ANALYSIS OF INNOVATIVE FINANCING SCHEMES FOR DEEP RENOVATION OF PUBLIC BUILDINGS

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The eCentral project summary

Addressing poor energy performances of public buildings is at the core of EU's Energy Efficiency Directive and Energy Performance Building Directive but also one of growing financial issues in Central European countries. To address that eCentral project will support key stakeholders to realize benefits of newly implemented building standard – nearly zero energy building (nZEB). eCentral project will prove that nZEB approach, although innovative, is optimal and cost-effective solution for renovation and construction of public buildings. Project aims to capitalise on results of previous and ongoing EU initiatives. Austria has a proven track record with nZEB renovation projects and will be leading other implementing partners (CRO, SLO, HUN) by example. Transnational cooperation will be used to receive maximum international visibility of selected pilot actions. Main outputs of the project are:

- energy performance certificate (EPC) Tool for public authorities
- deployment and promotion of innovative financing schemes
- training programme and project development assistance for nZEB projects
- building renovation strategies for selected regions
- state of the art pilot nZEB public buildings in selected regions
- established cooperation with scientific institutions and other nZEB initiatives

Transnational Assessment and Support Group, formed from project experts and scientific institutions will act as a support team and provide quality checks of each output. EPC Tool will be developed and used by public sector decision makers and project developers beyond eCentral project lifetime. Trained energy efficiency teams within the regional government will serve as a backbone for conducting future nZEB projects. The European Academy of Bolzano (EURAC), one of the leading centres of expertise on energy efficiency in the Central Europe region, will focus on policy analysis and dissemination of eCentral project results.

About this document

This document is part of activitiy A.T1.5 of workpackage T1 and named D.T1.5.1 Analysis of innovative financing schemes for deep renovation of public buildings. It gives an overview on innovative financing schemes such as public private partnership, energy performance contracting and crowdfunding and provides successful case studies for each scheme. These key findings will be used within the project and will contribute to the success of it. The document was prepared under the lead of EAS with special contribution of EURAC, REGEA and ENERGIAKLUB. The final version was reviewed and approved by all project partners.

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A. Report summary

Addressing poor energy performance of public buildings as well as growing financial issues is at the core of the European Energy Efficiency Directive and Energy Performance Building Directive. The eCentral project will support key stakeholders to realize benefits of nearly zero energy buildings, using innovative financing schemes such as public private partnership (PPP), energy performance contracting (EPC) and crowd funding (CF). PPP will be realised for the renovation of a hospice in municipality of Sveta Nedelja (HR), EPC will be used for renovating a kindergarten in BP18 of Budapest (HU) and CF will be tested for renovating a university building in Velenje (SLO).

These innovative financing schemes will be investigated for this report and one successful example per financing scheme will be described. Additionally, the technical aspects of renovations will shortly be assessed by rating different measures, e.g. thermal insulation of walls, window change, change of heating system, etc. according to their investment, payback time, implementation intensity, energy saving potential and effect on user comfort level.

B. Technical and financial aspects

1. Technical aspects

In this chapter, technical aspects (types of renovation measures) will be described since different measures have different financial requirements (small/big investments, short/long payback times, easy/difficult implementation, small/big impact on energy performance of building). Each measure shall be evaluated and rated according to the rating system below.

1.1. The rating

The rating is done be using icons and a range from 1 to 5. The meanings of the valuations are shown and explained in the table below. Every rating relates to a simple standard building (simple geometry, no skyscraper, no fancy architecture, medium building quality with potential to increase energy efficiency through implementation of renovation measures, etc.).

“Investments” are expenses in money. The volume of the investment for the measures depends from country to country. Nevertheless, a ranking of measures based on their level of investment (small, moderate, medium) by comparing the described measures among each other can be assumed based on experiences.

“Payback time” or payback period is the length of time required to recover the cost of an investment (no discount rate). The measured unit is stated in a range of years.

“Implementation” means the effort that will have to be done to implement the renovation measures. As a side indicator the number of crafts necessary to implement the measure.

“Energy performance” means the energy savings due to a renovation measure. The percentage of savings are referred to each single measure. Savings are estimated comparing the energy use of the status quo of the system (state of the art of the existing building) with the energy use after the renovation. The values are in percentage. For example, a renovation of the façade is done. The heating energy losses of the current façade is the status quo. The savings are then set into relation with the heating energy losses.

“Indoor user comfort level” is another important rating, usually forgotten when planning building constructions. Indoor comfort is defined by several parameters such as air quality control (temperature, humidity, CO_2, VOC,.), daylighting, open view on external environment, all aspects that contribute to organize a positive atmosphere[1,2]. The effect on the comfort level is based on the following scale:

- **No effect:** measures have no or only slight effect on parameters which affect the indoor comfort level of the users
- **Moderate effect:** comfort level is moderately improved **by hardly measurable effects** such as comfortable heat radiation through installation of surface heating, avoiding of draught (e.g. window and door change) **OR** comfort level is improved **by at least one measurable parameter**.
- **Big effect:** comfort level is highly improved. Improvement **is measurable by several parameters** such as better air quality (humidity, air exchange rate, CO_2, VOC,.), even room temperature distribution (e.g. avoiding cold surface radiation through thermal insulation, automated heating system control), noise reduction, etc.

1 https://living-future.org/lbc/

2 https://www.wellcertified.com/

Please note: the rating was done in a very general way using literature research and personal experiences from building technicians. It applies to simple building geometries, etc. and represents a very rough guideline. There is no guarantee that the rating applies in every case. If you are planning to implement refurbishment measures, please consult a building energy expert and make an individual check of your building.

Type	Impact	Rating
Investment	*Small investments compared to building size*	€
	Moderate investments compared to building size	€ €
	Medium investments compared to building size	€ € €
	High investments compared to building size	€ € € €
	Very high investments compared to building size	€ € € € €
Payback time	*Less than 3 years*	↷
	3 to 5 years	↷ ↷
	5 to 10 years	↷ ↷ ↷
	10 to 20 years	↷ ↷ ↷ ↷
	beyond 20 years	↷ ↷ ↷ ↷ ↷
Implementation	*Easy to implement, almost no adaptations needed*	⚒
	Small adapations needed, minor modifications	⚒ ⚒
	Medium adaptions needed, interventions in one craft	⚒ ⚒ ⚒
	Large adaptations needed, interventions in some crafts	⚒ ⚒ ⚒ ⚒
	Very large adaptations, interventions in various crafts	⚒ ⚒ ⚒ ⚒ ⚒
Energy performance	*Small savings refered to energy of single measure, up to 5%*	
	Moderate savings refered to energy of single measure, up to 10%	
	Medium savings refered to energy of single measure, up to 20%	
	High savings refered to energy of single measure, up to 40%	
	Very high savings refered to energy of single measure, beyond 40%	
Indoor user comfort level	*No effect (no improvement compared to initial building condition)*	☺
	Moderate effect (slight improvement)	☺☺
	Big effect (several measureable effects - air quality, thermal comfort…)	☺☺☺

Table 1: Rating of measures

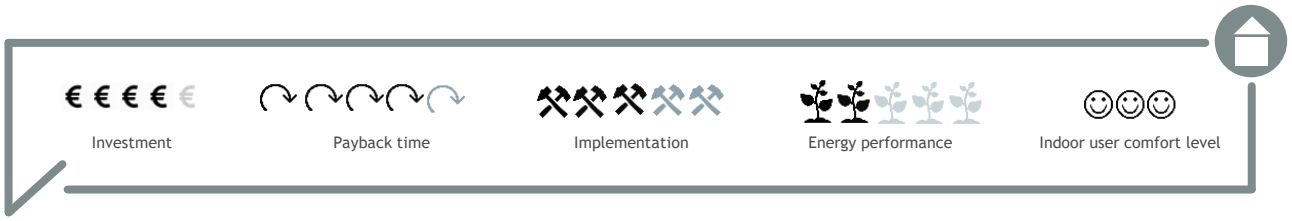
1.2. The energy renovation measures

This chapter provides an overview on energy renovation measures which aim to improve the energy efficiency of the building, the building quality and comfort and the use of RES. The described measures are:

- Measures at the building's envelope (e.g. thermal insulation of walls)
- Building technology (heating system, RES, lighting…)
- User behaviour

1.2.1. Building envelope

Renovation measures concerning the building envelope have always a high impact on the energy performance of the building. Relatively high investments are opposed to10-30 years of payback time due to savings in operating costs. Often the implementation of these measures affects more than one craft. Usually the comfort level for users is improved by implementing measures on the building envelope. Thermal insulation of walls, top floors, basement and window change may result in a better thermal comfort, since the cold radiation of different building parts can be reduced significantly (measurable by surface temperature).



1.2.1.1. Thermal insulation of walls

In several types of buildings, the surface area of external walls is high. In residential buildings the external walls contribute on average about 20-25% to the heat losses of a house. Measures in this craft have a high infect on the energy performance of the building and a low payback time. An external insulation brings many advantages (Austrian Federal Ministry for Sustainability and Tourism, 2014) as:

- To active the storage effect of the massive exterior components is retained. This can make the building inside cooler in summer (besides influence of shading) and keeps it warmer in winter. Larger insulation thicknesses up to 30 cm are possible (compared to inside insulation)
- To redesign the facade
- To reduce the temperature stresses in the supporting structure.

1.2.1.2. Thermal insulation of roofs

The isolation of roofs (and top floor ceilings) is an important renovation measure, because this architectonical element (for its geometry) has the lower thermal resistance value. This means high heat energy flows through it. In most residential buildings, top floor ceiling and roof account for up to 5-20% of the heating losses of a building. Measures in this craft have a good effect on the energy performance of the building and a low payback time. An insulation of the roof is therefore recommended as a particularly effective thermal modernization measure. The roof insulation can usually be accomplished at relatively low cost. (Austrian Federal Ministry for Sustainability and Tourism, 2014)

1.2.1.3. Thermal insulation of basement

Thermal insulation of the basement is a cost-effective way to save energy an usually implemented in energy renovations process. Not to be neglected is the coziness effect that occurs by avoiding "cold" floors in the ground floor rooms. If the basement is not used, e.g. for residential purposes, it might be enough to solely insulate the basement ceiling. (Austrian Federal Ministry for Sustainability and Tourism, 2014)

1.2.1.4. Change of windows and doors

Due to its area, windows and doors account for approximately 6-15% of the heat losses of a building, depending on the country (Austrian Federal Ministry for Sustainability and Tourism, 2014).Window exchange is a thermal modernisation measure with high investment costs and relatively low savings but a positive impact on the indoor comfort level. It's likely to happen that the investment never pays back in the window's lifetime. But it may differ from country to country. Windows glass typologies (single, double, triple…) changes in relation to the climate conditions: in winter season it should reduce the thermal losses but, at the same time, permit to gain the solar radiation, while in summer season this last effect should be minimum.

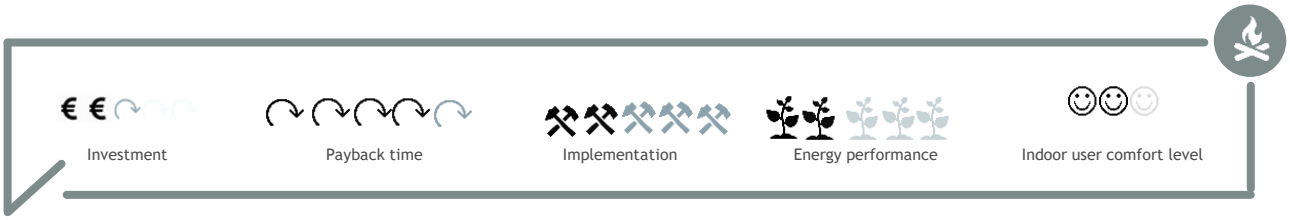
Please note:

- *The indoor humidity might increase, since these above described measures create a more airtight building. Additional measures such as controlled ventilation shall be evaluated.*
- *Avoid thermal bridges when implementing insulation measures (building edges, balconies, defective connection of windows with walls….)*

1.2.2. Building technology

1.2.2.1. Change of heating and domestic hot water system, cooling system and ventilation system

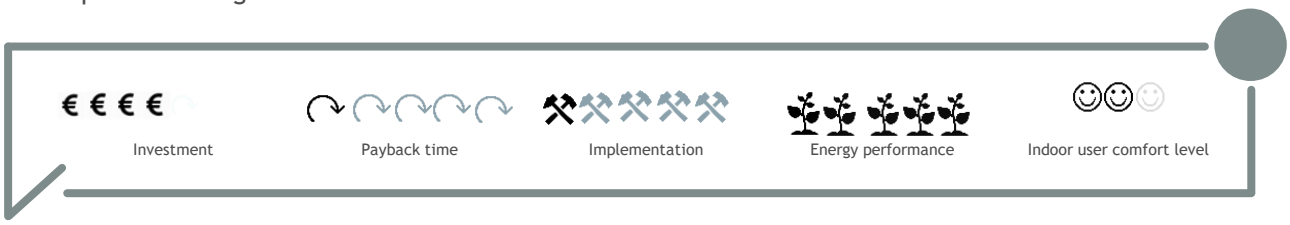
Measures in changing the heating, cooling or ventilation system are usually done by the end of the system's lifetime. If the energy carrier is switched and bigger construction works must be carried out, almost only then these measures have an economic profitability. It can be recommended to evaluate the heating system's condition after 15-20 years of operation. Changing the boiler, e.g. to new condensing boiler technology, it is often easy to apply. In general savings up to 20% are realistic[3]. A ventilation system requires an efficient heat exchanger to be economic profitable.



