



STUNNING



Sustainable business models for the deep renovation of buildings



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INTRODUCTION TO STUNNING

Increasing the visibility of innovative and replicable packages and business models for the deep renovation of buildings in Europe

Today's measured rate of refurbishment is much lower than what should be observed to remain in line with Europe's 2050 ambitions. There is a need to accelerate the market uptake and large-scale implementation of energy efficient refurbishment solutions and increase the annual renovation level to 3%. The poor market acceptance of innovative refurbishment solutions is in most cases attributable to the lack of adequate business models. Innovative business models have already been demonstrated, but their replication is very slow: how can this replication be supported?

To address this issue, a consortium of 5 European organisations received funding from the EU Horizon

2020 research and innovation programme in October 2017 to create and implement the project STUNNING: SusTainable bUsiNess models for the deep reNOvation of buiLdiNGs. Under the leadership of DOWEL Management, the STUNNING partners worked two years long on the identification and promotion of innovative packages and business models for the deep renovation of buildings, to accelerate their uptake by market players. Data on integrated and adaptable refurbishment packages, combined with innovative business models which allow consumers and the market to invest with confidence, were collated, synthesised and analysed so as to select and increase awareness of the most promising solutions.

This publication brings together the main results of the project, in the hope of inspiring you on how to successfully engage with the deep renovation of buildings and for further innovations in the field of energy-efficient refurbishment of buildings. You will find in this report:

- Benchmarking of refurbishment packages based on factors such as cost-benefit indicators, embedded technologies and technology readiness level
- Analysis of EU-wide barriers for deep renovation and recommendations on how to overcome them
- Mapping and analysis of promising and replicable business models, and presentation of their implementation on real buildings through case studies
- Presentation of the STUNNING Renovation Hub, the digital and collaborative knowledge sharing platform that promotes the diffusion of knowledge to accelerate the adoption of project results

Meet our consortium

DOWEL Management (France)
www.dowel.eu

**CSTB – Centre Scientifique et
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Steinbeis 2i (Germany)
www.steinbeis-europa.de

We hope that you will enjoy reading this publication.

The STUNNING Team

THE STUNNING RENOVATION HUB

Join the European collaborative platform for the energy-efficient renovation of buildings

One of the main goals of STUNNING was to create a collaborative, online knowledge sharing platform, in order to support the dissemination and promotion of successful and innovative building renovation packages and business models at European level. The STUNNING partners thus launched the Renovation Hub, which will be maintained after the end of the project.

The STUNNING Renovation Hub enables stakeholders from the entire value chain to gain and share knowledge through articles on innovative **refurbishment packages**, replicable **business models** and **case studies** of successful implementations.

Interested parties can register for free with the following degrees of participation:

■ FOLLOWER

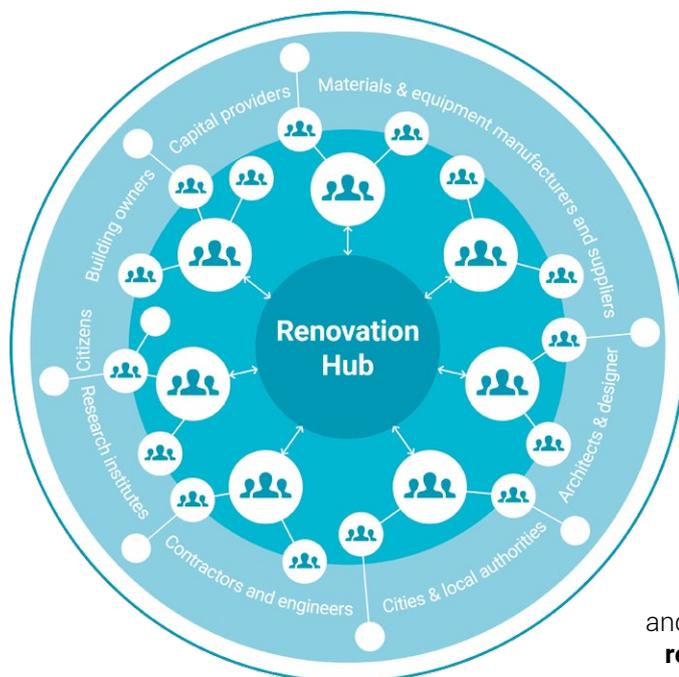
Access information through publicly available articles, our social media channels and our newsletter.

■ EXPERT

Get the additional ability to submit your own articles, validate articles from others and participate in workshops.

■ AMBASSADOR

Get additional exposure in leading the validation of articles and disseminating STUNNING in your own community.



Visit our platform
and register online at
renovation-hub.eu!



If you wish to share case studies, promote new business models or advertise your energy-efficient refurbishment package please get in touch with us! Contributions of members of national platforms are much welcome, as the Renovation Hub can offer additional visibility at European level.



Survey of renovation cases



The approach

The first stage of STUNNING was to **review existing renovation examples** and analyse the implemented renovation solutions, their performance, how they had been financed and the generated savings. These renovation cases have been collected through different sources (surveys, web platforms, interviews, partners' knowledge) and a database of more than 400 European renovation projects has been developed, and will con-

tinue to be enriched with new cases. About 80% of today's database comprises French cases (mostly single-family houses), for which data are available because they have benefited from different types of incentives.

The selected renovations have implemented different combinations of commercially available solutions, among the following:

| Envelope insulation | Heating system replacement/improvement | Ventilation | Renewable energy system installation |
|---|---|--------------------------------|---------------------------------------|
| Roof insulation (cold/warm loft) Floor insulation Façade insulation (Internal/External) Windows replacement (double or triple glazing) | Gas condensing boiler Heat pump (air to air, water to air) Electric heating system Radiant floor heating Heating system control | Ventilation with heat recovery | Solar thermal PV Biomass/Biogas |

More than 60 different combinations of these solutions were identified in the STUNNING database. By clustering all heating systems together, as well as renewable energy systems, and retaining only the packages effectively combining a minimum of two solutions, six types of package appear as being the most frequently used. They represent 55% of the studied cases and include the technologies listed in the table to the right.

In more than a third of the reviewed cases, a very extensive refurbishment package (RP06) has been implemented. Each component of these packages can be delivered by different types of off-the-shelf technologies and materials (for instance gas condensing boilers or heat pumps for heating – see first refurbishment package presented in the following pages). Almost all the remaining cases (not covered by those six packages) have implemented only one renovation

