling of the laboratory appliances with a closed circulation and a heat exchanger for the room heating, energy controlling system
- Organisational measures: concept for user motivation

Model

- A comprehensive EPC model with was developed for this pilot project under the quality trademark THERMOPROFIT. Goal was a total optimisation of the building, from the envelope, through the heating system and other energy technical units (ventilation, electric installations) down to the water consumption.

- The ESCO is in charge for operation, maintenance and controlling of the technical equipment. The main part of the investments was financed by the building owner. Additional funding could be gained from the Kommunalkredit Austria AG.

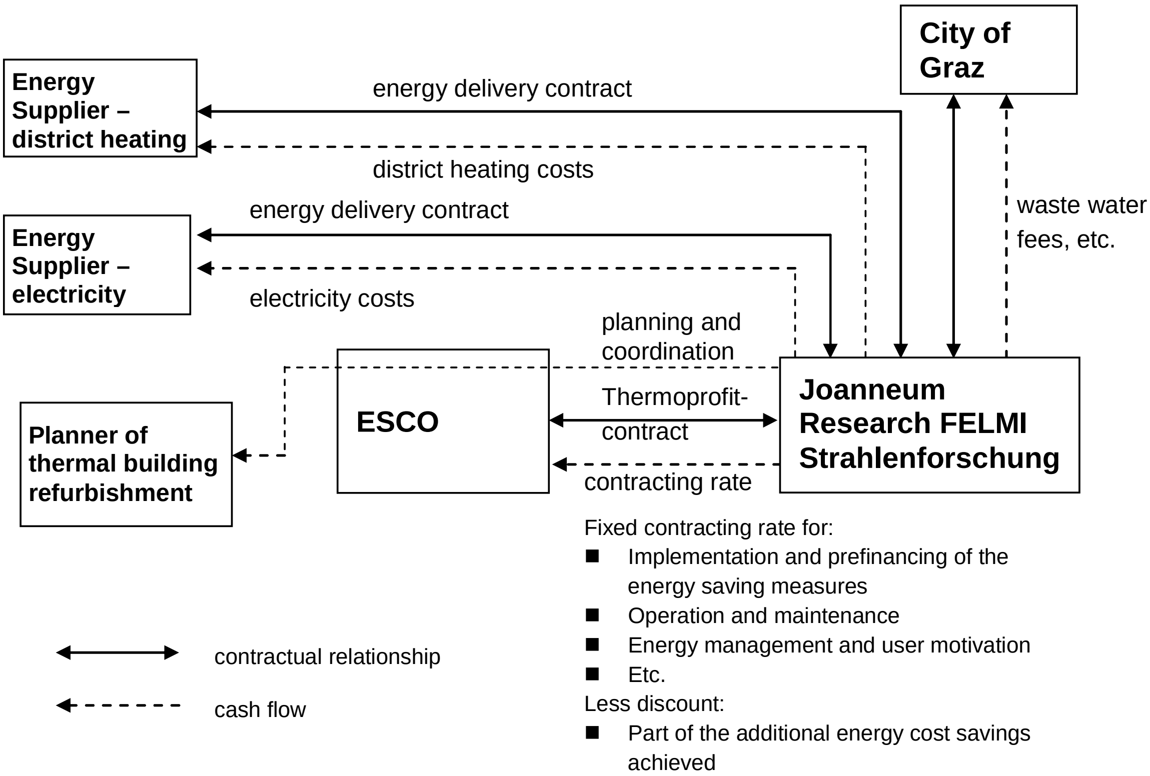

Figure 18- CR-Project Joanneum Research – EPC implementation model

Results

Highlight	Total optimisation of the building envelope, the heating system and other energy technical units
CO_2 reduction	99 t/a (more than 1.485 t during the contract period)
Savings	35.900 €/a or 29 % (guaranteed) 7.400 m^3 drinking water
Investment	1,5 Mio € (main part was financed by building owner, 181.682 € was a grant of the Kommunalkredit Austria AG) 1,3 Mio € for refurbishment 200.000 € for technical equipment
Bonus for Client	100 % of the additional saving amount
Period covered	15 years (September 2003 – August 2018)
Baseline costs	42.700 € heat, 56.000 € electricity, 24.600 € fresh and waste water costs
New energy indicator	37 kWh/(m^2*a) heating demand after renovation