[3] Experiences of building experts of Energy Agency of Styria

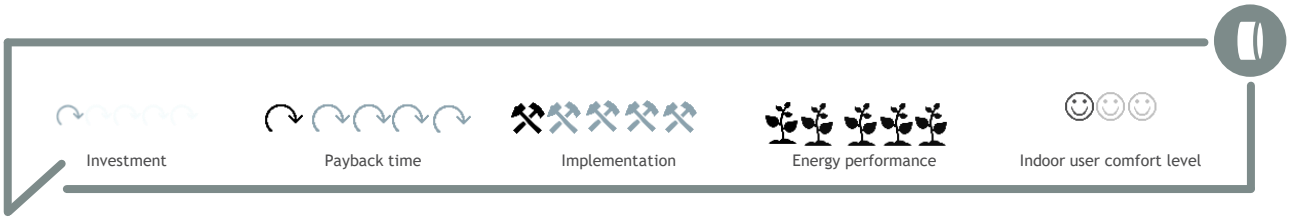
1.2.2.2. Change of heating distribution system

Change of heating distribution system from high (e.g. radiators) to low (e.g. floor heating) temperature distribution system more efficient permits to reduce the energy consumption and save moneys. This measure is often combined with the exchange of the heating system with a new one more efficient with low temperature delivery. (Paschotta, 2017) Nevertheless, the individual building's condition must be considered. Essential is that the heating system itself fits to the heat distribution system and the heat distribution system to the building. For instance, low temperature heating systems need enough surface to heat up the building.



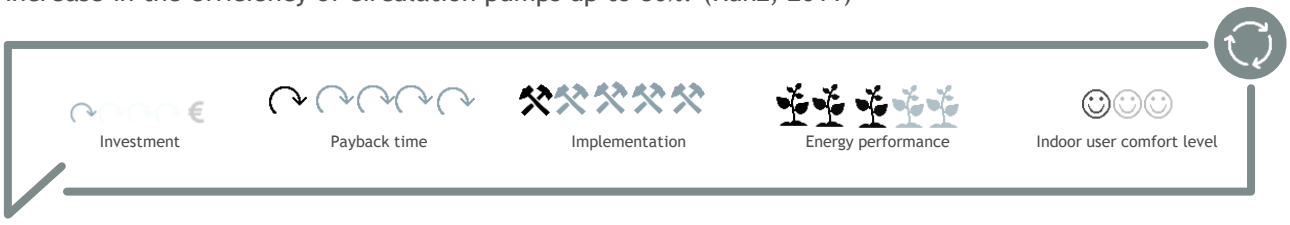
1.2.2.3. Insulation of heating distribution system

Optimizing the heating distribution system also includes the insulation of (visible) heating pipes. This measure gives high savings in energy compared to low investment costs.



1.2.2.4. Efficient circulation pumps

The change of old inefficient circulation pump hides major savings in electrical power. The reason is an increase in the efficiency of circulation pumps up to 80%. (Kunz, 2011)



1.2.2.5. Adding a ventilation system and/or cooling system

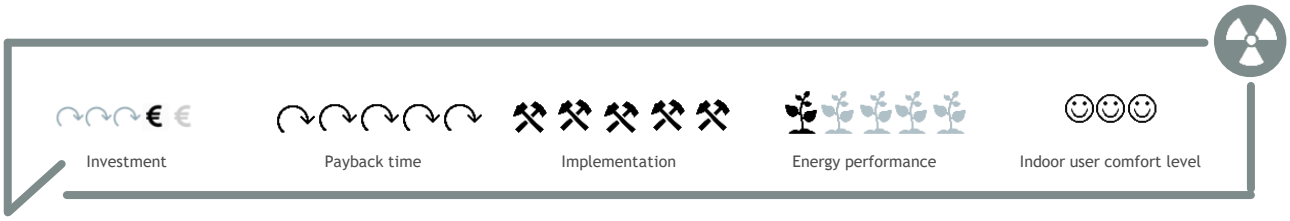
Adding a ventilation system with heat recovery system means in general no lower energy demands. In existing buildings, the ventilation changes depend on windows openings (status quo) that usually are lower than which one estimated. Comparing the energy demands of status quo and status renovated, where is present an automatic and continuous ventilations changes, the difference is very low together with the ventilation losses.

Besides adding a ventilation system means more indoor quality and comfort gains: it improves air quality, prevents mold and moisture, which ultimately affects the well-being and health of the users. It will be soundproofing. For example, those who are on a busy street can get fresh, mostly filtered air into their rooms via a ventilation system, without the noise being able to penetrate through open windows. Furthermore, usually installed air filters are also useful for people with allergies, as less dust and pollens get into the rooms.

Adding a cooling system in an existing building does not lower the energy demand of the building. It even raises the energy demand because there was no cooling done there before. Often central cooling systems are added with central ventilation systems. Renewable cooling possibilities are solar cooling, cooling with heat pumps and combining electric cooling systems with PV.

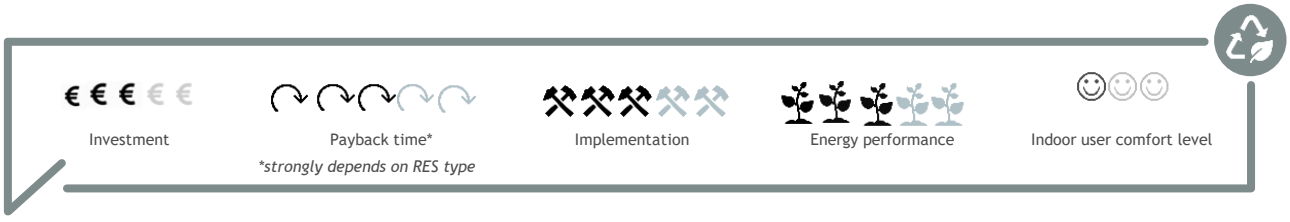
Apart from that the indoor quality will be increased because high temperatures in summer can be avoided.

Please take into account adding a cooling system is not necessarily an energy efficiency measure. It is often more profitable to add structural measures such as shading installations to avoid overheating in summer. Measures under 1.2.1 also help to keep indoor air cooler.



1.2.2.6. Renewable energy use

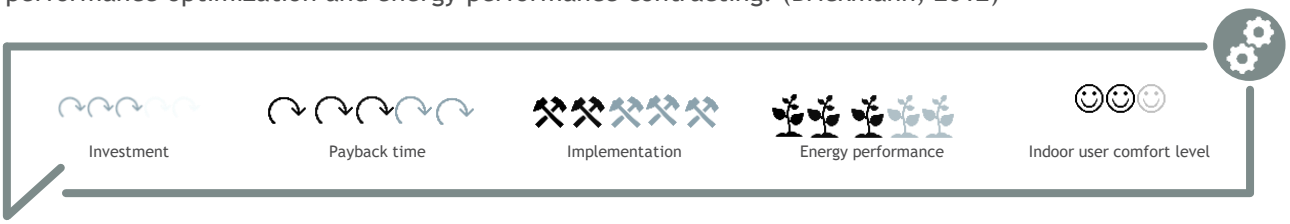
New renewable technologies are often not that easy to implement in existing building structures, although they may be necessary to achieve nZEB standard. With a good design of the energy system the energy performance of the building can be increased significantly. Adding these systems include high investment costs and a medium payback time.



- Photovoltaic
- Storage battery (currently very high amortisation times/no amortisation)
- Solar thermal energy
- Heat pumps and biomass boilers (implementation efforts depends on existing system)

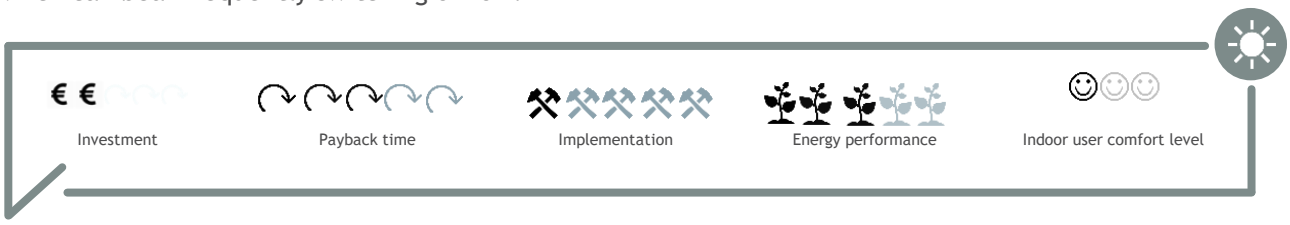
1.2.2.7. Implementation of building automation and building management system

Building automation is an essential element in the realization of sustainable energy efficiency in buildings. By optimizing various systems such as HVAC and lighting systems in conjunction with their automation, energy savings of up to 70% are mentioned in theory. However the savings in practice strongly depend on factors like building quality and the implemented technologies. In addition, various smart measures, strategies and services can significantly improve results. Examples of well-proven models include building performance optimization and energy performance contracting. (Brickmann, 2012)



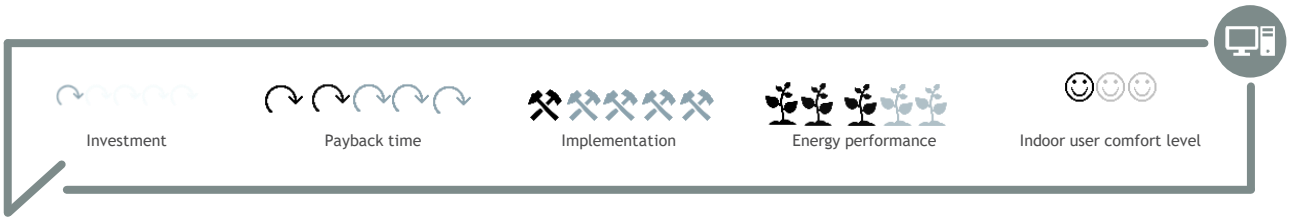
1.2.2.8. Lightning

Lighting is a major electricity consumer and causes a significant portion of the maintenance costs in many buildings. Worldwide, about 20-30% of the electrical energy used for buildings is needed for lighting, and by 2030 an increase of about 80% is forecast. In addition, the artificial lighting in buildings currently causes about 15 to 25% of the cooling loads (Pohl, 2010). Savings in electrical energy up to 70% are feasible by using energy efficient lighting technologies such as LED (licht.de, 2018). For showcases and other external lighting twilight switches reduce the use of energy. When changing bulbs it should be considered to take models which can bear frequently switching on/off.



1.2.2.9. Change of electric appliances

Measures in changing electric appliances to more energy efficient ones are usually done at the end of the system lifetime. Almost only then these measures have an economic profitability.



- Refrigerator/dishwasher in office kitchen
- Old printers and old PC
- Efficient circulation pumps
- Efficient elevators

1.2.3. User behaviour

These measures are feasible with low budget and have a high impact on the energy performance. User behaviour has a high impact, especially in buildings used by many people. User behaviour influences the heating demand, the cooling demand, electric power, and fuel. Methods for realizations can be workshops for the users or visual hints like stickers on light switches or radiators. Although these measures are easy to implement in theory, it can be much more difficult in practice. Experienced trainers/coaches for these topics may help.

- Heating, ventilation, lights, windows
- Fuel-saving training
- Energy efficiency for electric devices (avoid stand-by, efficiency programme of dishwasher, adequate temperature in refrigerator…)
- Avoid unnecessary printing

2. Financial aspects: innovative financing schemes

Following, three types of innovative financing schemes for deep renovation of public buildings will be described and one case study per financing form given:

- Public Private Partnership (PPP)
- Energy Performance Contracting as form of PPP
- Crowd Funding (CF)

All three approaches will be tested within the eCentral project in three different countries (Croatia, Hungary and Slovenia) until the year 2021. Due to the fact that the legal framework may vary from country to country (if it already exists), the authors decided to exclude this information if possible, since responsible project partners in the target country have to prepare reports on financing scheme implementation anyways. This report can be supplemented with this information after the three nZEB renovations were conducted (2021). Additionally, this report serves as base for DT1.5.2 assessment of policy framework in CE partner countries.

A general regulation on public procurement already exists within the European Union, which must be fulfilled. Public tenders and public procurement have a very strong impact on the economic performance in Europe: in 2011 approximately 19% of the EU's GDP or € 2406 Billion was the volume of public procurement markets. In this term, some harmonised regulations for the tender processes were developed by the European Commission to ensure a fair environment for all businesses across Europe. The following European regulations, already adapted on national levels, apply for the public procurement market (Wirtschaftskammer Österreich, 2015):

- Directive 2014/24/EU on public procurement

- Directive 2014/25/EU on procurement by entities operating in the water, energy, transport and postal service sector
- Directive 2014/23/EU on the award of concession contract

These directives regulate subject-matter and definitions, thresholds, exclusions, e-procurement, specific situations such as subsidised contracts or research services and rules on public contracts. Additionally, the European Commission revised its public procurement strategy in the end of 2017, defining six priorities for efficient procurement (European Commission, 2018):

- Ensuring wider uptake of innovative, green and social procurement: weaken the principle of choosing the cheapest bidder and encourage quality and sustainability
- Professionalising public buyers: training of public buyers to avoid lack of compliance with public procurement rules
- Increase access to procurement markets: make markets accessible for SMEs
- Improve transparency, integrity and data: improved and accessible data on public procurement will optimise market interactions
- Boost digital transformation of procurement: improving of e-procurement tools such as eCertis, ESPD, etc.
- Cooperating to procure together: encourage contracting authorities to carry out cooperative procurements: buying in bulk can lead to better prices and higher quality

In addition, other European Directives may also effect these three financing schemes. For example, the Directive 2012/27/EU about energy efficiency lists in Annex XIII items which must be included in energy performance contracts (see chapter 2.2**Error! Reference source not found.**).