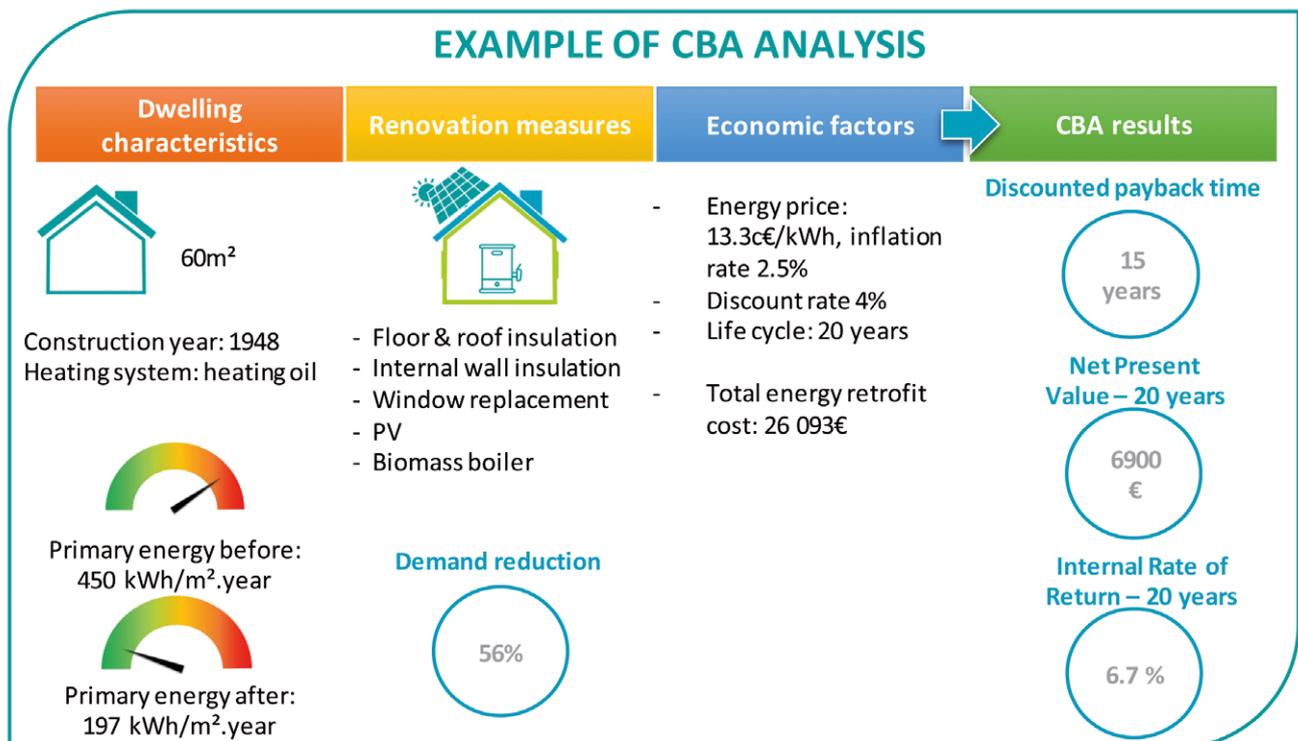
| Reference of package | Included types of solutions |
|----------------------|--|
| RP01 | Glazing, facade and/or roof insulation |
| RP02 | Glazing, roof, floor and facade insulation |
| RP03 | Heating system, glazing, ventilation, and facade insulation |
| RP04 | Heating system, glazing, ventilation, roof and facade insulation |
| RP05 | Heating system, glazing, ventilation, roof and floor and facade insulation |
| RP06 | Heating system, glazing, ventilation, roof and floor and facade insulation + solar |

solution, in most cases roof insulation, which means that close to half of the surveyed examples have implemented a 'shallow' energy renovation.

A **cost-benefit model to compare and rank selected refurbishment packages** was then developed. The proposed cost-benefit methodology considers the whole life-cycle of each renovation solution, and compares the benefits and costs of different renovation packages. This life-cycle cost approach provides different economic indicators (Net Present Value, Payback Period, and Internal Rate of Return) to determine whether the total economic benefits of a given solution outweigh its total costs, and by how much

relatively to other renovation alternatives. The empirical evaluation considers both financial and macroeconomic perspectives applicable to the whole life cycle of buildings (or renovation technologies) and considers different national standards.

This model then supports the benchmark and identification of the most cost-efficient refurbishment packages according to building characteristics. The corresponding data, clustered by building type and climate, will be available on the Renovation Hub. The different steps of the Cost Benefit Analysis (CBA) are presented below with the example of a French single family house.



As the objective of the CBA was to benchmark different refurbishment packages and compare their cost-efficiency, only the economic benefits of implementing these packages have been accounted for. The co-benefits such as better comfort (from thermal, acoustic, aesthetic, usability and accessibility standpoints), improved health (and productivity in the case of tertiary buildings), increased property value, reduced environmental impacts, have not been integrated into our model. However, these additional benefits are included in the studied renovation business models presented later on in this document. Non-energy benefits such as improved comfort are indeed key selling points for a holistic renovation.

Finally, to complete the survey of renovation cases using well-known technologies, a review of demonstrations and pilots showcasing more **innovative packages** was carried out. Most of these packages have been developed in the framework of EU funded projects, with the exception of a few national initiatives. Investigated solutions include for instance integrated multifunctional, active and/or prefabricated facades – as outlined below. This list is far from being exhaustive: It will be regularly updated with data and results from new projects and pilots.

Please visit the **Renovation Hub** to learn more and suggest new packages to be investigated!

| | Envelope insulation | | | | | Energy Efficient Heating, Ventilation and Air Conditioning | | | Building integrated renewables | | Building energy management | |
|--|---------------------|---------------------|--------------------------|---------------|--------------------|--|---------------------------------|--------------------------------|--------------------------------|---------------|----------------------------|---------|
| | Internal insulation | External insulation | Energy efficient windows | Prefab facade | Multifunct. facade | Heat pump | Efficient boiler (e.g. biomass) | Ventilation with heat recovery | PV | Solar thermal | BEMS & monitoring | Storage |
| « Conventional » deep refurbishment package | ✓ or ✓ | ✓ | ✓ | | | ✓ or ✓ | | ✓ | ✓ and /or ✓ | | | |
|  BRESAER | | ✓ | | | ✓ | | | ✓ | ✓ | | ✓ | |
|  E2VENT | | ✓ | | ✓ | | | | ✓ | | | ✓ | ✓ |
|  INSPIRe | | ✓ | ✓ | ✓ | | ✓ | | ✓ | | | | |
|  BERTINI | | ✓ | | ✓ | | | | | | | | |
|  Energie Sprong | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | | | |
|  GAP | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | | |
|  P2ENDURE | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | ✓ | | ✓ |

Coming soon on the Renovation Hub:  HEART  BuildHeat  REZBUILD  ReCO₂ST and more



“Conventional” deep renovation package



*Actual system proven in operational environment (with competitive manufacturing)
Widely used in renovations (with different possible combinations)*

Demand reduction

RES share

Payback time

Depends on the combination of solutions, country, building characteristics

Key Strengths

- Large range of available combinations: the package can be adjusted to the building characteristics and initial condition
- Excellent thermal properties, which can be adjusted to climate and regulatory requirements
- Different available materials for insulation, including bio-sourced ones (such as hemp and sheep wool, timber, etc.)
- Different available heating systems, incl. with renewable energy sources
- Includes common retrofitting solutions, well established in building codes and with extensive references

Next steps to accelerate market take-up

- Innovative business models to make it more affordable
- Reduced gap between foreseen performance and real one
- More efficient, higher quality renovation processes
- Development of a network of skilled professionals

Components



Roof insulation (warm/cold loft)
Wall insulation (external/ internal)
Floor insulation



Efficient heating system (incl. heat pumps, condensing gas boiler, etc.)