Table 4 - CR-Project Joanneum Research - Results

Advantages for the client

- Total optimisation of building shell in combination with the heating system and other energy technical units
- Guaranteed savings, service package as complete solution
- Guaranteed comfort standards in the building
- Risk transfer to the Contractor
- Contractor is also responsible for maintenance, energy controlling, reporting and user motivation
- Sustainability of refurbishment measures (for the long life of the contract)

Lessons learned

- The Guarantee model approach leads to a significant improvement of the quality of the measures in all refurbishment phases.
- Applicable tender procedures are necessary (partly functional, the refurbishment measures with performance specifications or a defined minimum standard).

6.3 CR-Light examples

6.3.1 Utility based ESCO: Ground coupled heat pump technology for residential consumers – Integrated Energy Contracting (Spain)

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Background

Ground coupled Heat Pump technology has efficient consumption both for heating and cooling. It can produce ratios up to 4 kW of thermal energy per kW of electrical energy.

This technology has hardly been implemented in Spain.

Aim

The objective of the project is to analyze if ESCO services for residential consumers based on ground coupled heat pump´s are a viable solution for mass implantation in the mid-term.

The project is been tested in their employee´s houses through Integrated Energy Contracting providing the utility with reliable information about performance in different Spanish regions.

Methodology

1. Selection of 30 houses
2. Detailed energy audit: selection of viable candidates (12)
3. Subcontracting: Monitoring
4. Integrated (performance + supply) contract signed with employee
5. Installation

Non viable candidates were rejected mainly due to inability to perform the necessary drilling.

Over 20% consumption reduction was obtained in this rejected candidates through comprehensive refurbishment (changing windows and sealing frames).

Technology Considerations

1. Active Equipment
   - ✓ Ground coupled Heat Pump : 10.7 thermal KW (~2.4 electric kW) COP ~4.2
   - ✓ The efficiency of the installation is constantly monitored (both COP and SPF) and guaranteed during the duration of the contact
   - ✓ Adaptation of heating appliance was needed when the original system did not operate with water

- ✓ Absorption machines where included in areas with cooling needs

2. Passive Measures (Refurbishment)
   - ✓ Refurbishment measures consisted mainly of:
     - ⇨ Changing window (glass, frame or both)
     - ⇨ Sealing frames and door frames