2.1. Public Private Partnership (PPP)

PPPs can contribute to economic growth and sustainable development in the European Union.

According to the Organisation for Economic Co-operation and Development (OECD, 2018) a "public-private-partnership" is an agreement between the government and one or more private partners (which may include the operators and the financers). The private partners deliver the service in such a manner that the service delivery objectives of the government are aligned with the profit objectives of the private partners. The effectiveness of the alignment depends on the sufficient transfer of risk to the private partners". Additionally, PPP is based on a long-term relationship (at least three years).

More precise, (EUROSTAT, 2013) claims that PPPs involve substantial capital expenditure to implement the project by a private partner, which then operates and manages the project to produce or deliver services to the public. At the end of the contract, the public partner usually acquires legal ownership of the project (e.g. infrastructure or other fixed assets like public services).

The basic structure of a PPP can be seen in the next figure. In contrast to traditional public procurement, the government commissions a private partner, which is then responsible for all further actions. At traditional public procurement, the public party must fully take care of the implementation of the project.

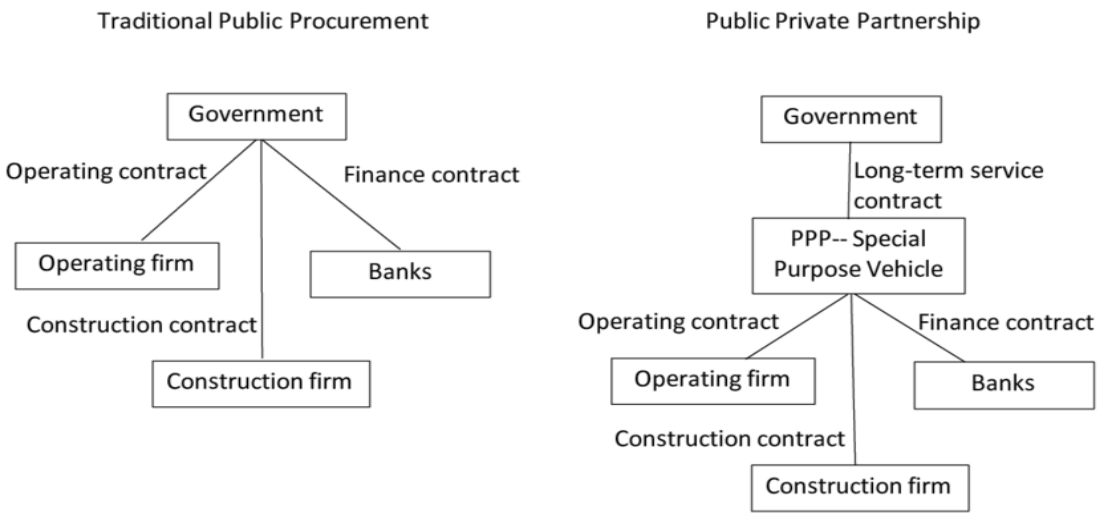


Figure 1: Scheme of PPP (Hui Jin, Isabel Rial, 2018)

PPP have different manifestations, depending on type of PPP. When building a PPP the public partner defines the required quality and quantity and allows the private partner to implement actions according to this framework (Corner, 2006). The picture below shows the different shapes of these partnerships and the risk allocation. The higher the degree of privatization, the more is the risk reduced for the public party.

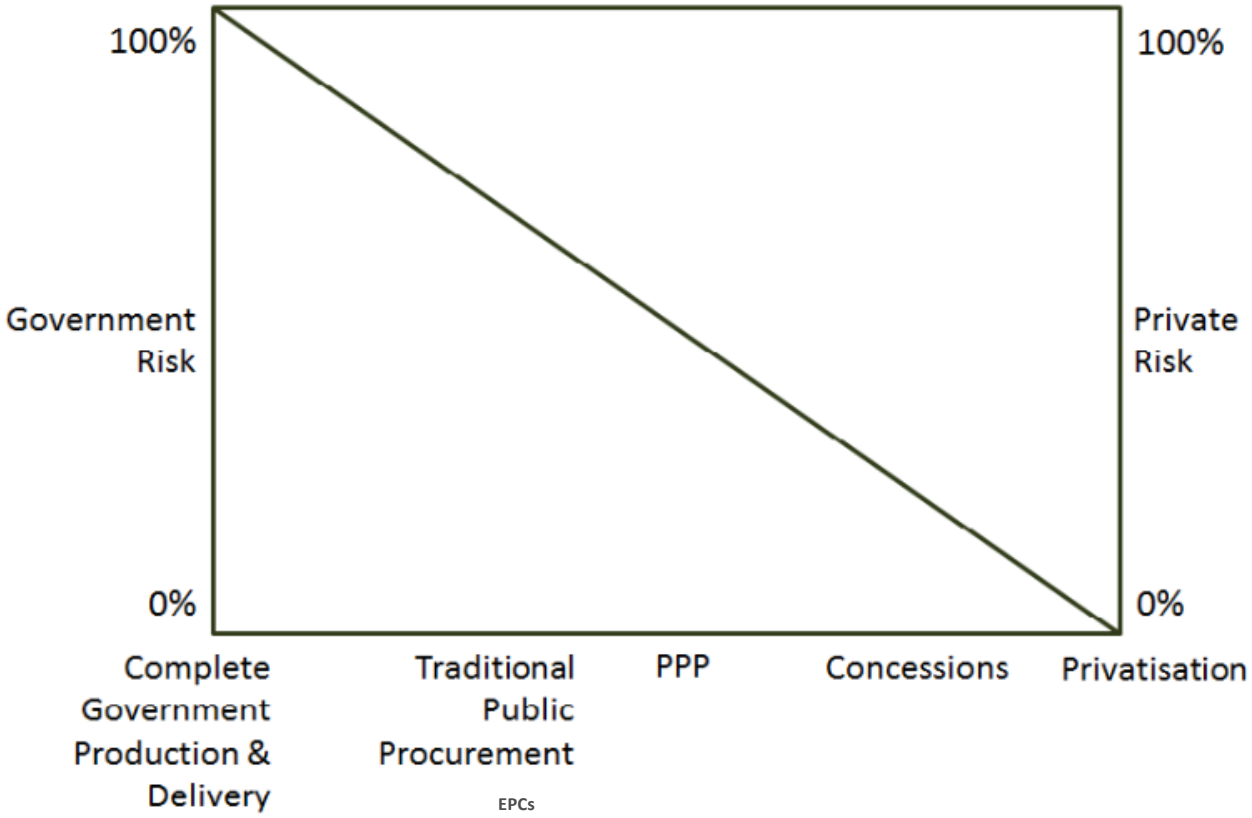


Figure 2: different combinations of public and private partnerships, classified according to risk and type (OECD, 2018)

As shown in the picture above, the types of partnerships can basically be divided into:

- Complete government production and service
  - All actions are completely carried out by governmental institutions
- Traditional public procurement
  - Private partners, chosen by tender processes, deliver certain services, etc.
- Public Private Partnerships PPPs (as well as EPCs as form of PPP)
  - The private company finances, maintains and operates the project and is paid for it. The project e.g. building reverts to the control/ownership of the public sector at the end of the contract term
- Concessions
  - Can be considered as type of PPP
- Privatization
  - Full responsibility for service/project is given from public to private partner

The main difference or advantage of PPP versus traditional public procurement is the lack of needed initial investment. The major investment in the beginning is done by the private partner, whereas the

public contractor pays a certain fee on a regular basis over the contracting time. This allows public institutions to distribute expenses over a longer period, which may have positive influence on public accounts. The basic principle is shown in the next figure. PPP's usually require a lower initial capital contribution by the public party, which may result in higher operating costs (additional costs for service fee for private partner, etc.)… The detailed cost allocation depends on the contractual arrangement between the involved parties.

In literature it is recommended to already have sufficient or major public monetary resources before commencing PPP models for keeping the financial part of the project in public responsibility. Although the financial liabilities can be outsourced and considered as off-balance sheet in certain cases, they are still present and affect the public budget for a long-term. In addition, public parties usually get cheaper financing from banks, since they usually have a better rating (creditworthiness) than private companies.

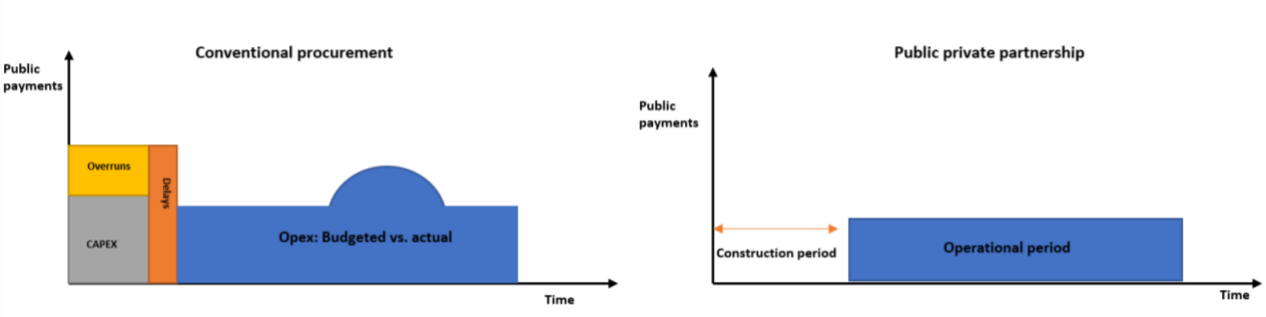


Figure 3: Conventional public procurement vs. PPP, own illustration based on (Loay, 2012)

2.1.1. Impact of PPP on the public balance

In public accounts, assets constructed under PPP contracts can be recorded **on or off government balance sheet.** In the case that the asset is recorded on government balance sheet, initial investment in the beginning is recorded for government during the period of construction, with a negative impact on government deficit/surplus. An increase in government debt is also recorded for the same amount.

In the case that the asset is recorded off government balance sheet, the impact on government deficit will be limited to the regular service fees paid to the partner, which are spread over the long-term contract and no debt impact will be recorded.

The possibility of off-balance sheet recording makes the use of PPPs very attractive for undertaking investments while complying with the deficit threshold established in the Maastricht Treaty (EUROSTAT, n/a).

When apply the rules of the Maastricht Treaty? The assets as well as the initial investment is allocated to the partner, which bears the majority of the risks. PPPs are classified as off balance sheet for the public sector, if:

- construction risk is born by the private partner **and**
- either the availability risk or the demand risk is born by the private partner.

A construction risk is considered as "risk of delay in construction, cost overruns, failure to obtain permits…", availability risk can mean that "assets are not provided according to the agreed standards" and a demand risk includes that the provided service may not be accepted by end users (e.g. few users on highways..). (EUROSTAT, 2013)

These risks must be analysed beforehand to be able to decide, which partner has to allocate the asset. The "European system of accounts – ESA 2010" provides obligatory rules for the correct asset allocation and implementation of PPP contracts. The national statistical institutes of each member states (list of national institutes available at Eurostat) analyse PPP contracts and decide on their sector classification following the statistical rules of ESA 2010. If the national institutes are in need of clarification for PPP contracts, Eurostat can provide advices in terms of "pre-implementation" and statistical treatment of an already implemented contract. (EUROSTAT, n/a)

2.1.2. Different forms of PPP

The following chapter provides an overview about the most common forms of PPP. The exact definition of a PPP contract depends on the extent of involvement of different parties and the risk taken by the private partner. The PPP is usually defined in an agreement or contract between the public and private partners, were responsibilities and requirements are written down and the risks allocated.

The following figure provides a rough overview on different PPPs, provided by the World Bank group. The main forms of PPP can be divided into four different types:

- Management and operating agreements (World Bank Group, 2018):
  - Public party contracts a private company for implementing certain services or actions; private party is paid by a fixed fee
  - Generally short term (2-5years)
  - Public party bears risk of asset condition
  - Agreements can be performance-based, oblige the private party to maintain the assets and to take over some operation risks
  - Commonly used in Europe for waste water management, waste disposal etc.
- Leases contracts (Worl Bank Group, 2016):
  - Public party as owner of the assets contracts a private company as operator. A part of the incomes out of the operation is paid back by the private company to the public contractor, the remains are retained by the operator.
  - Usually the fee for lease is fixed, the private operator takes risk on income collection (e.g. charging of customers...)
  - Public contractor remains responsible for financing and managing investments in the assets
  - Usual contracting durations of 8-15 years
  - Commonly used in Middle Eastern Countries and Africa for water and sanitation services
- Concessions (World Bank Group, 2018):
  - Public party gives a private "concessionaire" the long term right to use all utility assets conferred on the concessionaire, including responsibility for operations, maintenance and some investments
  - Concessions can be given for existing assets, an existing utility, or for extensive rehabilitation and extension of an existing asset
  - Concessionaire takes risk of condition of asset and risk on income collection

  - Usual contracting durations of 25-30 years (possibility to amortize major initial investments)
  - Concessions are usually given for infrastructure services e.g. operating a road, a railway network, etc.
- Contracting models such as Energy performance Contracting (see chapter 2.2)
- Build Operate Transfer (BOT) – type of concession (World Bank Group, 2018):
  - Private contractor receives a concession from the public entity to finance and construct the utility or system and operate it commercially until the end of the project period. Afterwards the public contractor takes over the facility
  - Private operator obtains its revenues usually by charging the public contractor
  - Private entity bears a substantial part of the risk
  - Long-term contracting durations of 25-30 years (possibility to amortize major initial investments)
  - Typically used to develop a generally new (greenfield) discrete asset
- Further variations of concessions: the following forms can be advantageous forms of financing projects, depending on the external circumstances. These forms provide possibilities to lower political risks (e.g. in developing countries), technical risks (e.g. unforeseen construction conditions) and financing risks (e.g. foreign currencies, market risks, etc.) There are several more forms available, the most common known ones are listed below.
  - DBO (design-build-operate): public contractor owns and finances construction of new assets, private contractor designs, builds and operates it (World Bank Group, 2018)
  - BOOT (build-own-operate-transfer): private contractor additionally owns the asset during the concession period and the ownership is transferred back to the public authority (Marquard & Bahls AG, n/a)
  - BOO (build-own-operate): ownership remains at the private company (TechTarget, 2009)
  - BLT (build-lease-transfer): private company builds the project and leases it to public entities. After the end of the leasing period, ownership is transferred to the government (Business Dictionary, n/a)
  - DBFO (design-build-finance-operate): similar to BOOT, but no ownership transfer (public entity is owner over the project period). (Thomson Reuters, 2018)

The above mentioned matters are graphically summarized in the figure below. The extent of private sector participation rises with different financing schemes from left to right.