Efficient windows (double/triple glazing depending on climate + shading)



Ventilation with heat recovery



PV and/or solar thermal



Innovative, cost-effective, adaptable and industrialized “envelope system” for buildings refurbishment



*System prototype demonstration in operational environment
Demonstration: Universidad de Burgos campus in Burgos, Spain*

Demand reduction

RES share

30%

75%

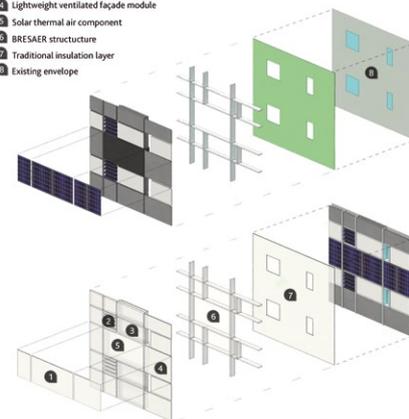
Key Strengths

- Customizable, adaptable to various buildings, climate and situations
- Cost-effective (industrialized solution)
- Active (PV) and multifunctional
- Improvement of indoor environment quality and comfort
- Innovative Building Energy Management System
- Easy assembly and disassembly to reduce on-site work and maintenance

Next steps before commercialisation

- Large-scale program and industrialization to reduce costs
- Development of a network of skilled professionals
- Detailed studies on ageing behaviour

- 1 PV Film integrated onto the envelope components
- 2 Dynamic window with automated solar blinds
- 3 Multifunctional insulation panel + Nanocoating
- 4 Lightweight ventilated façade module
- 5 Solar thermal air component
- 6 BRESAER structure
- 7 Traditional insulation layer
- 8 Existing envelope





Energy Efficient Ventilated Façades for Optimal Adaptability and Heat Exchange



System prototype demonstration in operational environment
 Demonstrations: in Burgos, Spain and Gdansk, Poland

Demand reduction

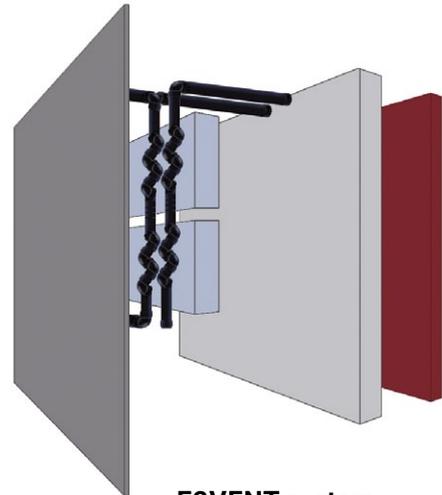


Key Strengths

- Full integrated solution (insulation + air renewal + thermal storage) that fits into a business as usual ventilated façade renovation
- Precise piloting based on measured internal comforts to fully adapt to the needs
- High performance energy and environmental performance

Next steps before commercialisation

- Develop key partnerships (manufacturer)
- Improve maintenance process
- Optimize weight for installation of the LHTES (Latent Heat Thermal Storage Energy System)



E2VENT system



EU Horizon 2020 (GA No. 637261)



www.e2vent.eu



Complete multifunctional prefabricated solution for buildings refurbishment



Actual system proven in operational environment (with competitive manufacturing)
 Demonstration: Dieselweg residential area in Graz, Austria

Demand reduction



RES share



Key Strengths

- Low-tech and passive solar system
- Active (PV) and multifunctional (insulation, RES)
- Minimized operating and maintenance costs
- Improvement of indoor environment quality and comfort
- Integrated processes and interaction of all components
- Quick installation thanks to prefabrication (the building can be occupied during renovation)

Next steps to accelerate commercialisation

- Large-scale program and industrialisation
- Development of a network of skilled professionals



www.gap-solutions.at



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 768287.



Prefabricated timber modules for building renovation supported by the RenoBIM digital tool



System prototype demonstration in operational environment
 Demonstration: Tecnalia's full scale experimental facility KUBIK

Demand reduction



Key Strengths

- Easy and quick installation
- Low intrusiveness of the works
- Sustainable solution using local and recyclable materials (timber)
- Suitable solution for avoiding thermal bridges

Next steps before commercialisation

- Methods and tools for highly accurate data acquisition on facades to fully industrialize the process



EU Horizon 2020 (GA No. 636984)



www.bertim.eu

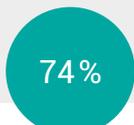


Prefabricated integrated façade for long-term guaranteed net-zero energy, high quality and comfort refurbishment

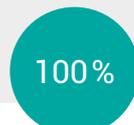


Actual system proven in operational environment (with competitive manufacturing)
 Demonstration: Vilogia Social Housing in Hem, France

Demand reduction



RES share



Key Strengths

- Precise off-site prefabrication technique that produces high quality results due to a controlled production process
- Integrated solution, with pre-installed windows and HVAC devices
- Built-in renewables (PV)
- Fast mounting process with minimum disruption for tenants, no weather downtime for on-site works
- Free scope for facade design

Next steps to accelerate commercialisation

- Streamlining of logistics and planning process, through the development of local partnerships
- Further decrease costs (thanks to economy of scale and industrialisation)



www.energiesprong.fr





Wooden frame envelope module incorporating ducts and air-to-air heat pump



*System complete and qualified
Demonstration: in Ludwigsburg, Germany*

Key Strengths

- Precise off-site prefabrication technique that produces high quality results due to a controlled production process
- Integrated solution, with pre-installed windows and HVAC devices
- Fast mounting process with little disturbance of the inhabitants, no weather downtime for on-site works
- Ecological performance with high CO₂ storing capacity due to wood utilization, better LCA than polystyrene-based ETICS

Next steps before commercialisation

- Reduce thickness of additional layer
- Improve the treatment of interstices between 2 panels
- Build experience for the mounting of prefabricated modules

Prefabricated timber framed facade



 EU FP7 (GA No. 314461)

 bit.ly/2z1aEP2



Plug-and-Play product and process innovation for energy-efficient building deep renovation



*System prototype demonstration in operational environment
Demonstration: Residential district in Lekkerkerk, Netherlands*

Demand reduction

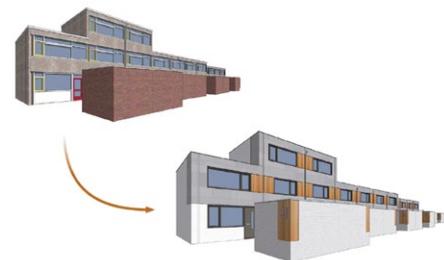
60%

Key Strengths

- Modular and adaptable to a wide range of building typologies: includes prefabricated multifunctional panel, efficient windows, thermal collectors, etc.
- 3D scanning and printing technologies
- Rapid production and on-site assembly with low-disturbance
- Monitoring and improved IEQ

Next steps before commercialisation

- Setting-up of local partnerships
- Standardisation of the P2ENDURE solutions and deployment of integrated packages
- Development of the P2ENDURE Technology Commercialization Platform for EU-wide take-up

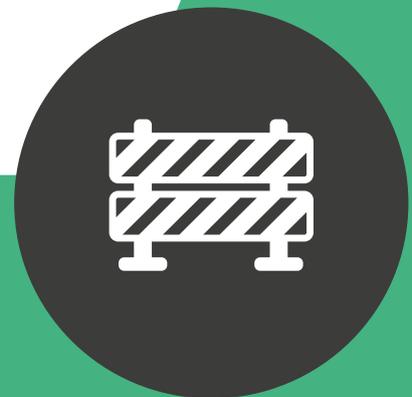


 EU Horizon 2020 (GA No. 723391)

 www.p2endure-project.eu



Barriers



EU-wide barriers for deep renovation

In the frame of STUNNING, various activities have been performed to understand the dynamics behind the market barriers that have impeded the EU to achieve the yearly targeted renovation rates and general objectives of the Energy Performance of Buildings Directive (EPBD). Moreover, potential solutions regarding these barriers were explored with particular focus on integrating SMEs, which represent over 84.6% of employment and 95% of the total number of enterprises in the construction sector in Europe.

The **preliminary analysis of the renovation market mechanisms and trends** was conducted through the observation of macroeconomic indicators such as energy prices, GDP, unemployment, loan and interest rates, along with energy efficiency policy instruments and more generalized data on deep renovations and the building sector throughout Europe. It was noted that after a long period of economic stagnation, conditions for the construction and renovation industry are currently favourable. The general economic framework is characterized by diffused economic expan-

sion, housing market growth and low interest rates, which implies a low yield of free and low-risk investments and the absence of attractive alternative forms of investment with the same risk profile. Despite positive macroeconomic conditions, growth of renovation investments until at least 2015 has remained rather weak, indicating the need for a more detailed study on market barriers. A review of existing literature, partner experiences and market knowledge as well as external consultation, interview processes, case studies and a full ranking and contextualization of the main barriers have led to significant conclusions. The following table provides an overview of the barriers that were contextualized in depth due to their high significance scores obtained in the STUNNING survey as well as barriers related to public procurement and Public Private Partnerships (PPPs). While most of these barriers limit the uptake of refurbishment solutions at the decision making level for homeowners and customers, others prevent key market actors to take part in the renovation processes and therefore hinder the delivery of a fully functioning renovation market.