Contracts and Cash Flows

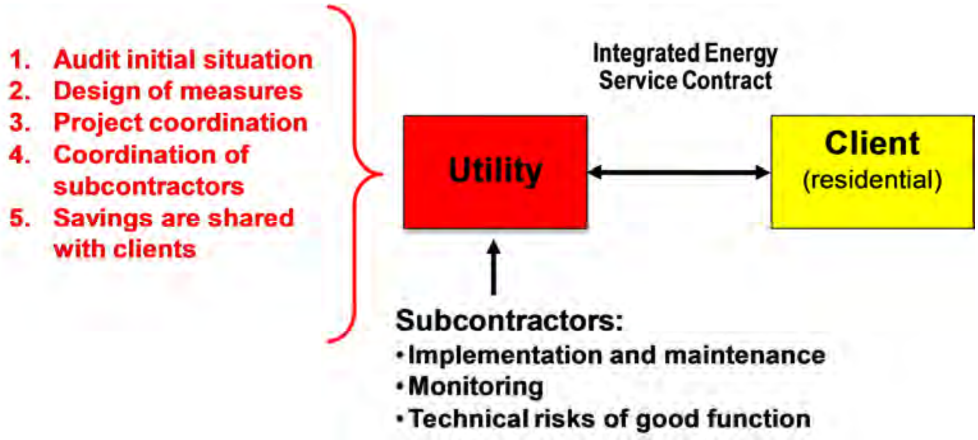

Figure 19– Integrated Energy Contracting Heat Pumps – Contractual relationships

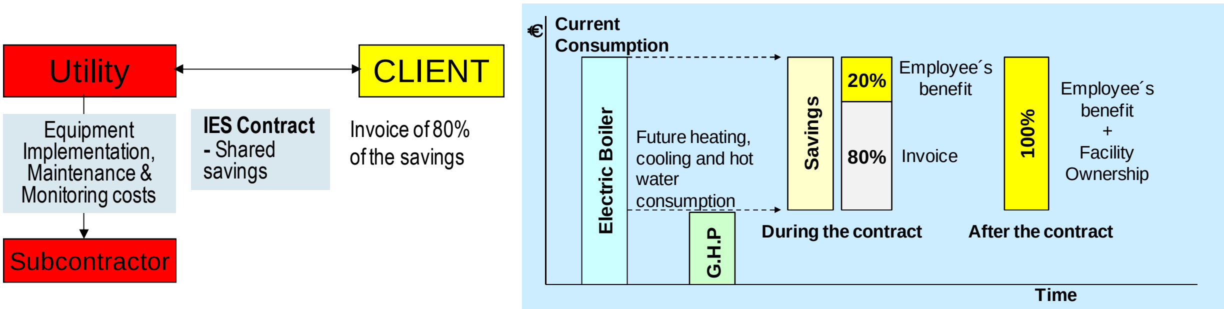

Figure 20– Integrated Energy Contracting Heat Pumps – Cash Flows

- ✓ The utility takes care of all the installation (grants, licence, etc) and owns the facility during the contact duration.
- ✓ The client pays upon electric savings, this is, assuming an electric boiler.
- ✓ The clients pays the electricity company for his electric consumption (as before the ESCO project).
- ✓ The ESCO charges 80% of the savings achieved for the installation, maintenance and monitoring. The client is not charged by the ESCO for its consumption (which he has to pay to the electricity company) but for the savings achieved.

Conclusions:

- ➢ Facilities are now under construction

- No information has been provided about how the installation is going to be financed. Utility´s assets can surely back the investment
- Utility needs to work to develop highly replicable solutions for residential consumers
- Utility demands stable regulations and needs to invest in high qualification training

6.3.2 Integrated Energy Contracting - "CR-Light" and Energy Supply Contracting for a Conference Centre and Guest House (Austria)

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Grazer Energieagentur GmbH

Facility:

- Conference and hotel
- Different construction periods: 16th century, 1960 and 2009
- 3 buildings supplied by heating network
- Heated area: 4.000 m^2

Initial situation:

1. Inefficient natural gas boiler, high energy cost
2. No insulation of building envelope (protection of historic monument)
3. Energy consumption ratio: ~ 185 $kWh/m^2/year$
4. Demolition of old boiler house to make room for new guest house

Figure 21 - Pictures of conference center and guest house in Austria

Goals of building owner:

1. New boiler installation
2. Outsourcing of energy supply and financing

3. Reduction of energy demand, -cost and CO_2
   through demand side energy efficiency measures

Measures (selection):

1. Condensing gas boiler and micro CPH for heat and electricity baseload
2. Insulation of upper floor ceiling with inflated cellulose (recycling product)
3. Energy management and –controlling
4. …

Figure 22 - Insulation of upper floor ceiling with inflated cellulose

Business Model: Integrated Energy-Contracting

1. Combination of energy efficiency and useful energy supply
2. Quality assurance substitutes EPC savings guarantee (see figure)
3. Awarding: Combined competition of price and ideas on the bases of a functional service description