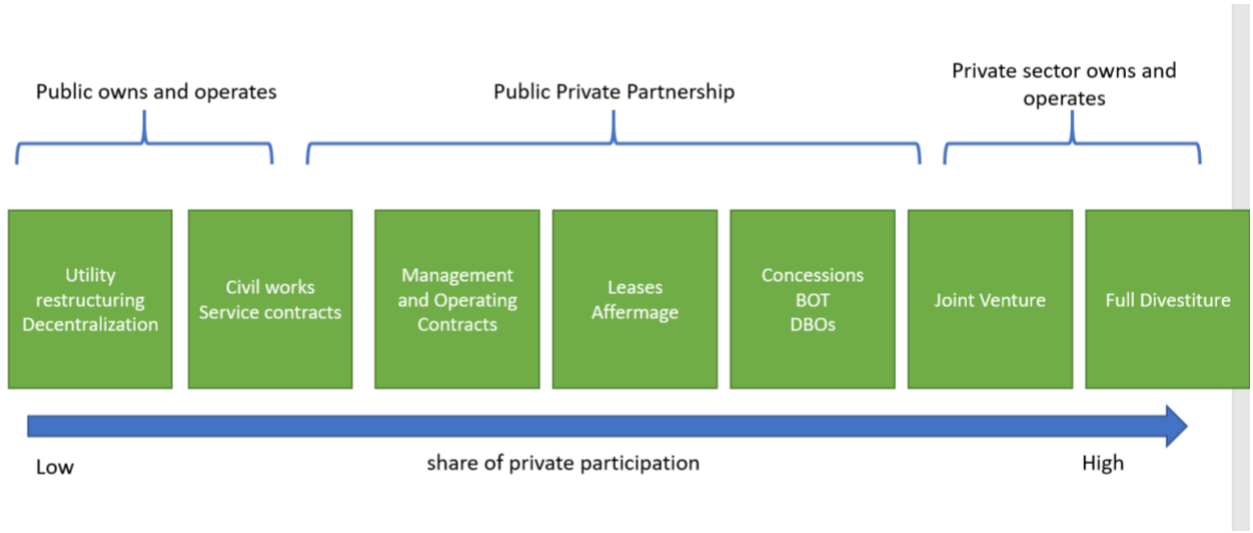


Figure 4: Basic variations of agreements, own illustration based on (World Bank Group, 2016)

The table below gives an overview on the base models. Usually, these base models never occur in their pure form on the market. More common are mixed variations. Basically the table shows the share of private participation in different project phases:

Model	Ownership	Operation	Financing
Operating model (e.g. BOT)	private/public	private	private
Cooperation model (e.g. management and operating agreements)	private/public	private/public	private/public
Concession model	private	private/public	private/public
Contracting model (e.g. EPC)	private/public	private	private
Leasing model	private	private/public	private/public

Table 2: Overview on PPP standard models (Jedelhauser & Kaufmann, n.y.)

2.1.3. Advantages

PPP can offer several advantages for participating parties (Wilfried & Weingärtler, 2008), (World Bank Group, 2016)

- Use of private know-how
  - Extent of needed private know-how depends on public body, e.g. if a small municipality needs to carry out a one-time project (building of a new school or sewage treatment plant...), private partners such as construction companies may have superior knowledge

- PPP can be used to gradually expose state owned enterprises and government to increasing levels of private sector participation (transfer of skills…)
- Governments can abstract from concrete management and focus on results

- Use of innovation potential
  - Traditional public tenders usually consider the actual state-of-the-art. Requirements of tenders must be fulfilled quite strict during the implementation phase. This can be an advantage of PPP: if potential efficiency increase possibilities occur during the planning and implementation phase of a project, private partners can take these possibilities easier.
  - Private sector technology and innovation are introduced to public infrastructure, which may result in better operational efficiency
- Lifecycle-oriented project development and budgetary certainty
  - In PPP projects it is state of the art to consider lifecycle-costs of a project. This guarantees to find the cost-optimal solution
  - Improved budgetary certainty for present and future project costs
- Renegotiation in public tenders
  - In public tenders it is very difficult or even inadmissible to renegotiate contracts and costs. Private partners don't underline these rules and can try to achieve cost advantages through negotiations
- PPP is an incentive for private sector to deliver in time and within budget
- PPP can be seen as way for developing local private sector capabilities through joint ventures with large international firms, as well as sub-contracting opportunities for local firms in areas such as civil works, electrical works,….
- risk transfer to the private sector over the life of the project – from design/ construction to operations/ maintenance
- Supplemented limited public sector capacities, increased and earlier provision of infrastructure (expectations of public services haven risen steadily)
- Lower initial capital contribution by the government (deferring spending, without deferring the benefit, lower immediate impact on government borrowing)
  - Short-term public fiscal targets can be reached (tempting for cash-strapped governments)
- Accounting framework (ESA 2010)[4] allows public involvement in PPPs, under certain conditions, to be registered as off-balance sheet items. This incentivises their use for enhanced compliance with the Euro Convergence Criteria, also known as the Maastricht criteria[5]

4 Regulation (EU) No 549/2013 of the European Parliament and of the Council of 21 May 2013 on the European system of national and regional accounts in the European Union (ESA 2010) (OJ L 174, 26.6.2013, p. 1), applicable to all Member States as of September 2014.

5 https://www.eca.europa.eu/Lists/ECADocuments/SR18_09/SR_PPP_EN.pdf

2.1.4. Disadvantages and risks

The most common disadvantages and risks of PPPs are mentioned and described below. (World Bank Group, 2016)

- High transaction costs boost project volume (Development, procurement (bidding process), contract management, termination management). Additionally, private partner has to make a profit, so projects are more likely to be expensive. The public partner must determine if the greater costs involved are justified
- Off-balance sheet debt creates contingent and future liabilities – reduces budget flexibility in the long term
- Private sector will do what it is paid to do and no more than that – therefore incentives and performance requirements need to be clearly set out in the contract. Focus should be on performance requirements that are out-put based and relatively easy to monitor
- Government responsibility continues – citizens will continue to hold government accountable for quality of utility services. Government will also need to retain sufficient expertise, whether the implementing agency and/ or via a regulatory body, to be able to understand the PPP arrangements, to carry out its own obligations under the PPP agreement and to monitor performance of the private sector and enforce its obligations
- A clear legal and regulatory framework is crucial to achieve a sustainable solution
- The private sector is likely to have more expertise and after a short time have an advantage in the data relating to the project. It is important to ensure that there are clear and detailed reporting requirements imposed on the private operator to reduce this potential imbalance
- Renegotiation is common and tend to favour private partners (55% of all PPPs are renegotiated, in average every 2 years (tariff increase, concession fee decrease, decrease of the private company's obligations…)

2.1.5. General information on legal framework

Legal frameworks, which must be considered when implementing PPP depends on the country of implementation. Below a list consisting of possibly relevant legal matters for infrastructure PPP projects. The list was created by the World Bank (World Bank Group, 2016):

- General Legislation
  - PPP Laws/Concessions Laws
  - Privatization Laws
  - Legal Frameworks for Project Companies under Civil Law
  - Insolvency Laws
  - Anti-Corruption/Freedom of Information Laws
  - Procurement Laws
  - Theft and Non-technical Losses
- Sector specific legislation
  - Energy Law and Regulation
  - Telecoms Law, Regulations and Licenses

- Water Laws and Regulation
- Regulatory Framework for PPPs in Roads
- Railway Laws and Regulations

Since every eCentral project partner country will implement different forms of financing schemes in the pilot renovations in WP T3, they really need to consider the legal requirements. The assessment of the policy framework in the target regions is the base for successful pilot renovations and will be processed in follow up deliverable DT1.5.2.

2.1.6. Case study of successful PPP for renovating buildings

The following two case study provide information on successfully implemented PPP projects in Croatia for renovating an old county palace and for building a new school.

2.1.6.1. Reconstruction of the Varaždin County Palace

The renovation of the County Palace took place in 2006 and was the first example of PPP in renovating cultural heritage in Croatia. Pictures of the reconstructed county palace are available on Google.

As already mentioned, the public-private-partnership scheme has never been used for reconstructing a public building. Therefore, the county used it as a pilot project which was supposed to test the market and create a potential pipeline of future PPP energy renovation projects. The advantage for the public partner in this case was that the private partner bore all technical risks in this investment, which was an important factor with reconstruction of cultural heritage buildings. Also, due to budgetary constraints regarding county's borrowing capacity for capital investments PPP model was more desirable as it was not recorded as an increase of public debt. (Agencija za investicije i konkurentnost, n/a).

Contract data	
Public partner:	Varaždin County
Private partner:	Meteor-Privatno Partnerstvo d.o.o
Year of the contract signature:	2006
Expected duration of the contract:	20 years
Building owner:	Private partner for 20 years, afterwards public partner is building owner (construction land is always owned by public partner)
Subject of the contract:	Granting exclusive building rights for the use of construction land and financing, designing, reconstructing, managing and maintaining the county's building
Charge paid by public partner to a private partner per month:	104.101 HRK (~13.880 EUR) → rent of building
Charge paid by private partner to a public partner per year:	1 HRK (~0,13 EUR) → Use of construction land
Capital expenditures of the project:	8.976.983 HRK (~1.196.931 EUR) - fully covered by the private partner
Building data	
Annual energy need for heating demand	139 kWh/m²a

Energy class	D
Heated net floor area	1.975 m^2
Gross heated volume	11.121 m^3
Factor for the building's shape	0,37 m^{-1}

2.1.6.2. Construction of the Gymnasium ''Fran Galović'', City of Koprivnica

Main reason to choose public-private-partnership scheme in this case was inability to finance project in classical ways (own incomes, state budget, credit). The advantages of PPP in this case were that PPP ensures achievement of the goal (construction of the building), maximally protects public interest, private sector finances the construction, ensures contracted quality in 25 years period, ensures achievement of the optimal costs of construction and maintenance. (Agencija za investicije i konkurentnost, n/a). Pictures of the Gymnasium 'Fran Galović' are available on Google.

Contract data	
Public partner:	Koprivnica-Križevci County and City of Koprivnica
Private partner:	TEHNIKA SPV d.o.o.
Year of the contract signature:	2006
Expected duration of the contract:	25 years
Building owner:	Private partner for 25 years, afterwards public partner (City of Koprivnica) is building owner (construction land is always owned by public partner)
Subject of the contract:	Granting exclusive building rights for the use of construction land and financing, designing, building, managing and maintaining the school and renting a school building
Charge paid by public partner to a private partner per month:	545.741 HRK (~72.765 EUR) Koprivnica-Križevci County and 298.644 HRK (~39.819 EUR) City of Koprivnica) → rent and operation costs of building
Charge paid by private partner to public partner per month:	43.849 HRK (~5.846 EUR) to City of Koprivnica → Use of construction land
Capital expenditures of the project:	69.566.786 HRK (~9.275.571 EUR) - fully covered by the private partner
Building data	
Annual energy needs for heating demand	43 kWh/m^2a
Energy class	B
Heated net floor area	5.412 m^2
Gross heated volume	25.920 m^3
Factor for the building's shape	0,23 m^{-1}

Table 3: Overview on contract data

2.2. Energy Performance Contracting (EPC)

2.2.1. EPC at EU level

The European Directive 2012/27/EU on energy efficiency declares in Article 18 that member states shall promote the energy services market and access for SMEs to this market e.g. by disseminating clear and easily accessible information on energy service contracts, financial instruments and other support to energy efficiency service projects, encouraging development of quality labels and supporting the public sector in taking up energy service offers, in particular for refurbishments. Therefore, the European Commission defined a contract model for energy performance contracting. The contract must include at least the following items (European Commission, 2012):

- Clear and transparent list of the efficiency measures to be implemented or the efficiency results to be obtained;
- Guaranteed savings to be achieved by implementing the measures of the contract;
- Duration and milestones of the contract, terms and period of notice;
- Clear and transparent list of the obligations of each contracting party;
- Reference date(s) to establish achieved savings;
- Clear and transparent list of steps to be performed to implement a measure or package of measures and, where relevant, associated costs;
- Obligation to fully implement the measures in the contract and documentation of all changes made during the project;
- Regulations specifying the inclusion of equivalent requirements in any subcontracting with third parties;
- Clear and transparent display of financial implications of the project and distribution of the share of both parties in the monetary savings achieved (i.e. remuneration of the service provider);
- Clear and transparent provisions on measurement and verification of the guaranteed savings achieved, quality checks and guarantees;
- Provisions clarifying the procedure to deal with changing framework conditions that affect the content and the outcome of the contract (i.e. changing energy prices, use intensity of an installation);
- Detailed information on the obligations of each of the contracting party and of the penalties for their breach.

Other legal requirements concerning national regulations will be described for each eCentral project partner country in the follow-up deliverable *D.T1.5.2 "Assessment of policy framework in CE target countries"*.