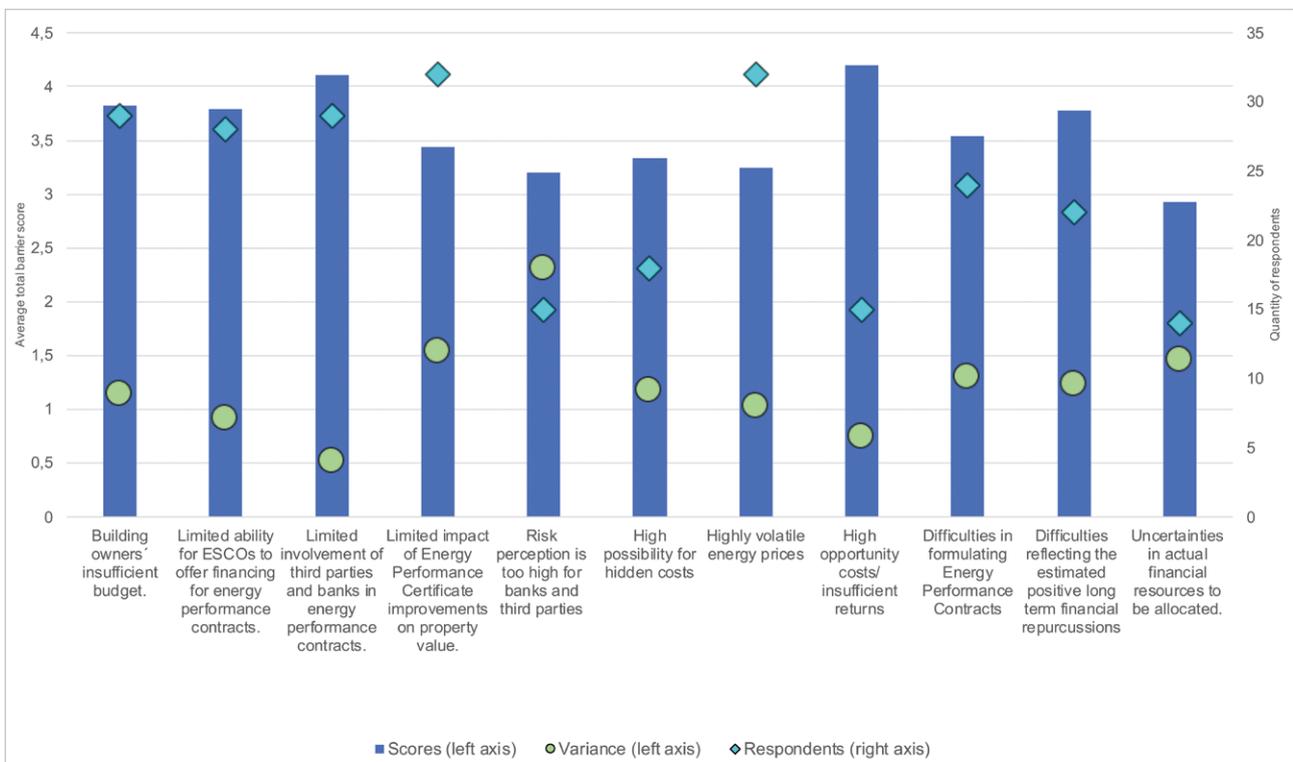
| Barrier Category | Barrier typology | Barrier |
|--|---|--|
| Barriers that limit uptake of refurbishment solutions at the decision making level for homeowners, buyers or end-users. (likely to be found in most regions in some form or another) | Technical | Performance gap and uncertainty |
| | | Lack of technological and product developments |
| | Embedded market inefficiencies | Split incentives and conflicts of interest |
| | Informative | Lack of knowledge dissemination and convincing end users of the benefits of deep renovations |
| | | Difficulties in conveying non-energy benefits of retrofits |
| | Financial | Limited financing options offered by ESCOs and limited TPF involvement |
| | | Limited impact of Energy Performance Certificate improvements on property value |
| | | Limited financing/insufficient budgets |
| | Barriers that prevent stakeholders taking part in the renovation process (architects, ESCOs, construction companies...) to implement with ease successful business models | Organization and structure of the EE renovation market |
| Insufficient resources on part of SMEs to tender for public procurement schemes | | |
| Regulatory | | Lack of continuity in regulations |
| | | Limited government subsidies and programs |
| Knowledge-informative based | | Lack of skills/Lack of training |

Within this set of barriers, certain typologies have garnered particular attention due to the amount of feedback received through interview and exchange processes with stakeholders, the significance scores they obtained in the survey and their recurrence and evidence in case studies. These typologies include financial barriers and barriers pertaining to the organization and structure of the energy-efficient (EE) renovation market. In terms of financial barriers, some of the most notable effects observed are the **limited capacities for energy service companies (ESCOs) to come up with financing options for potential energy performance contracts as well as the limited participation of third party financing entities**. In addition to savings requirements, borrowing for ESCOs also requires collateral and credit history which presents disadvantages for SMEs with scarce resources. These barriers are especially pertinent for smaller or new ESCOs with no previous experience in borrowing, poorly documented credit history and little resources for collateral. This hinders the market as a whole since ESCOs financing Energy Performance Contracts (EPCs) through third party financing (TPF) institutions could impose itself as a solution to the insufficient budgets

of stakeholders like social housing operators that have limited possibilities or inclinations for obtaining TPF themselves and **offer lower scale projects that are of little interest to ESCOs with funding capacity**.

The following figure summarizes the barriers significance scores for financial typologies obtained during the course of the project when interacting with different professionals and stakeholders from the architecture, engineering and construction sector. In addition to the actual significance scores, variance levels of responses for each barrier have been represented as well in order to provide indications on the disparity in scoring from different respondents. When variance is high, different respondents segmented in types of stakeholders, geographical areas or other variables appreciate the significance or importance of a barrier heterogeneously; when variance is low, a barrier is appreciated or "rated" homogeneously across all respondent categories.

Moreover, in terms of barriers pertaining to the EE renovations market structure and its shortcomings, particular focus is brought towards difficulties in co-



ordinating work with other stakeholders involved in projects as well as barriers relevant towards public procurement scheme barriers such as insufficient resources on part of SMEs to tender for these contracts.

Amongst the solutions investigated in the frame of the STUNNING project, particular focus has been put on the **potential of One-Stop-Shop business models and SME clusters**. These constitute **multi-stakeholder, multidisciplinary, cooperative-based solutions which tackle many of the identified barriers at the same time**. The creation of additional national or even transnational clusters of SMEs or associations with structures that truly favour multilateral interaction between all relevant stakeholders in the EE renovation value chain could serve as a viable driver towards increased EE renovation rates. Current as-

sociations and clusters are generally more compartmentalized by discipline rather than being comprehensive and including all elements and actors of the EE renovation value chain. Generally speaking, it has been demonstrated that barriers are not one dimensional and can be resolved through enhanced cross-sectoral and cross-disciplinary collaboration favouring synergies, learning opportunities and long-term cooperation in the EE renovation and construction sector. The aim of such clusters would be to **enhance collaborations among SMEs and other agents to pool financial and technical resources and provide integrated and innovative solutions in the EE renovation market**, joining SME products and services from the dispersed EE renovation value chain and providing solutions in service and product packages.