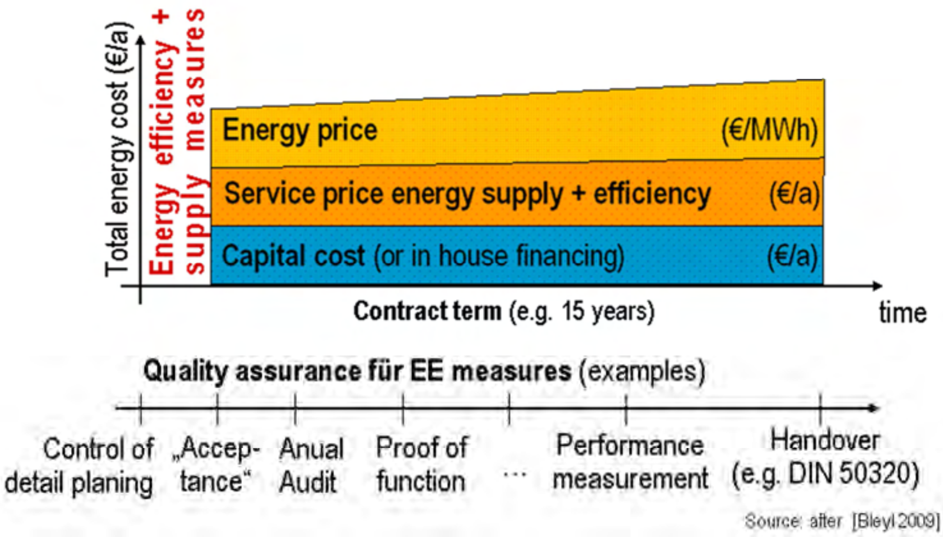


Figure 23 - Integrated Energy-Contracting Business Model

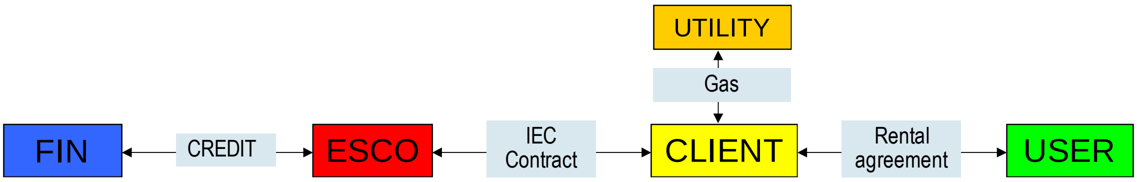


Figure 24- Integrated Energy-Contracting contractual relationships

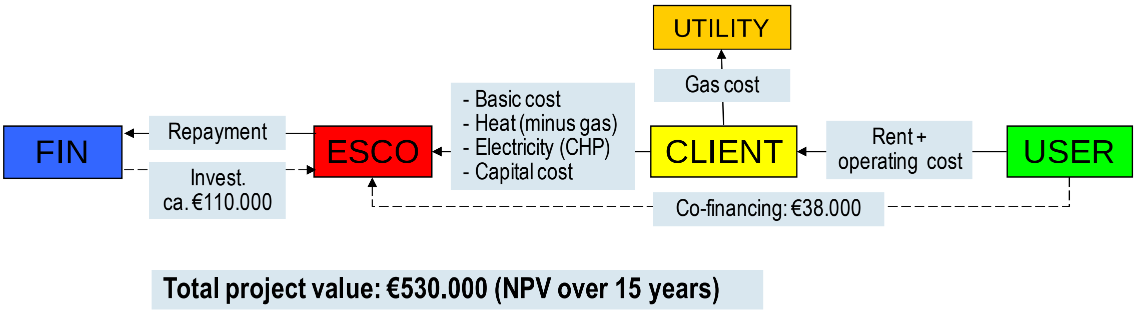


Figure 25- Integrated Energy-Contracting cash flows

Facts:

- Duration of contract: 15 years
- Total project value: €530.000 (NPV over 15 years)
- Total investment costs: €110.000
- Costs on energy (heat): €33.000 per year
- Investment costs for energy efficiency measures: €27.000
- Savings through energy efficiency measures: €2.000 (46 MWh) per year

Lessons Learned, Innovations and Client's Advantages:

1. IEC modell: the combination of energy effiency and useful energy supply works!
2. Building owner: Coordination of interfaces and controlling of ESCo as general contractor is necessary. Especially when other construction work is going on in parallel (new guest house)
3. The development of comprehensive energy efficiency projects requires at least one dedicated protagonist and endurance.
4. Protected historic monument: Only insulation of upper floor ceiling works easily (low cost option with inflated cellulose, provided the attic is not used)
5. ESCo finances CHP at own risk and sells electricity
6. Co-financing by building occupant decreases capital cost

6.4 Building Refurbishment – In-house implementation examples

6.4.1 CR of low income dwellings, ECOLISH-Pilotproject Vrieheide (Netherlands)

Reported by: Ger Kempen, ger.kempen@essent.nl
Essent Energy Services

Facility:

- Block of 6 houses,
- Low income dwellings

Figure 26– Vrieheide low income dwellings, picture

Measures:

1. Insulation of roof, bottom floor façade, bottom floor rear
2. Isolation gables and rear wall surfaces
3. High Efficiency glazing rear doors living rooms and doors rear bedroom
4. Self-adjusting ventilation

Meeting the Goals:

1. First savings calculations were too optimistic (7.500 m^3 gas/year) → extra insulation underside overhang

2. Financial optimization: lower VAT for isolation (for homes over 15 years) and subsidy of 20% for High Efficiency glazing

Business Model:

- ✓ **Essent as a general contractor afford this comprehensive refurbishment Investment sum € 114.000 included VAT**

Funding possibilities:

1. Financial Lease
   - ⇨ Not suitable for investment in the building envelope
   - ⇨ Interest 11%
   - ⇨ No deduction of tax
2. Mortgage
   - ⇨ Total funding from VVE
   - ⇨ Interest 5%
   - ⇨ Value of the house as deposit
   - ⇨ Reducible from tax
3. Revolving fund
   - ⇨ Cooperation with municipal government
   - ⇨ Interest 2%

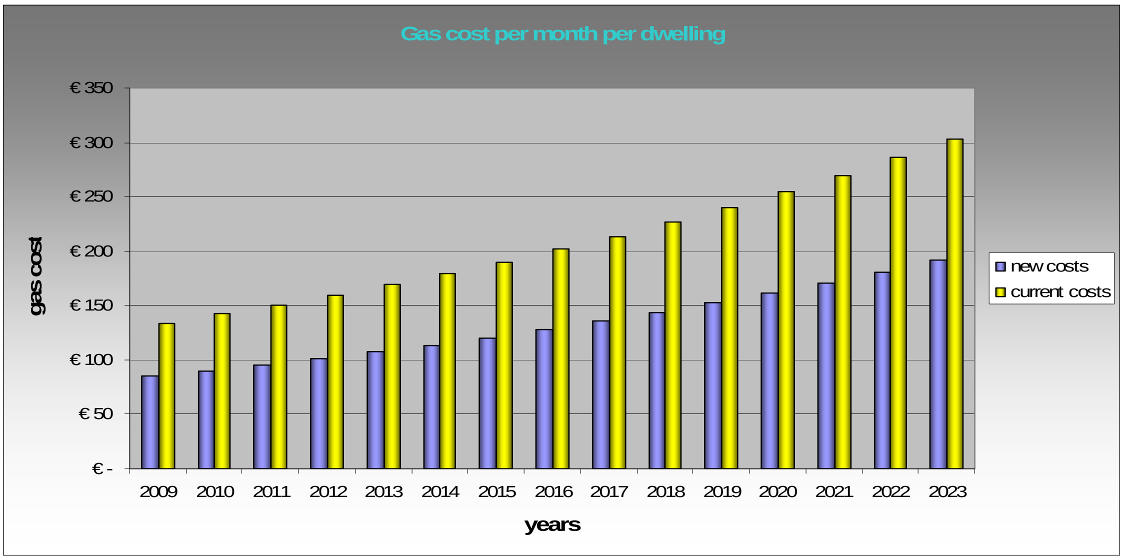


Figure 27– Energy cost forecast for Vrieheide dwellings

Cash flows with customer financing:

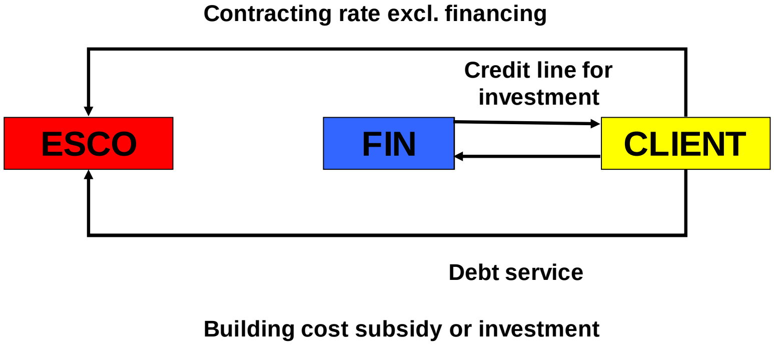


Figure 28– Cash flows CR-Pilotproject Vrieheide

Lessons learned, innovations and client's advantages:

- ✓ Project covers a block of 6 dwellings (complex);
- ✓ Project can only be done collectively;
- ✓ Funding from savings € 63,000
- ✓ Own contribution average about € 8,500 per dwelling on investment of € 19,000 per dwelling;
- ✓ Advantage because of subsidies and especially revenues from flowing back through energy savings;
- ✓ Energy savings calculated using normal combustion behavior. Saving more by efficient behavior, so additional benefit;
- ✓ Significant improvement house and eliminate overdue maintenance: 90 % from € 19,000 = € 17,000
- ✓ Next steps:
  - Effort from municipal government to establish a revolving fund
  - Establish an association of owners

6.4.2 Reduction of Cooling (and Heating) Loads with Window Films – a Chance for Energy Contracting (Belgium)

Reported by: Lieven Vanstraelen, lieven.vanstraelen@fedesco.be
Managing Director, Fedesco, Belgium

Facility:

The National Archives are part of one of the largest federal public building sites, covering a total of 210.000 m² in the heart of Brussels' historical centre. Other buildings of this "Mont des Arts/Kunstberg" complex, where the window film was also applied, include the Royal Museums for Fine Arts and the Royal Library. Some technical details:

- Surface of building: 49 331 m²
- Windows with double glass (standard from 70's to 90's)
- Glass specifications: U = 2,9 W/m²K (coefficient of heat transmission) and TL = 0.8 (coefficient for light transmission)

Figure 29 – Picture of National Archives in Belgium

Initial situation:

- Electricity bill: 555 713 + 208 292 = € 764 005 (VAT incl., 6 701 255 kWh/yr)
- Gas bill: 96 667 + 172 079 = € 268 746/year (VAT incl., 5 280 464 kWh/yr)
- Total energy consumption ratio: 243 kWh/m²
- Important cooling and heating consumption due to the requirement for constant temperatures and humidity all year round for conservation purposes
- 2 boiler rooms

- Several cooling and ventilation units
- Ease of installation (on the inside) without the use of scaffolding or height workers
- Avoid risk for glass breaking (requiring low absorption)
- The need to preserve natural light for comfort reasons

Goals:

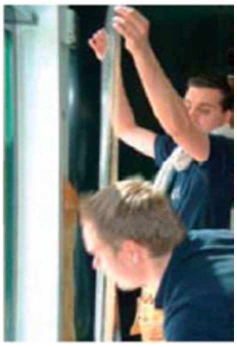
- Reducing the need for cooling (and heating)
- Long term guarantees on the installation of the product
- Good quality of service to satisfy the end customer and create no disturbance in existing activities of conservation and office work

Measure:

- ✓ Luxasolar Clearview film installed on 960 m² of double glass

Technical Specifications

•Visible Light Transmitted (VLT) :	71%
•Visible Light Reflected (VLR) :	11%
•Total Solar Energy Transmitted:	31.5%
•Total Solar Energy Reflected:	41.6%
•Total Solar Energy Absorbed:	26.9%
•Solar Heat Gain Coefficient:	0.455
•Total UV-reflection :	99%
•Total infrared-reflection :	93%



- ✓ Clear film allows visible light to go through: visible light spectrum, no extra need for lighting unlike tinted or mirrored film
- ✓ Maximum rejection of solar heat: UV spectrum
- ✓ Minimum absorption: otherwise heat convection
- ✓ Isolation in the winter: deep IR spectrum

Fedesco subsequently realized on-site measurements in two identical rooms, one equipped with the film, the other without. The following graph shows inside radiation temperature meetings at 50 cm from the window, while the airco was turned off. The meetings took place from august 13th to 16th 2009 with sunshine.