Especially when it comes to public authorities' energy costs are one of the most unpredictable costs of the financial sector. Since the national building standard of the EU-regions should decrease its energy demand in the next two to three decades it is necessary to overcome organisational and economical barriers as well as the lack of technical know-how, with modern organisational structures such as energy performance contracting. The aim of such operator-user cooperation is the improvement of the energy efficiency of a building as well as alongside the energy conversion chain (Schäfer, 2016).

The EU commission declares in a definition that EPC is a form of creative financing for capital improvement which allows funding energy upgrades from cost reductions. An external organisation (Energy Service Company - ESCO) introduces measures to reach energy efficiency or implements renewable energy projects.

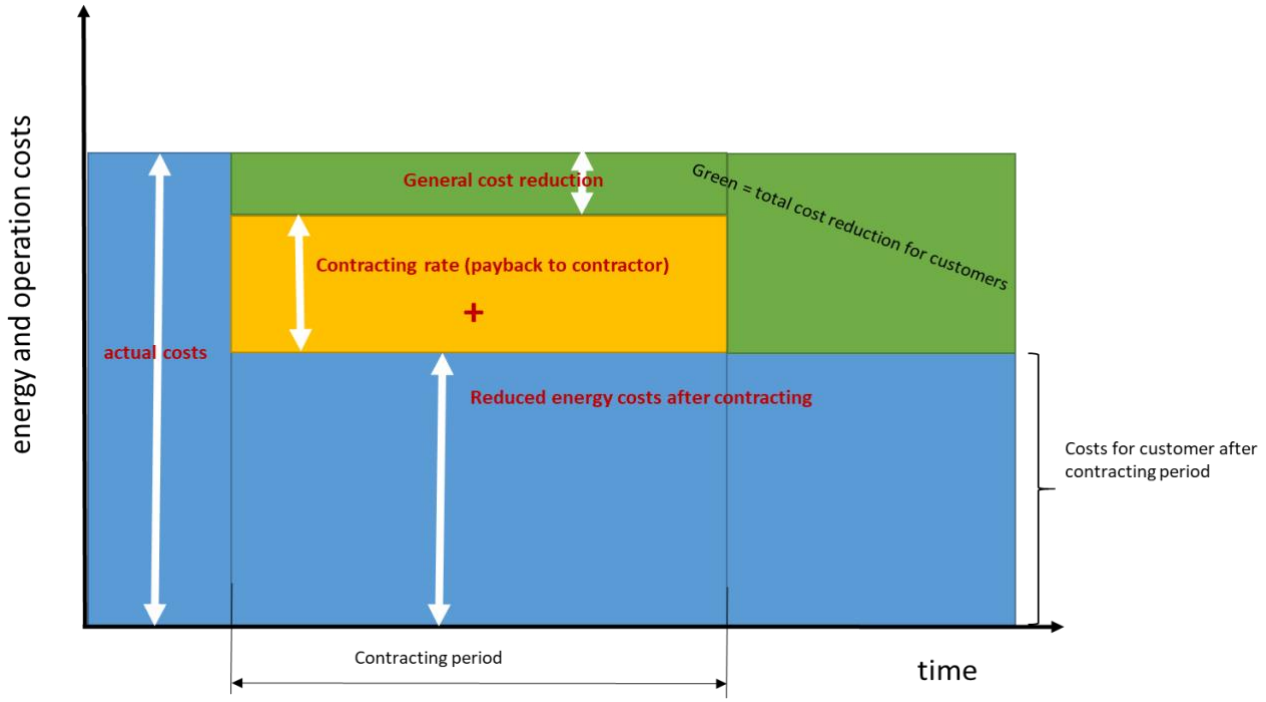


Figure 5: Basic scheme energy performance contracting, own illustration based on (European Commission, 2018)

The main idea is to use the surplus of income from the cost savings to repay the projects costs, including the investment costs. It is essential that the ESCO won't receive any payment, unless the ESCO cannot provide the guaranteed savings. The approach shifts the technical risks from the host to the ESCO on performance guarantees given by the ESCO. Basically, the ESCO's remuneration depends of the performance in terms of energy savings throughout the contracting period. The main idea is to overcome the lack of energy engineering skills, manpower or management skills to implement infrastructural improvements onto owned facilities (European Commission, 2018). EPC financing is a form of PPP. The basic financial concept of EPC as described above is shown in the figure below.

The figure below outlines the classic scheme of an energy contracting model. One party, the host institution, hires the contractor (e.g. an energy service company) to take over the whole operation of an energy facility, to overcome the lack of technical knowledge of the building owner.

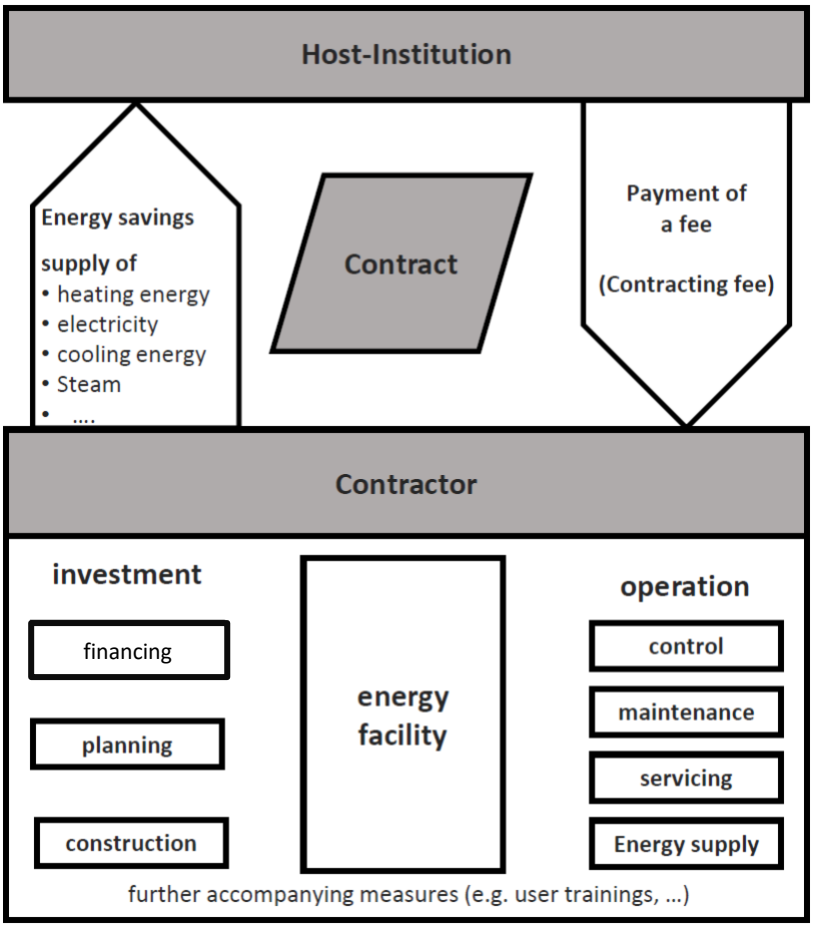


Figure 6: Basic Contracting Idea (own illustration based on Schäfer, 2016)

The authors (Hilke & Ryan, 2012) describe energy performance contracting as a way of financing energy efficiency projects. It contains an ESCO, which is able to provide a range of services including financing in some cases, and usually will guarantee energy savings of a certain amount. The remuneration of the ESCO depends on the achievement of the guaranteed savings. As the guarantor of the savings, the ESCO remains involved in measuring and verifying the savings during the debt repayment period. ESCOs may also provide other forms of contracting, such as "chauffage", "first-out", "Built-Own-Operate-Transfer" or leasing contracts (see next chapter for details). Generally energy performance contracting (EPC) are mostly found in the public sectors. Nevertheless, there are some examples of existing EPC's in the industrial and commercial building sectors.

Energy Performance Contracting should be considered if one of the following conditions applies (klimaaktiv, 2016):

- Energy costs are very high or steadily increasing;
- Energy saving potentials are available, but the volume is reduced for an autonomous contracting project:
  - Roughly, from annual energy costs of €20.000 EPC can be a good option (economic minimal size);

- Ancillary costs for organising EPC (costs for contract, legal consultations, notary, etc.) can be high;
- If the contracting volume for one single building is too small, try to pool several buildings for reaching the economic level (to reach economic minimum size of € 20.000);

- No sufficient own resources available (personal, time, know-how, financial, etc.).

The contractor should have the following characteristics for ensuring an efficient and adequate implementation of the contracting issue:

- Know how in the fields of building planning, energy planning, building services and cross craft knowledge;
- Necessary trade law rights for offering energy performance contracting;
- Demand already implemented reference objects of the contractor for its services.

2.2.2. Types of energy performance contracting

Generally, there are various ways of structuring an energy performance contracting such as

- *First out*:
  - ESCO investment is 100% paid by achieved energy savings;
  - Contract duration depends on level of savings, but will last until ESCO is fully repaid;
- *Guaranteed savings*:
  - ESCO guarantees performance, customer has credit risk and repays loan by achieved savings;
  - If guaranteed savings are not achieved, ESCO has to pay for debt difference;
  - If guaranteed savings are exceeded, customers pays negotiated fee to ESCO;
- *Shared savings:*
  - Customer takes over some performance risk, ESCO takes customer's credit risk;
- *Chauffage* (form of energy management outsourcing):
  - ESCO only takes responsibility for energy service (e.g. space heat..) and installs efficiency measures;
  - Different forms possible: pure chauffage model may only include efficiency measures on the supply side, whereas integrated models combine measures/physical investments on the supply and demand side;
  - Customer pays as much as before minus a percentage saving for defined contracting time (up to 25 years).

The most frequent ways of organizing an energy performance contracting is 'first out' or 'guaranteed savings'. In both cases all contractor's costs (e.g. equipment, installation, mark-up, fees, …) are repaid through the savings within the contracting process. The usual period of time for such contracts is four to eight years. Within the contract period all costs shall be paid for. In both energy performance contracting versions, it is possible to add extra measures throughout the contracting progress leading to increased savings to cover higher costs (International Institute for Sustainable Development, n.a.).

Another type of contracting model is commonly known as 'shared savings'. The customer and the contractor agree, that the customer pays a contracting rate to the ESCO, which is lower than the annual achieved energy saving costs. This means that the customer pays immediately less for the energy, whereas the ESCO

gets a fee. Investment costs are usually carried by the ESCO and the customer has no duty to pay off those costs. In return, the performance contractor is not obliged to give a performance guarantee throughout the contracting process. Those contract periods last usually up to ten years, because the investments need a longer period of time to pay off. In this EPC version the risks for the contractor are considered to be higher (International Institute for Sustainable Development, n.a.).

The last form of EPC is called 'chauffage' or full energy/environmental services contract. The principle behind this contracting version is, that a performance contractor takes over the whole administration of the customer's utility or production facility in terms of operating them in an (energy) efficient way. The host institution usually pays the contractor the amount of the (energy) bills before the contractor takes over. It also can be a random fee, which has been negotiated between both parties. This form of EPC was founded in Europe, where the complete management of a building or facility by a contractor is more common (International Institute for Sustainable Development, n.a.).

Typical energy performance contracting models usually have characteristics such as

- time-limited cooperation between contractor and the host institutions on a contract basis, which defines the duties of each participating party;
- implementation of measurements-bundles from the contractor on one's own account, which includes the realisation of economic viable improvement of efficiency regarding energy management (energy supply, energy transition or energy use) of a building;
- shifting risks to the contractor through a special financial/funding model, mainly project-based instead of enterprise-based investments (Schäfer, 2016).

The duties of a contractor can consist of

- energy analyse of the building;
- evolve strategies as well as selection of technology;
- financing;
- construction of the chosen energy system;
- technical operation of the system including services, maintenance, repair and fuel supply (ASUE, 2005).

Investments can be taken to finance new plants as well as extensions, renovation or modernisation of the existing technology. It can modernise the fields of heating, cooling, electricity, steam and/or compressed air. Although everybody can appear as a contractor, in practice most of the contractors are local energy supply companies (55 - 60%), pure energy service providers (30 – 35%) as well as other branches such as engineering and planning offices (around 10 %) (Schäfer, 2016).

2.2.3. Advantages and disadvantages

The benefits for building owners (as public authorities) by operating an energy facility through an energy performance contracting system are versatile. First, investments can be taken without burden the public budget, because mostly investments will be pre-financed by the contractor and existing capital can be invested elsewhere. In the long run, the contracting model should reduce costs for the administration of buildings. Other benefits for the host institution are:

- Better liquidity;
- Guaranteed savings by contract (and/or upper limit for energy costs);
- Risk transfer to the contractor: the contractor carries the risk for the technical and economical reliability of the (energy) facility;
- Comprehensive special know-how, professional planning and implementation service from one source (provider);

- Only one contact and contract partner for the whole project execution, (this leads to a reduction of administration expense);
- If ESCO takes over financial risk the EPC is considered as off balance sheet for public customers (no increase of public debt);
- Relief of administration duties;
- Focus in core activities;
- Increase of user comfort;
- Conservation of value or even increase of value of the included buildings and facilities (better rentability or resale-value);
- Sustainable use of valuable resources.

Because of the implemented energy efficiency measures, contracting models can also have positive impacts onto the environment in terms of reduced climate-relevant emissions. Also reducing local emissions of classic pollutants is another benefit when it comes to contracting models.

For public authorities it is helpful to reach environment-related targets such as Kyoto or other relevant national or international goals. Contracting also provides an economical and sustainable handling with tax money. Another side effect is the positive impact on the regional economy if they are included throughout the contracting process.