One-stop-shop and SME clusters should aim for the:

- Development of competitive new packages or integrated solutions
- Identification of complementarities among companies and encouragement of collaborative projects
- Promotion of knowledge exchange for the implementation of innovation and new development and business and professional exchange
- Enhancement of access to public assistance and potential investments in R&D
- Promotion of the participation of associates in the energy efficiency renovation market through information on tenders, commercial contracts, EPCs etc.
- Dissemination and promotion of capabilities, products or services offered by associates towards other industry professionals, as well as building owners and users (training courses, participation in trade fairs, conventions, promotional campaigns, etc.)

To read more about the detailed breakdown of barrier scores and on the different suggested approaches to alleviate the identified market barriers in the energy efficient renovations market, you can download the STUNNING deliverables D4.1 and D4.2 from the Renovation Hub: renovation-hub.eu

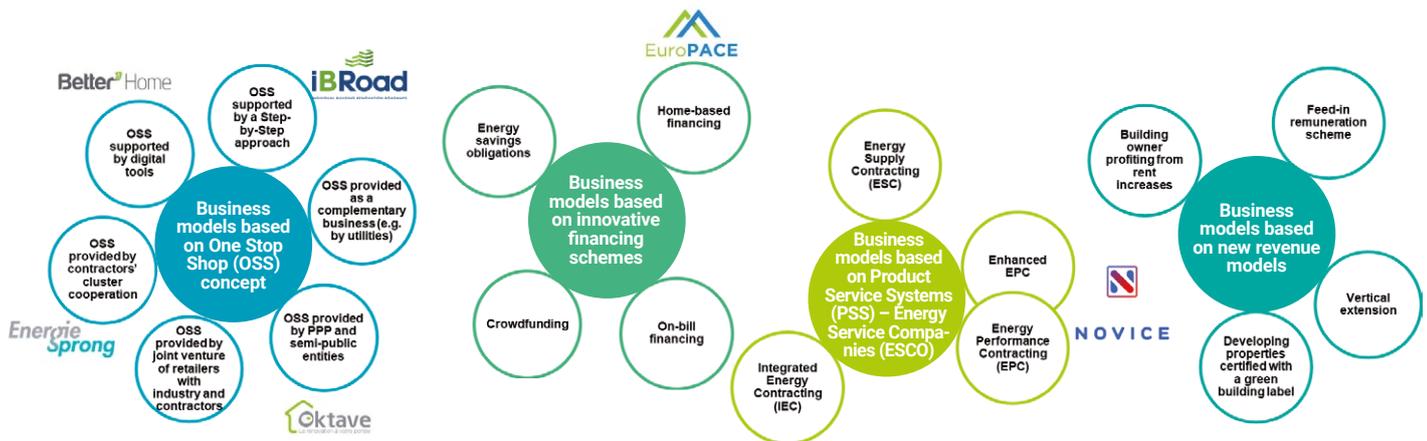
Business models



Approach and Mapping

Within the project, a substantial effort has been dedicated by the consortium towards the identification and evaluation of innovative business models (BMs) for key stakeholders of the construction sector. As a result, a structured business models Database has been created to collect data on business models and business cases so as to define BMs clusters. This enabled the identification of four main families of BMs that promote new routes to make renovation more affordable and bring the renovation rate up to 3% by 2020.

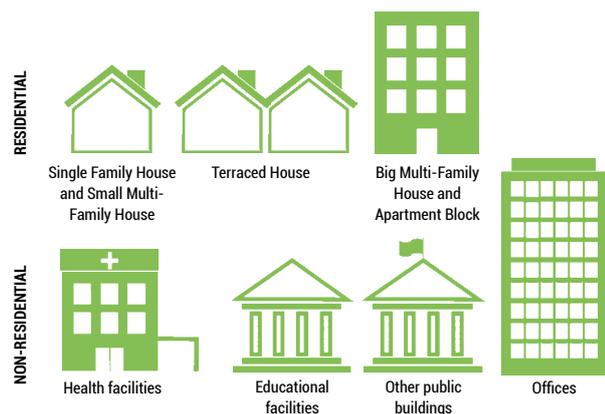
The figure below provides an overview of these four main families and related sub-categories of business models, among which the most promising ones have been evaluated according to their coverage in terms of targeted market segment (building typology, climate) and capacity to foster the achievement of European targets. Real business models are often a combination of several business model patterns, and BM families should not be considered in isolation: on the contrary, combining several patterns can provide a more robust business model.



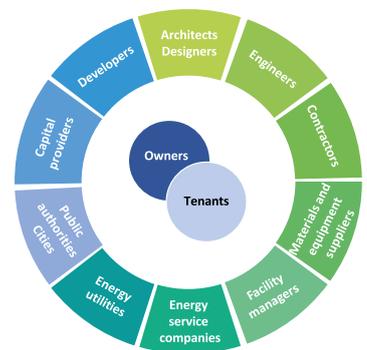
Each business model presentation is structured in four blocks: **What? Who? How? Why?**

“What” (value proposition): The “What” section describes what is offered to the target customer. This notion is commonly referred to as the value proposition. It represents the added value that a certain business model provides to the target customers.

“Who” (target customer): Every business model serves a certain customer group. In the context of STUNNING, the customers are the owners of the buildings to be renovated, and their nature (e.g. public, single owner, multi-owners, social housing association, etc.) is often correlated to the type of building that it is considered for renovation.



“How” (value chain, activities, resources): The third section describes how to build and distribute the value proposition, in terms of processes and activities, along with the involved resources and capabilities. The key partners for delivering the added value to the target customers as well as the technologies and processes involved in terms of refurbishment solutions are detailed. The involvement of the different stakeholders within the renovation value chain, depending on each specific business model, is illustrated by highlighting the key actors on a “Stakeholder map”.

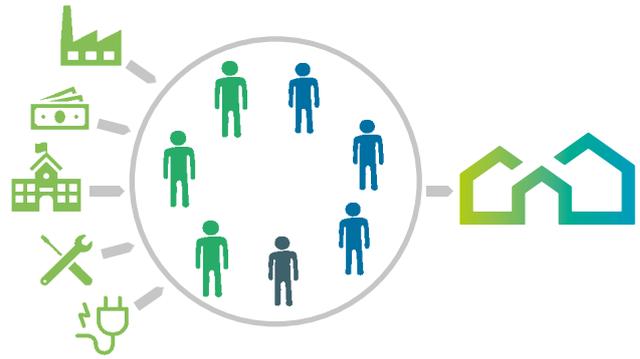


“Why” (revenue model and cost structure): The fourth section explains why the business model is financially viable. In essence, it unifies aspects such as the cost structure and the applied revenue mechanisms, generally from the point of view of the market actor using this business model to sell a service or a product.



One-Stop-Shop provided by a multi-disciplinary team

In this model the project is carried out by a **multi-disciplinary team in a cooperative manner**, consisting of partners with complementary competences, such as architects and designers, constructors, energy-efficiency experts, market and financial experts, technology suppliers, strategy and operations planners. Starting from the initial design phase, the team works together, in strict collaboration with the building owner, in order to select the optimal renovation measures to adopt, planning the whole renovation project according to customers' needs. The cross-fertilisation of gathering different actors together in an early phase of the renovation project permits to define a **holistic approach** to the renovation intervention. In this way sustainable and energy-efficient retrofitting solutions can be deployed,



with an optimal control over the total costs of the renovation project and guaranteed efficiency performances.