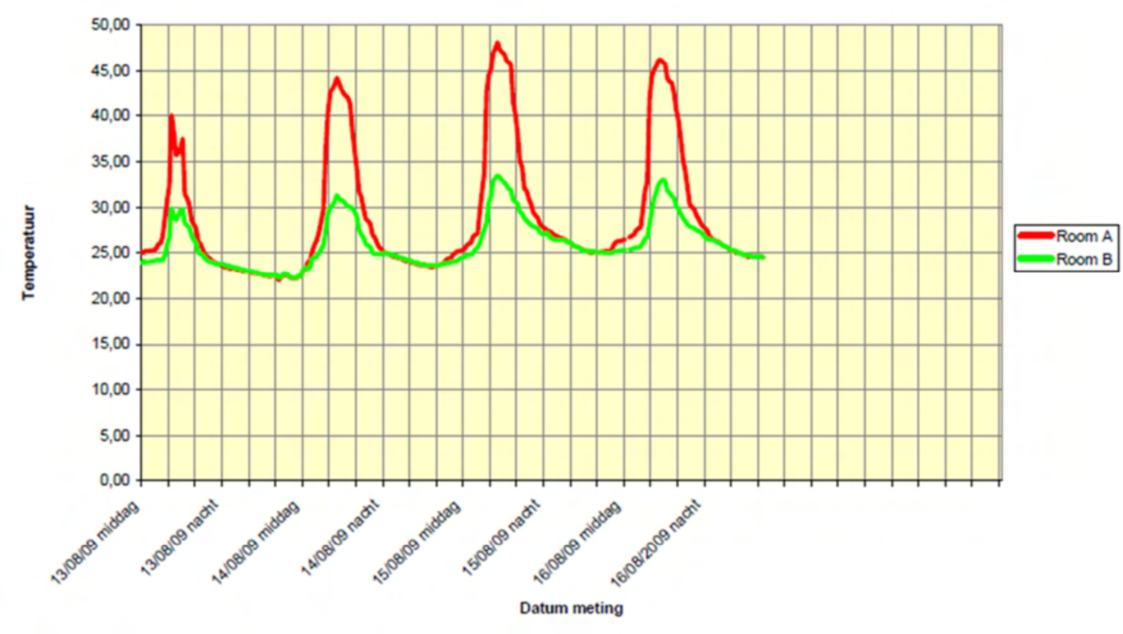


Figure 30– Radiation temperature measurement with installed window films (B) and without (A)

The following graphs shows measurements in December in a similar building, showing both the solar heat reducing and the isolating effects in the winter, lowering needs for both cooling and heating. As a matter of fact the window film straightens the overall temperature pattern which is much more fluctuating in the room not equipped with the building. Average temperature differences measured at night are 3 to 3,5 °C with maximums of up to 6 °C.

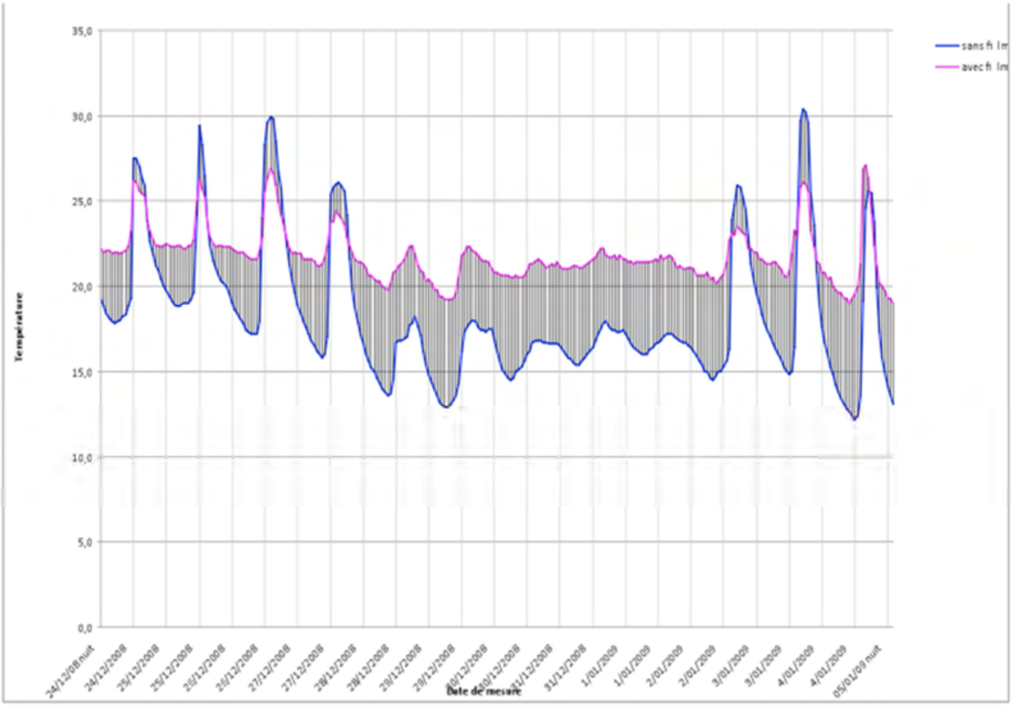


Figure 31 Temperature measurements in the winter showing isolating effect

Business Model

The technical and economical calculations were done at a practical case study at the Royal Archives in Belgium. The outcomes show that this solution is suitable as an individual measure, but also as a measure of EPC or Comprehensive Refurbishment with EPC. It can be integrated in GC, GP and CR-light models.