Tenants, which rely on contracting models are profiting by comfortable light, temperature and ventilation. In addition, contracting models should lead to user-friendly facilities (e.g. local regulation of the heating system within flats/apartments). Lower costs for energy is usually guaranteed by the contractor and can also be counted as a benefit (Österreichische Gesellschaft für Umwelt und Technik, 2016)/ (International Institute for Sustainable Development, n.a.).

Because services always include a certain customer integration, it can be assumed that the performance of providing energy services (energy savings) are influenced by one another. The result of the performance is mainly determined by the use of the building (host-institution) and the measures the contractor is implementing. The higher the degree of integration of the customer, the riskier is the reaching of the energy saving target. This is very important for the contractor since he is committed to guarantee savings and is liable for it. The main problem is the lack of incentive of the host institution to act in an energy efficient way. On the other hand, a fixed fee leads to a lack of incentives for the contractor to implement energy efficient measures within the contracted facility or building. This lack of motivation for the host institution to act energy efficient and the missing incentive for the contractor lead to the so-called double-moral hazard problem, because both parties can occur as the principal as well as the agent. This is the reason why the decision of the contract type and the way of remuneration for both parties is crucial for the future performance of the contracted facility. Yet such substantiated approaches, which would support the outline of such contracts appropriately are missing (Schäfer, 2016).

	Advantages	Disadvantages
Host institution	▪ Better liquidity, ▪ Guaranteed savings by contract (and/or upper limit for energy costs), ▪ Shifting technical risk to the contractor, ▪ Comprehensive special know-how, professional planning and implementation service from one source, ▪ No burden for the public budget (depends on type of EPC), ▪ Increase of user comfort, ▪ Relief of administration duties, ▪ Focus in core activities, ▪ Conservation/increase of facility value, ▪ Sustainable use of valuable resources, ▪ Predictable energy costs, ▪ Overcome lack of know-how.	▪ Low competition, ▪ Lack of control mechanism, ▪ No motivation for the contractor to save energy/costs (fixed rate), ▪ Limited overview about own facilities/buildings. ▪ Double-moral hazard problem
Contractor	▪ Freedom of decision, ▪ Ability to create revenues through maintaining facilities, ▪ Long-lasting contracts creates stability within companies	▪ Business risk, ▪ No incentive for the building owner to safe energy, ▪ Double-moral hazard problem, ▪ Depends on building use.

Table 4: Overview advantages and disadvantages EPC

2.2.4. Conclusion on EPC

Especially for bigger institutions EPC is an adequate method to shift the technical risk of an efficient operating (energy) facility to the contractor. A core element of the EPC is the contract negotiation. If the contract tends to prevent incentives of the contractor or the host-institution, it can lead to the double-moral hazard problem, which is discussed in section 2.2.3. The double-moral hazard problem is caused because of the host institution is not interested in energy savings, when paying a fixed fee to the contractor. In this case the contractor has the greater risk to run the facility properly. Therefore, the negotiation of the contract is a crucial step within the EPC method. For example, the shared savings concept lead to positive influence onto the energy facility not only coming from the contractor, but the host institution. To sum up, EPC can be an appropriate way to manage energy facilities with benefits for both parties. Although, as mentioned before the parameter-setting of the contract is a necessity to create incentives to save energy (and money) for both parties involved in the EPC process.

2.2.5. Case study of successful EPC for renovating buildings

Hospital Bad Radkersburg (AT)

This case study describes a successful implementation of an energy performance contracting implemented in the Southern Styrian Hospital Bad Radkersburg (AT) with Siemens AG as contracting partner. Owner of the hospital is Federal real estate company of Styria (Landesimmobiliengesellschaft LIG) and therefore 100% owned by the public.

The hospital accommodates approximately 120 patients and about 100 employees. It was firstly opened in 1964 and has a heated area of 5.800 m². Initially, the building envelope was not insulated, the heating system was an inefficient light-fuel-oil boiler, hot water conditioning was inefficient and there was no energy monitoring installed.

The goals of the building owner LIG were:

- Change of heating system to renewables and outsourcing of heat energy supply and financing
- Reduction of energy demand, energy costs and CO_2 emissions through demand side energy efficiency measures (Schinnerl, 2013)

After a European wide tender in 2010 the company Siemens AG was chosen as contractor. The tender was organised on the following premises: result-oriented competition (prices and ideas) with functional specifications of demanded service based on negotiation procedure (according to Austrian procurement law: companies are invited to formulate offers according to relatively open tender documents (majority of requirements must be open and not too specified). The detailed content of the tender contract is negotiated). The selection procedure was based on the following criteria: 1) lowest costs of energy delivery, 2) use of environmental friendly technologies, 3) savings on demand side rated by amount of savings, amortization, quality and quality management. Therefore, bidders were invited in this negotiation procedure to make offers for energy efficiency measures with amortisation time below 15 years including information to investment costs, potential savings, amortization and constant quality management

In the end, Siemens AG was chosen and invested € 320.000 incl. VAT (thermal insulation of building, change of heating systems, solar panels and energy management system).

Pictures of the building are available on the webpage of the hospital.

Following EPC conditions applied to this case: LIG = customer, Siemens = contractor (Ungerböck, Schinnerl, & Bleyl-Androschin, 2010):

- Energy supply contracting ("integrated chauffage") combined with efficiency measures on the demand side;
- Contractor (Siemens) implemented the measures on its own risk, afterwards sold them to the customer (LIG);
- Contractor (Siemens) provides performance guarantee and high quality;
- Contractor (Siemens) provides financing offers to the customer (LIG) including;
  - Partially or up to 100% of investment costs are assigned to the customer (LIG), with option for early repayment
  - Siemens gets a contract fee <1% plus 1-2% flat fee of financing volume
  - service and maintenance fee must be paid directly to the contractor (not part of financing offer)
- contractor (Siemens) is only financing mediator but responsible for financing during the implementation phase of the measures;
- costs for heat supply are directly paid to the district heating grid operator.

The contract arrangements and cash flows are shown in the figure below (Ungerböck, Schinnerl, & Bleyl-Androschin, 2010):

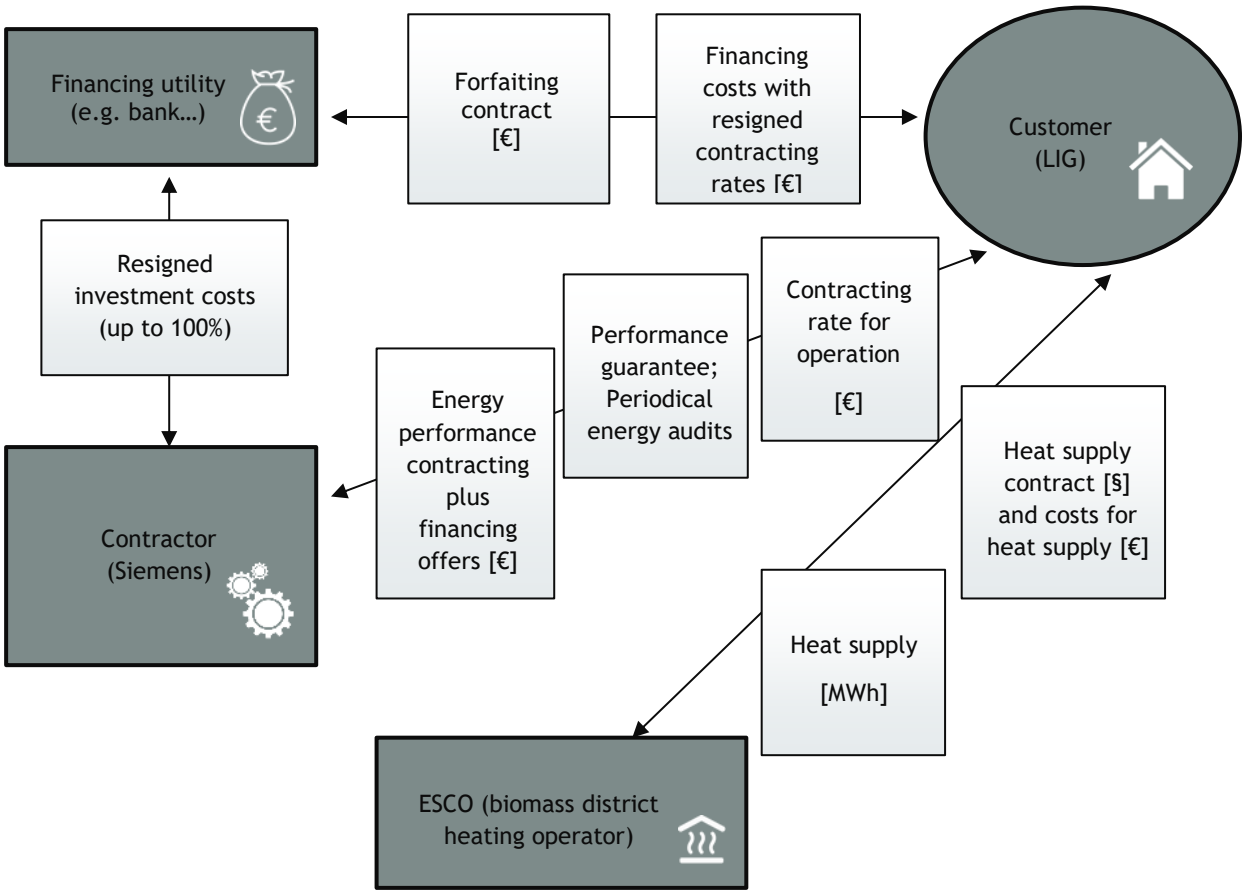


Figure 7: Contracting model of Hospital Bad Radkersburg (Energy Performance Contracting), own illustration

The next table shows important data at a glance (based on two reports (Ungerböck, Schinnerl, & Bleyl-Androschin, 2010), (Schinnerl, 2013).

At a glance	
Building	Year of construction 1964, 5.800m² heated area, no thermal insulation, no energy monitoring
Before EPC	
Heating system	Oil boilers from 1979: 2 x 930 kW Oil demand: 135.000 litres per year (~1.305MWh) CO_2 emissions per year: 398,025 tons
Electricity	442 MWh per year, peak load 131kW
Hot water	Inefficient preparation with heating system, problems with legionella bacteria
Costs	Heating costs per year: approx. € 68.000 Electricity costs per year: approx. € 66.000
After EPC in 2010	
Heating system	Change of heating system to biomass district heating (320kW connected load) Refurbishment of heating distribution system (hydraulic control with adapted circulation pumps, installation of valves, improvement of controlling and installation of energy saving function, installation of limitable thermostatic heads) Installation of water conditioning system to avoid legionella bacteria
Building	Installation of solar panels (153 m²) and puffer storage (2 x 4.000 litres) Insulation of top storey ceiling Installation of energy management system and online energy controlling Lightning change (new energy saving lamps) Water saving fittings
Others	Performance guarantee and periodical energy audits by Siemens AG as extended service Awareness raising and motivation of employees (workshops, events)
Energy savings	Annual heating energy demand (2012): approx. 695MWh; -47% reduction compared to 2010 Annual solar production (2012): 74,1 MWh (10% of heating energy demand) Annual electricity demand (2012): 344 MWh; -22% reduction compared to 2010 Annual water consumption (2012): 7.167 m³; -35% reduction compared to 2010
Costs	Investment costs covered by Siemens (Contractor): € 320.000 incl. VAT Heating costs per year: approx. € 45.000 (-44%) Electricity costs per year: approx. € 59.000 (-11%)
	Contracting time: 15 years

Table 5: Data of case studies at a glance

As conclusion, the participating parties were satisfied with the implementation and the effects. Several other buildings of LIG were also renovated by using the EPC approach. Advantages for the building owner

were the financial services, implementation of adequate renovation measures and performance guarantee, awareness raising for employees and continuous monitoring and energy performance audits by building experts over the contracting period.

A recommendation of the planning company is that implementing EPC can be valuable if the building has a low quality (old building, nearly no refurbishment, outdated heating system, etc.) and annual energy costs exceed € 25.000 per year. The process starts then with a motivated building owner, who is willing to exploit efficiency potentials. Additionally, LCA shall be used by planers and contractors to highlight the advantages of energy savings, energy efficiency and using renewables.

2.3. Crowdfunding (CF)

Crowdfunding approach is an alternative method, completely different to the common typical business process, used to raise capital through small collective efforts (amounts of money) of a large number of people, friends, family members, customers and individual investors, and finance a project.

In particular, it allows to know about a business even before it is launched, and being based on a network of people, large investments have to be planned using multimedia information systems (text, audio, images, video, animations, …) that should to persuade investors (no banks or other institutions involved) without providing guarantees of the business plan.

Crowdfunding is mainly based on three types of actors (Figure 8):

- the founder (or company), who has the project idea and aims to develop it;
- a large crowd of people (investors), who support the idea with donations, rewards or loan crowdfunding (crowd lending);
- web-platform, an organization where it is possible to launch, apply and share the idea.

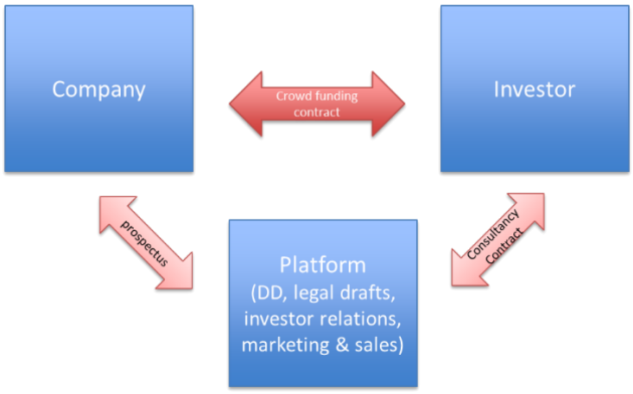


Figure 8: Basic overview on participating parties (Winkler, 2017)

The action steps to develop a Crowdfunding project are (Figure 9):

- Set target amount and define rewards;
- Elaborate a story and prepare the project;
- Build a community even before the campaign starts;
- Define the campaign's duration;
- Chose a platform.