WHAT

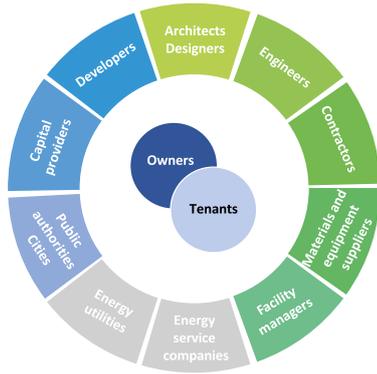
- Support of a wide network of professional multi-disciplinary team of experts, providing a holistic approach to the renovation project
- Owner directly involved in the definition of the intervention measures to be included in the renovation project
- Optimal integration of different measures thanks to cooperation between different actors involved in the renovation project
- Optimal control of the total costs in an early phase of the project
- Total design and operational concept for retrofitting which covers life cycle of the building
- Responsibilities and risks are shared between the members of the team
- Performance guarantee

WHO

The customer segments targeted by the multidisciplinary team cooperation business model are **large buildings (offices)** with private owners, or **multi-family buildings and terraced houses**, with private or public owners, with a specific focus on social housing.



HOW



The model covers the complete chain of players of the renovation sector, involving them in a collaborative approach of design, aiming at defining the renovation project, merging a range of expertise and professional capabilities. This leads to a more integrated and innovative result, with an improved quality of implementation.

WHY

For the service provider:

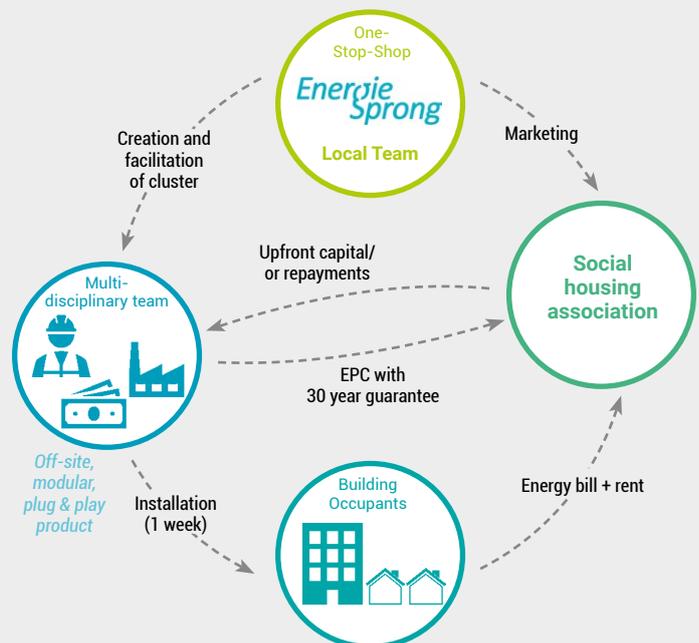
Saved costs and increased profit with the help of well structured and well managed process.

EXAMPLE

Energiesprong: Energiesprong is a whole house refurbishment and new built standard and funding approach. It originated in the Netherlands as a government-funded innovation programme and has set a new standard in this market. It is now being replicated in the UK, France, Germany and Italy.

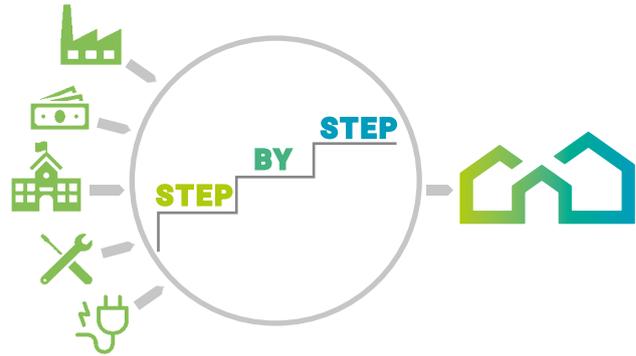


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| <p>Problem addressed Energy refurbishment is considered too complex and costly by home owners</p> |
| <p>The solution Desirable, warm, affordable homes for life <u>Net zero energy (NZE) consumption warranted over 30 years</u> Attractive, comfortable (new kitchen, bathroom) Investment financed 100% by energy savings over 30 years Retrofit performed in a maximum of 1 week</p> |
| <p>Target Social housing (terraced houses mostly, now also multiapartments) in the Netherlands, United Kingdom, France and Germany</p> |
| <p>How <u>Cooperation cluster</u> (solution providers, market development team, contractors and SMEs), partnership with social housing companies</p> |
| <p>Achievements Close to 10,000 renovations NZE certified Objective: enter mass market by 2020, target price of EUR 65,000</p> |



One-Stop-Shop supported by a Step-by-Step approach

The Step-by-Step renovation model is a widely diffused model of building refurbishment that consists in the replacement of different building components (such as windows, plasterwork, roof covering, boiler etc.) according to their life duration. One of the benefits of such an approach is that it gets the most out of each building component so that the initial investment is taken advantage of to its fullest. The need for replacements of various components arises at different points in time which means that in the case of a complete building retrofit, components that are still intact are renewed unnecessarily before their due time, leading to sub-optimal investments. With the Step-by-Step approach this can be avoided. When applying this approach, a **building renovation plan should be made for all measures, including those which lie in the distant future,**



before starting the work. In this way, it can be ensured that an optimal end result is achieved in terms of cost-effectiveness, energy efficiency and quality.

WHAT

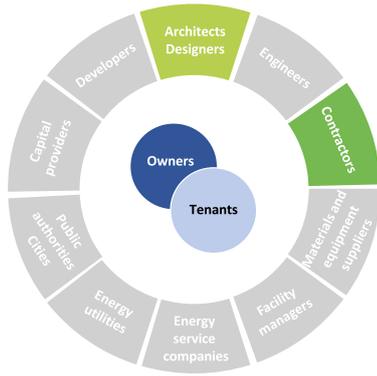
- With a Step-by-Step renovation, one can normally avoid unnecessary renewal of components that are still good in terms of appearance and functionality
- It allows to spread the investment costs for renovation measures over a longer period of time, which is easier to bear for the building owner (and the first generated energy savings can also be used to finance the following measures)
- A Step-by-Step modernisation may be developed even without taking out a loan, i.e. only equity may be used. For many building owners, this is the most important reason for carrying out renovation measures in succession instead of all at once
- Certainty that the agreed energy standard will actually be achieved thanks to the building renovation plan

WHO

The customer segments targeted by the Step-by-Step business model are **public or private building owners** that intend to renovate their property over a long period of time, targeting high levels of energy efficiency and a certification of the achieved results.



HOW



The public or private building owner defines, in collaboration with the designer

(planner), a plan for the renovation measures to be carried out and a timeline of their implementation.

The designer (planner) is the key player in this business model, because he/she is in charge of the whole renovation plan, including the different steps to be carried out and the time schedule. The owner maintains an important role being responsible, in collaboration with an optional project manager, of the entire project. The different contractors are involved by the owner (or eventually by the project manager) in successive phases, according to the initial plan of the renovation project. The design risk is shared between the owner and the designer, while different contractors assume the construction risks associated to each of their tasks.

WHY

For the designer (planner):

- The main costs are associated with the training for the use of the tool and accreditation, along with standard design activity costs (salaries, administration and support costs, marketing costs, etc.).
- Remuneration for the service provided. Additional revenues are related to the certification procedure (optional).

EXAMPLE

iBRoad: iBRoad project is strongly supporting building owners in Step-by-Step deep renovations, removing barriers and lock-in effects. With a proposed innovative approach, the project aims to become a real driver for deep renovation. Representing an evolution of the Energy Performance Certificates and energy audit systems, **building renovation roadmaps** developed within the project will serve as a tool outlining a customised renovation plan with a long-term horizon for deep Step-by-Step renovation of individual buildings (iBRoad-Roadmap) combined with a repository of building-related information (iBRoad-Logbook).