The payback times are between 2 and 9 years and vary with the direction of the windows (east, north, west and south), with the double and single glazing of the windows, with the coefficient of performance (COP) of the cooling equipment and the electricity costs (cent€/kWh).

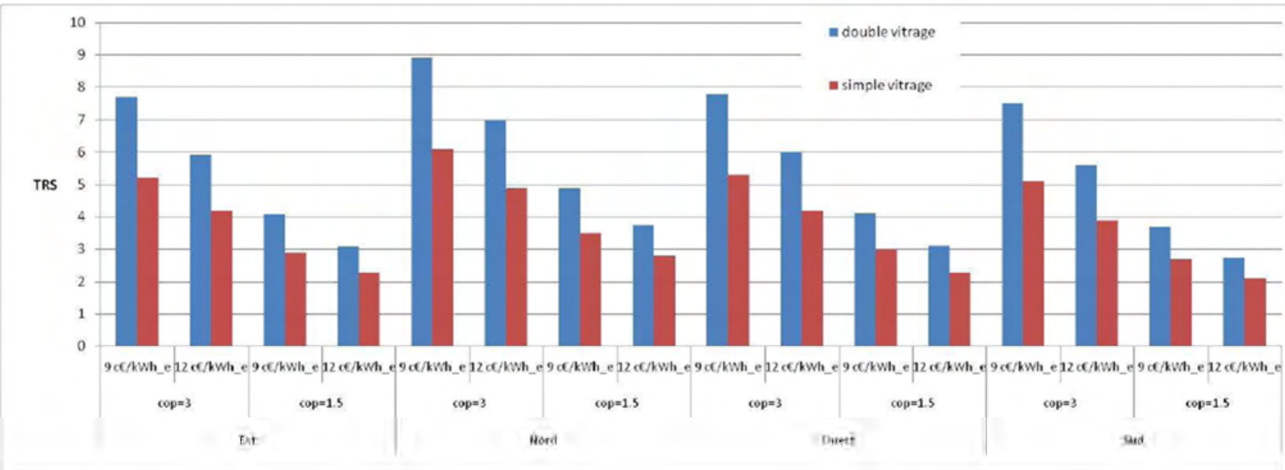


Figure 32– Window films economical calculations

Lessons Learned, Innovations and Client's Advantages

- ✓ Reduces energy consumption and CO2 emissions
- ✓ Short time from identification (cooling YES/NO) to realization and thus savings: 6 to 8 weeks (compared to HVAC, relighting: 6 - 12 months and CHP: 12 – 24 months)
- ✓ Not expensive: 70 – 80 €/m² installed
- ✓ Installation on inside
  - ➢ No height workers or scaffoldings
  - ➢ No temperature influence
- ✓ Easy to understand for clients
- ✓ No maintenance (10 year guarantee – 15-20 year life time)
- ✓ Many advantages compared to external sun shadings
- ✓ Not yet well known:
  - ➢ SSS is an innovative technology based on many years of engineering research
  - ➢ 5 layers of film with metals and metal oxydes designed and engineered to perform to requirements)

- ✓ Window film has been around for a long time, but not a good reputation:
  - ➢ Tinted, Mirrored, External window film
  - ➢ Problems with demetalization
  - ➢ Distributed through resellers and DIY outlets
- ✓ Cooling? People don't know about it!

Next steps for a market development for window films:

Fedesco plans to measure real energy savings throughout 2009 and 2010, using its EMBV energy monitoring, bookkeeping and verifications system. Given the measurements they are expected to confirm or even surpass the calculations.

- Connection with EPC and CR-EPC through Task XVI national implementation actions
- Technical steps: test temperature in the winter, develop M&V method for window film (does not exist in IP MVP annexes), measure Savings over full season (EMBV planned in Royal Archives), compare real savings to estimated savings and generalize this approach
- Plan and execute other installations

Figures

Tables

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