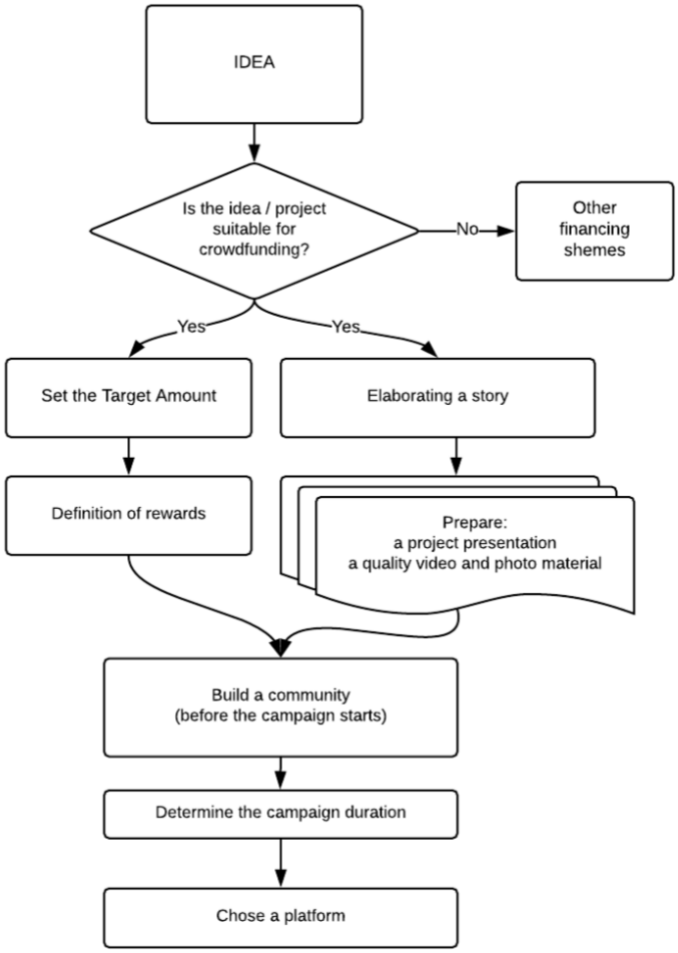


Figure 9: Crowdfunding project preparation (Source: G. Paoletti Eurac Research)

2.3.1. Forms of Crowdfunding

Crowdfunding has been used to fund several projects in different fields: art, scientific research, medical, travel, renovation, social, civic projects, etc.. This alternative financing scheme takes place through internet channels and social-media platforms that allow to share project ideas and keep in touch with project developments.

Currently, there are different financing scheme typologies used to define different CF approaches in relation to the reward, benefits and service developed (Figure 10):

- Donation based
- Reward based crowdfunding
- Pre-Sales crowdfunding
- Equity crowdfunding – crowd investing
- Loan-based crowdfunding - crowdlending
- Mixed approach

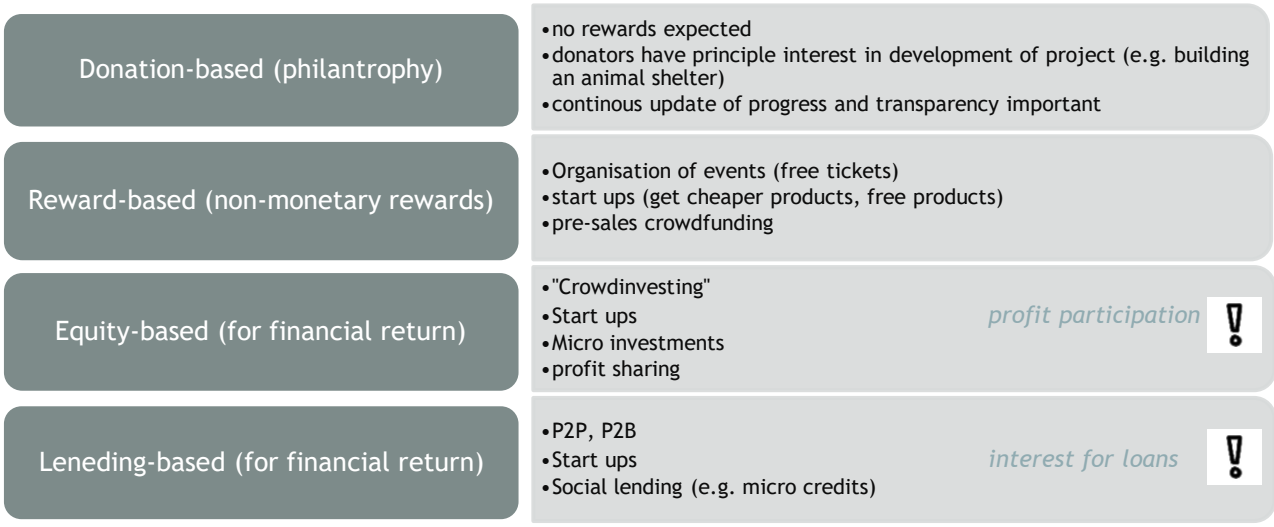


Figure 10: Overview of different form of crowdfunding (Winkler, 2017) and its characteristics.

Donation based

It is based on money donation. The amount received is a "pure" donation since investors are not motivated by profit. This model attracts donation for a specific project development, donors know that their money will be used for this specific project. The founder will keep the donors updated on the project progress by social channels, also to improve and stimulate donations. The principal interest for donors is the development and the completion of a project, which has some noneconomic value for them. (Morri & Ravetta, 2017)

Reward based (or pre-sales) crowdfunding

The reward based crowdfunding model is similar to a donation-based one, but in this case the entrepreneur can offer a reward to the supporters, such as a pre-sale of the final product (or service), before it is produced, without incurring in debt or in the need of selling shares. In this case, donors can get a discount on the final price. This model is common used in the events organization, where the reward can be free tickets, while retaining full ownership of the project or company being funded. If the target is not reached, the amount pledged will be given back to the donors and the idea will not be funded. (Morri & Ravetta, 2017)

Equity crowdfunding – "crowd investing"[6]

Equity crowdfunding permits to collect money to invest in start-ups or small and medium companies with an economic return. It is an online investment where it is possible to buy a participation in a company. In the equity crowdfunding approach, investors bear risks. They may lose all or a portion of their investment but can earn high returns on investment.

In Italy, Consob, the public authority responsible for regulating the Italian financial markets, has been the first in Europe allowing it since 2012. The law applied only to innovative start-ups and established, among other rules, a national registry for equity crowdfunding platforms and disclosure obligations for both issuers and platforms. This kind of crowdfunding is the one used in real estate, where investors buy shares of

[6] Decreto Legge 18 ottobre 2012, n. 179 (il c.d. Decreto Crescita *bis*, o 2.0) convertito con modificazioni con Legge 17 novembre 2012, n. 221. adozione di una disciplina specifica in materia alla CONSOB che, in data 26 giugno 2013 con delibera n. 18592, ha adottato il regolamento in materia di "Raccolta di capitali di rischio da parte di *start-up* **innovative** tramite portali online

projects. (Morri & Ravetta, 2017) Since 2015 this type of financing is also allowed in Austria. Companies can collect up to € 5 million of capital through alternative forms. (Green Rocket GmbH, n/a)

Loan or debt based crowdfunding – "crowd lending"

Lending based models are very similar to a traditional bank loan, with the difference that money come from a wide group of people. The role of the platforms can be diverse. Some of the platforms will act as a middle-man and will also make the repayments to the lenders, where other platforms act only as match-makers and the borrower and lenders will be connected when the deal is closed. (European Crowdfunding network, 2012).

- *Social Lending:* some platforms give the possibility to lend to social projects with no interest being offered, for example where businesses in developing countries can receive micro-financing without any interest being paid to the lending party.
- *Peer-to-Peer Lending (P2P*): it gives an economic return to the funder by receiving interest on their principal investment into the venture. The sponsor will then give back the amount he has received plus an interest over the period of time. This model mainly matches people that have excessive liquidity with people that are looking (through the web) for loans with a lower interest rate than the one they can get from a bank. (Morri & Ravetta, 2017)
- *Peer-to-Business Lending:* similar to P2P lending, there are platforms that provide loans to small and medium sized businesses. So far, this form of crowdfunding has attracted the attention of government funds as co-investment, for example in the UK. (European Crowdfunding network, 2012)

In addition, there is also the possibility to mix these models. It is can be changed in relation to the final needs of the project proposal.

2.3.2. Costs of crowdfunding models: fees and taxation

The crowdfunding platforms can apply fees in order to pay the management of the platform and to get their revenues. Below there are several fee typologies listed that can be required by crowdfunding platforms:

- Signup Fee is usually is zero;
- Fundraiser Fee may be a percentage:
  - up to 5% when the funding goal is reached;
  - 0% when funding goal is not reached, because the money will be refunded to backers;
- Donor Fee: can be a percentage or a fixed cost;
- Variable fees/costs:
  - Donor fee;
  - Processor fee;
  - Profit sharing fee;
  - Pledge fee;
  - Copywriter fee;
  - Web developer fee;
  - Hosting costs (website…);

- SSL (Secure Sockets Layer) Certificates;
- Discounts;
- Payment processing fee.

Taxation

Crowdfunding campaigns are considered a business model, and such as the other business models the taxation will be applied where required by the European Commission (Directorate general taxation and Customs Union).

In general, in the pre-sale crowdfunding process the Value Added Tax (VAT) (European Commission, 2015) must be applied to the final object or service in case that VAT is included on it. The taxation percentage changes in relation to the EU countries.

Furthermore, Europeans can invest in CF only if the platform is located in EU countries, such as the case of Housers platform, based in Spain, but with investment in Italy and Portugal.

2.3.3. Advantages/disadvantages

The following table gives an overview on common advantages and disadvantages of CF projects and tries to integrate the perspective of founders and investors (sources for table: (Nickel, 2017), (Wiener Börse AG, n/a), (Gasser, n/a)).

	Advantages	Disadvantages
Founder (receives CF)	• Several investors – no dependency on one main investor (founder keeps control) • Raise finance with no upfront fees • Financing possibility for very risky projects • Risk may be carried by investors • Relatively cheap financing form • Support through crowd during implementation process possible and immediate feedback on CF idea (honest feedback, improvement of product) • Easy access to crowdfunding platforms • Good CF campaign is valuable marketing • Get experiences, guidance and support through crowdfunding platform	• no guarantees to achieve the pre-defined budget • In case the funding goal is not reached, money will be refunded to backers (if possible) • Crowdfunding campaign is very time-consuming and can last for several weeks/months • Protect the project proposal with a patent or copyright, in order to reduce the risk of steal of project proposal.
Investors	• Possibility to invest in highly innovative, young companies • High rates of return possible • Philanthropically satisfaction (donation-based) • Small investments possible – increased flexibility • Easy access to new financing forms • Access to exclusive new products/services possible • Transparent financing form	• Highly risky investment form – possibility to lose all money • Relies on information of founder • Previous know how necessary (CF, market, product…)

Table 6: Summary of advantages/disadvantages

2.3.4. Real Estate Crowdfunding

Real Estate Crowdfunding (RECF) started in 2012 in USA with the Jumpstart Our Business Startup Act (JOBS Act).

Real Estate Crowdfunding is mainly based on equity and debt (lending)

In equity RECF, investors become **part owner of the property**. They receive an equity stake when they fund a project in commercial or residential properties. Returns are a share of the rental income generated by the property or of their capital gains.

In debt based RECF (lending based approach) investors **loan to the borrower**, investing in the mortgage loan associated with a property. Loans are repaid monthly or quarterly with interests, giving a percentage to each investor participating in the deal.

As for any investment, the difference is that equity investments offer the potential for higher returns due to the fact that the profitability of a debt investment is limited by the interest rate associated with the loan. However, equity investments have also a higher level of risk and typically require a longer holding period, which makes them more illiquid. If something goes wrong and the property is foreclosed and sold, the **debtholders get paid first** (Ippolito, 2016)**.** In a liquidation situation like this, **equity holders** often have no recourse. It could represent an interesting opportunity for private individuals to have an exposure to direct real estate investments. (Morri & Ravetta, 2017)

2.3.4.1. Real Estate Crowdfunding in EU

Real estate crowdfunding investments are allowed for European residents only if the platforms are located in Europe. It is not permitted, when the platforms are located in US.

A completed overview of EU regulation on RES CF in each EU country is reported in the document elaborated by Osborne Clarke. (Aschenbeck-Florange & Dlouhy, 2015)

2.3.4.2. Crowdfunding regulation and Renewable Energy Systems (RES) market developments in EU

Within the H2020 CrowdFundRES project were investigated the RES crowdfunding in EU member countries. The results show that:

- all member states have crowdfunding platforms
- ten member states (Germany, UK, France, Italy, Spain, Belgium, Austria, the Netherlands, Finland and Lithuania) have implemented a specific crowdfunding regulation
- RES CF is more developed in Western Europe than Easter Europe where the donations and rewards model prevail
- 17 of 28 member states have crowdfunding platforms which include RES projects as potential investment, 9 of this 17 countries (Germany, UK, France, Italy, Austria, Portugal, Spain, the Netherlands, Finland) have crowdfunding platforms focused exclusively on RES projects. (Kohl, 2017)

Within the report "Practical experience of RES project financing using crowdfunding" the platforms regulation, technology, and strategies used in some platforms located in Netherlands (Oneplanetcrowd), Germany (BetterVest / GreenCrowding), France (Lumo) and United Kingdom (Abundance) are analyzed. For each platform it is presented at least one case study, complete of all project information:

- Bettervest: Hotel Magnetberg CHP Plants
- Lumo: SERGIES SAEML
- Abundance: Upper Pitforthie Windgen PLC, BNRG Gorse Plc, REG WindPower
- CONDA Project Case Study: Clean Capital, Solar power plant Lärchenholz

In conclusion:

- Platform regulation as defined at national level, should give to the platform space to grow in order to develop robust business off the back of the regulation.
- loan or debt crowdfunding model was the most used: debt significantly larger than equity market
- the responsible of management and assets of the project are the owners and the renewable professionals.