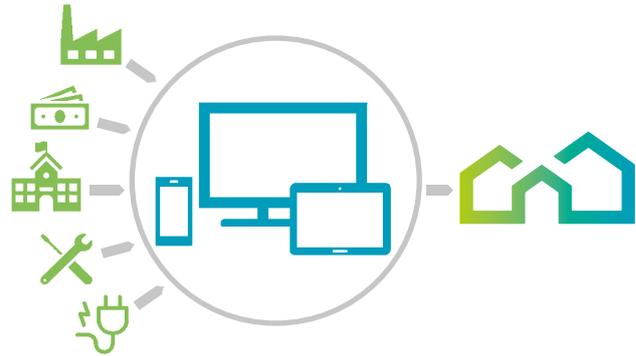


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| <p>Problem addressed</p> <p>Energy refurbishment is considered too complex, expensive and time consuming by home owners, lock-ins may occur</p> |
| <p>The solution</p> <p>Individual Building Renovation Passport with a customized Step-by-Step renovation plan with long-term horizon (Roadmap) plus a digital repository of building information (Logbook) Flexible approach: The Roadmap supports requests for quotes and financing while the Logbook supports building improvements and documents its performance. Initial savings can finance future steps</p> |
| <p>Target</p> <p>Residential buildings (with pilots in Germany, Bulgaria, Poland, Portugal)</p> |
| <p>How</p> <p>EU project with involvement of national energy agencies and a network of trained and qualified energy auditors. Targeting market and policy makers for broader adoption</p> |
| <p>Expected results</p> <p>iBRoad creates Roadmap, Logbook, training toolkit for energy auditors in pilot countries, policy and practice recommendations for EU-wide implementation</p> |



One-Stop-Shop supported by digital tools

In this business model the key player is supported by **digital tools guiding home-owners as well as designers (or contractors) in the initial planning of the renovation work.** The tool usually acts as a guide to optimize the application of the overall retrofitting process by for example collecting all the information related to the initial state of the building to be renovated and the preferences, the needs and desiderata of the building owner. The ICT tool processes the information gathered and suggests an optimised approach to the renovation project. The main advantage is the possibility to effectively manage the whole process in a comprehensive way. As the idea is very much based on creation and availability of process descriptions, checklists and tools, the maintenance and update of the material are key. It is also highly important to be able to create reliable initial information about the building stock and provide robust initial model. In order to make reliable assessment about the saving potentials in terms of energy and costs, the actors involved must be able to use



appropriately the tools for energy performance assessment and be able to make justified conclusions about the savings. Here the quality of the initial information is highly important. In addition, a solid understanding of the users' behaviour and willingness to commit to energy savings is essential.

WHAT

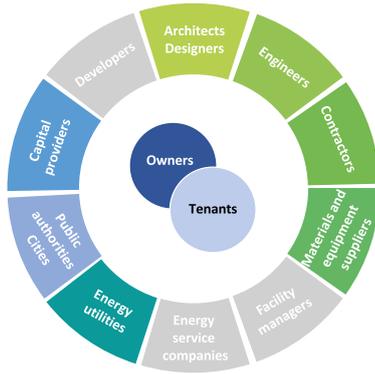
- Automation of the design process via the ICT tool, that supports for the identification of the best technical solutions and interventions to be implemented
- Comprehensive renovation intervention, including correct evaluation from the life-cycle perspective of energy-efficiency and overall costs
- Holistic approach to the renovation project, with the support of an ICT tool
- Effective process management – if sufficient initial information is provided
- Customer satisfaction monitoring and continuous improvement

WHO

The business model specifically targets **private buildings' owners** in the need of renovation and in particular single and multi-family buildings. Other possible building are private office buildings.



HOW



The ICT tool supports the key player (designer, contractor) in order to map the main project objectives and to suggest an optimized plan of renovation. This key player needs to be adequately trained. Other involved stakeholders include banks, providing the financing. The One-Stop-Shop and its ICT tool can be provided by manufacturers of renovation solutions (see Better-Home example), public authorities or energy utilities.

WHY

For the service provider:

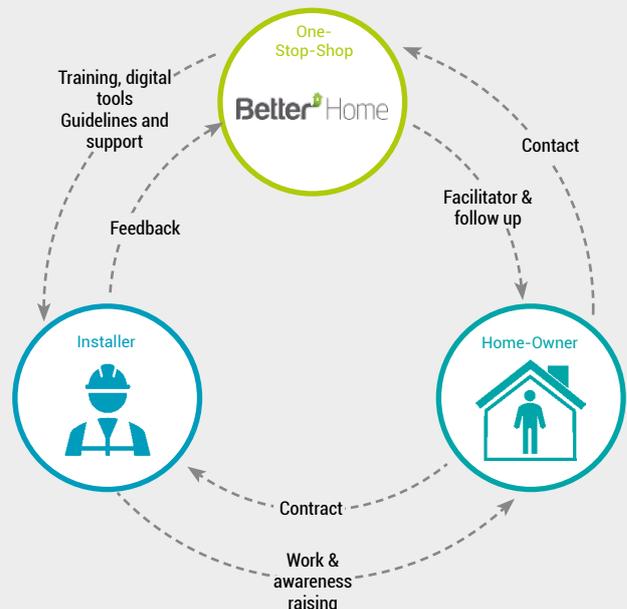
- Saved costs and increased profit with the help of well-structured and well managed process
- More efficient sales and thus better profit with the help of effective client profiling, initial data management and well-focused offering

EXAMPLE

BetterHome: BetterHome is an industry-driven One-Stop-Shop model, which has proven successful in boosting demand for holistic energy renovations in Denmark, since the model was launched in 2014 by Danfoss, Grundfos and Rockwool.



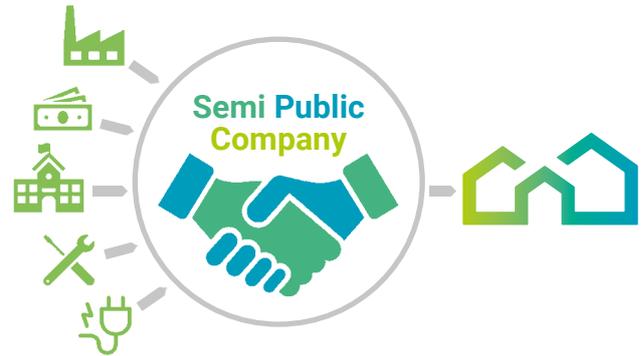
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| <p>Problem addressed Energy refurbishment is considered too complex by home owners</p> |
| <p>The solution Home-owner centric renovation journey: Transparent and reliable process, value for money <u>Digitalisation-driven</u> through web platform and digital toolbox</p> |
| <p>Target Single family houses in Denmark</p> |
| <p>How 4 founding companies (Danfoss, Grundfos, Rockwool, Rockfon) in cooperation with banks and network of installers</p> |
| <p>Achievements High conversion rate (>10% from leads to order) Turnover in all lead channels: EUR 66.7 mio. in 2015–2018 (1182 projects) Average project size: EUR 50,000–60,000</p> |



One-Stop-Shop provided by Public Private Partnerships and semi-public entities

Public Private Partnerships (PPP) are a well-known delivery model in the construction sector, involving a **contract between a public sector authority, the building owner, and a private contractor in charge of the management and the development of the building renovation project**. The private party provides the service to the public authority, assuming substantial financial, technical and operational risks in the renovation project. This model is already widely used around the world, on a project basis, i.e. a new PPP is usually settled for each building (or set of buildings) to be renovated.

The Energy Performance Contracts (EPCs) where the public sector uses private energy service companies (ESCO) through Public Private Partnership arrangements, fits for instance in this category, and more information can be found under the EPC description.