For further information, see the "Report on the practical experience of RES project financing using crowdfunding". (K. Harder, R. Van Maaren, 2018).

2.3.5. Case studies of successful CF

In the course of developing this deliverable it appeared to be challenging to find European public buildings or building renovations financed by crowdfunding. Due to this, the authors decided to give three different European case studies where public infrastructure was financed by crowdfunding. These case studies may bring interesting insights how successful campaigns were implemented.

2.3.5.1. Luchtsingel bridge

The Luchtsingel bridge in Rotterdam (NL) could be considered as the first crowdfunded infrastructure project of the world. In 2011 the city of Rotterdam cancelled a previously announced plan for an office district development which resulted in many vacant office spaces and empty public spaces in Hofplein. (Stichting de Luchtsingel, 2018) The architecture office ZUS Zones Urbaines Sensibles proposed a city development concept to regenerate this area. They presented it in the course of the International Architecture Biennale Rotterdam (IABR) under the name "Test Side Rotterdam" in 2012. Purpose of the bridge is to reconnect the Hofplein area with the northern part of Rotterdam. (Bifulco, 2015)

The Luchtsingel bridge consists of a wooden pedestrian bridge of 390 meters. Pictures of the bridge and its surroundings are available on Google.

The financing of this bridge was initiated through crowdfunding and partly by winning the Rotterdam city initiative, which enabled further financing of the project in 2012. The crowdfunding initiative was named "I make Rotterdam" and was quite successful. With a donation of 25€ each donor will be entitled to have a message inscribed on one plank. The inscriptions can advertise a business, convey a message to a loved one, or simply state the donor's name. By completion of the construction works over 8.000 boards were sold. After the end of construction period on 2015 the bridge was donated to the township of Rotterdam (ZUS - Zones Urbaines Sensibles, 2016)

The project demonstrates that public spaces and facilities can be created, not only by governments, but also by citizens. They get the chance to directly initiate valuable project within their living area, which might not be a priority of their administration. The Luchtsingel case proved the community's capacity to directly intervene in its own issue and to build a public facility to resolve the problem.

For making the crowdfunding attractive to possible funders, they get something as reward. The Luchtsingel footbridge project prints donor's names or their messages on the bridge and it becomes a visible emblem of the community cooperation for the chronic pedestrian mobility issue.

Additionally, the success of the Luchtsingel in Rotterdam suggests a crowdfunding campaign as a new way for citizens to participate and to encourage social and policy changes. Upon the completion of crowdfunding for the Luchtsingel, the architectural office ZUS embarked on the construction. The Rotterdam-based architecture firm attempted to show citizens and governments how this project transformed the urbanscape

on a real-time basis. It successfully led them to join the further phases and ancillary projects. As a result, the city government of Rotterdam approved spending four million euros decades ahead of the original schedule outlined in the city's development masterplan. According to ZUS, the motivation behind the "I Make Rotterdam" campaign was to 'test the policy framework and design visions for the city of Rotterdam and to experiment with alternative development strategies for the city.

However, the Luchtsingel project proves that citizens' participation increases their own capacity to transform where they live on their desired timeline, a role that had been unique to governments. (TheUrbanWeb, 2016)

2.3.5.2. Bologna: renovation of Portico of San Luca

The Portico of San Luca is one of the most important architectonic construction of the city of Bologna. It was built between 1674 and 1715. It is composed of 658 arches and 3796 m of length. Pictures of it before and after the renovation are available on Google.

In 2013 the Bologna municipality decided to renovate the Portico of San Luca, due to its state of deterioration and decline. The project "Un passo per San Luca" ("one step for San luca") was the first Italian CF civic initiative promoted by a public partner (Bologna municipality). The project was launched by GINGER, a platform which usually promotes initiatives at regional level, within Emilia Romagna region. The CF goal was to collect 300.000 €. Bologna municipality, in order to promote the initiative was the first donator giving 100.000€. At the end, the supporters were 7.111, with a final budget collected of 339.0743€ (113%), surpassed the estimated one.

2.3.5.3. Playground of primary school Blattur in Götzis, Vorarlberg (AT)

The playground of the primary school Blattur in Vorarlberg was built by using a donation based crowdfunding initiative. Purpose was to extend the outdoor area of elementary school using the half of the large area behind the building. The new area, for the outdoor activities was projected in order to improve the garden and the outdoor activities. In addition, the playground is accessible by public, which allows children to use the area on the weekend or after school. (Caballero, 2015)

Since the municipality of Blattur could not afford to construct the playground, the director of the primary school introduced a crowdfunding campaign to facilitate the investment. In total approximately € 80.000 were needed for transforming the playground, 10% should be gained by crowdfunding, € 29.400 by the municipality and € 33.000 federal subsidies. (Heinzle, 2016)

The crowdfunding campaign was implemented via the Austrian platform mit.einander.at, which is hosted by the bank Vorarlberger Raiffeisenbanken. Goal was to collect €8.000 between May and July 2015. In the end 43 supporters donated €10.350 to the project. Arguments for the donations were

- Municipality supports the project, but financing is still uncertain
- New playground which can be used by several institutions (primary school, kindergarten, public...)
- Project is pedagogically worthwhile
- Bringing joy to children and support their healthy development

The construction works were finished in July 2016. To save costs the school classes helped during the construction works (planting plants, etc.) and they will support the maintenance of the garden by taking care on the planting beds.

Pictures of the project are available on Google.

C. Conclusion and recommendations

The first part of the report describes the technical aspects of building renovations. Different measures have different financial requirements and impact on the building quality. The measures listed in chapter 1.2 are grouped in measures for the building's envelope, technological systems and user behavior. Each renovation was rated according to their impact on investment, payback time, difficulty of installation (installation requirements), energy performance and indoor user comfort level. The rating is based on literature research and professional experiences and represents a very rough guideline.

The second part focuses on the three innovative financing schemes public private partnership, energy performance contracting (form of PPP) and crowdfunding. Each scheme is summarized and a case study developed.

Based on the findings, the following picture shows in which situations alternative financing schemes may fit for building renovations. It has to be mentioned, that this is only a very rough overview – individual consultations with experts for finding adequate financing schemes for projects are recommended.

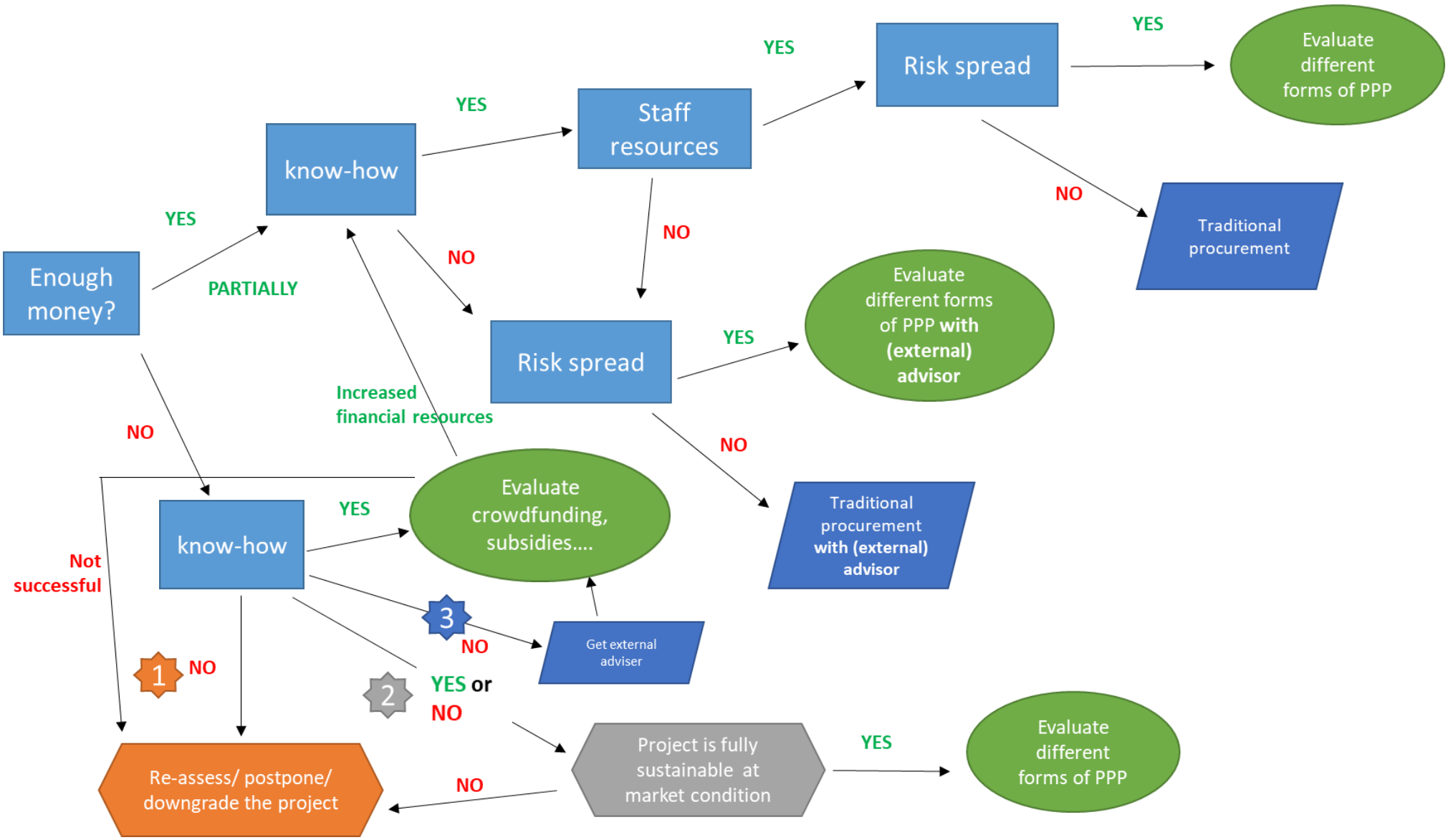


Figure 11: Decision making tree, own illustration

In general, the authors identified four relevant questions in the decision making process:

- Are enough public monetary resources available?
- Is internal (technical) know-how for implementing the project available?
- Are enough public personal resources available?
- Do I want to spread the risk?

In a first step it should be assessed, if enough money is available for the planned investment. In literature it is recommended to already have sufficient or major public monetary resources before commencing PPP models for keeping the financial part of the project in public responsibility. Although the financial liabilities can be outsourced and considered as off-balance sheet in certain cases, they are still present and affect the public budget for a long-term. In addition, public parties usually get cheaper financing from banks, since they usually have a better rating (creditworthiness) than private companies. In the course of the research for this deliverable, this advice was often not followed in practice.

Nevertheless, if the investment volume can be fully/partially covered by public resources the next step should be the internal evaluation if enough know-how is available for the implementation of the project. It should be assessed, if technical and economic know-how is available and if sufficient internal personnel resources are ready during the project duration. If not the authors assume that there are two options left:

- Since one main advantage of PPP is the distribution of risk to the private partner (technical/financial, depending on type of PPP) it must be evaluated, if this is an valid argument for commencing PPP:
  - If yes, different forms of PPP for the project may be evaluated with the help of external experts;
  - If not, traditional public procurement of private services (e.g. building of infrastructure, building renovations…) with (external/additional) advisors may be the best option.

In case of sufficient public personnel resources for implementing the project, the same questions can be asked:

- If risk distribution is desired, the public party can start to evaluate PPP forms for the project;
- If not, traditional public procurement may be the best and cheapest option.

Based on this, if the public financial resources are not sufficient for implementing the project and depending on the internal know-how, the authors of the report identified four different options:

1. If internal know how is available, the increase of public financial resources shall be carried out e.g. by crowdfunding, subsidies, EU funding, etc.;
2. If no internal know how is currently available, the project can be re-assessed, postponed or downgraded to a cheaper version;
3. In case that the project if fully sustainable at market conditions (e.g. public transportation services, waste water management or other public services etc.) different forms of PPP can be assessed for implementing the project;
4. The fourth option is to get an external adviser/expert for increasing financial resources.

In addition, (Etva & Sinloc, 2017) identified the following points as indicators or as small market test for choosing a financing scheme:

- Project is fully sustainable under market conditions:
  - Evaluate adequate PPP form;
- The project is not sustainable under market conditions:
  - Public resources (financial/personnel…) are sufficient to implement the project → traditional procurement;
  - Public resources are not/partially sufficient → find alternative financing sources (e.g. crowdfunding, subsidies, mortgage, bond emission…);
- The project is partially sustainable under market conditions:
  - find alternative financing sources (e.g. crowdfunding, subsidies, mortgage, bond emission…);
  - evaluate effect of in-kind contributions;
  - Review the whole project.

In conclusion it can be said that alternative financing schemes are quite innovative for financing public infrastructure. Since approximately 15 years public private partnership models appear to be relevant for infrastructure projects in Central Europe. The new experiences within eCentral by implementing public nZEBs with PPP, EPC and Crowdfunding will bring valuable lessons learned for future projects.

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