The collaborative model presented hereafter differs from the traditional PPP model and presents the model of **One-Stop-Shops (OSS) provided by semi-public entities**, where local authorities and private companies join forces to provide sustainable OSS structures – so called **renovation platforms** – to support the residential renovation market.

WHAT

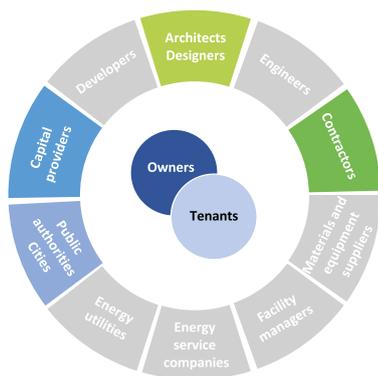
- Holistic and owner-centric approach to the renovation project, with the support of the renovation platform team
- Effective process management – the renovation platform team provides technical assistance and administrative support. It acts as a facilitator and, if asked by the owner(s), as a general contractor
- Support of a network of trained and referenced workers and contractors
- Pre-financing of incentives and in some cases third-party financing of the initial investment
- Comprehensive renovation intervention (not limited to energy), including correct evaluation from the life-cycle perspective of energy-efficiency and overall costs. This also enables to better assess the financial risk and support the application for a loan

WHO

The market segments targeted by this business model are **residential buildings**, mostly owner-occupied single-family houses. **Condominiums** are also targeted.



HOW



The “renovation platforms” providing the OSS are semi-public companies jointly owned by local governments/authorities and private entities such as banks. They develop a network of trained contractors/installers as well as key partnerships with banks (in some cases they can themselves provide third-party financing). The renovation platform acts as a facilitator between all involved stakeholders, and for specific project – if requested by the owner(s), it can itself be the general contractor.

WHY

For the semi-public entity:

- The costs of the renovation platform are mostly related to staff and marketing costs.
- Liquidities are also required to cover the pre-financing of investments and, when relevant, the loans to customers.
- Revenue types vary from one platform to the other and may include annual fees from the registered contractors/installers (who benefit from training and referencing) and fixed fees from customers (depending on the level of service requested). Usually public funding (regional, national or European – e.g. ELENA) is required to ensure the financial sustainability of the platform.

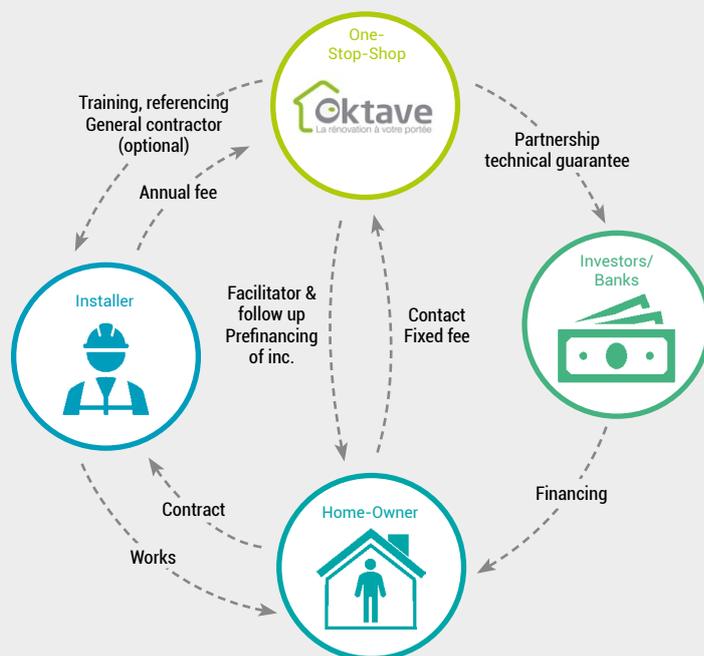
EXAMPLE

Île-de-France Énergies: Created by the Île-de-France Region, Île-de-France Énergies (formerly Energies POSIT’IF), is the Paris Region specialist for the energy renovation of condominiums with more than 50 dwellings. It provides a complete offer that makes energy renovation simple and accessible to everyone: audits, project management, implementation of a financing plan, construction monitoring, and performance monitoring.

Oktave: Oktave, the Integrated Service for Energy-Efficient Renovation launched by the region Alsace Champagne-Ardenne Lorraine, aims to considerably increase the number of thermal renovations in housing. Oktave, through a dedicated Mixed Economy Company, offers private households technical support and financing facility for their renovation projects (at present limited to single family homes).



| |
|--|
| <p>Problem addressed Energy refurbishment is considered too risky and costly by home owners</p> |
| <p>The solution Owner-centric, reassuring renovation journey: Administrative support Third-party financing Technical assistance Home improvement (beyond energy)</p> |
| <p>Target Single family houses and condominiums France, Région Grand Est</p> |
| <p>How Région Grand Est, ADEME, with involvement of local authorities, network of certified and trained installers, partnership with banks. Status of <u>semi-public company</u></p> |
| <p>Achievements 2014–w2018: assistance provided to 488 households, with 168 energy-efficient renovations (EUR 10.4 mio. – average EUR 622,000) 250 referenced installers/contractors</p> |



One-Stop-Shop with home-based financing

This business models took inspiration from the Property Assessed Clean Energy (PACE) concept, widely piloted in the US, where local governments issue bonds for renovation projects. The building owner repays the loan through an additional special "assessment" payment on its property tax bill for a specified term. These "assessments" are comparable to loans as the property owner pays off its debt in instalments over a period of various years but from a legal point of view they are not considered as such. When the property changes ownership, the remaining debt is transferred with the property to the new owner. In other words, PACE financing is a **mechanism set up by a municipal government** by which **property owners finance energy efficiency and renewable energy measures via an additional tax on their property**. The property owners repay the "assess-



ment" **over a period of 15 to 20 years** through an increase in their property tax bills. In the US, property tax payments are made annually or in arrears but payment modalities may be different in other countries, especially in Europe.

WHAT

- 100% upfront financing (mostly through green bonds), with long-term financing of up to 20 years
- Can be combined with utility, local, regional, and state incentive programs
- Financing is repaid with regular property taxes
- Simple and clear value proposition that speaks directly to people's needs
- Local energy services contractors act as local sales force ("PACE providers")
- Financing is attached to the property and can be transferred to a new owner upon sale
- Digital platform allows for quick and easy approvals of applications to the programme
- Technical and customer assistance is provided throughout the process
- Comprehensive consumer protection policies

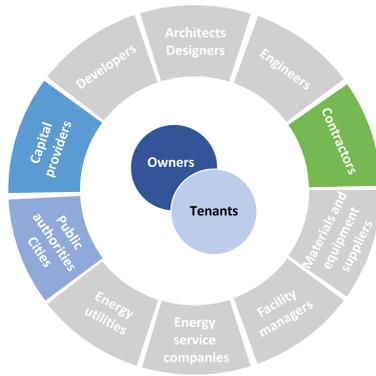
WHO

The customer segments targeted by this innovative financing scheme are in principle all building owners eligible for property taxes with a **particular focus on small, residential and commercial buildings** since these business models enable a long-term approach where building owners can spread the investment costs across the project life time. The model is relatively new, and current programmes



in the U.S. apply to owners of existing free-standing residential houses and commercial buildings.

HOW



Payments are collected using existing tax mechanisms: This so called on-tax financing is a type of financing mechanism used to collect repayments for investments in building improvements that meet a 'valid public purpose', e.g. save or produce energy. Typically, investors lend money for deep retrofits up-front and then get repaid regularly through an additional charge on a tax bill. The EU project EuroPACE (see below for more details) is a form of on-tax financing and it builds upon an existing relationship that municipalities have with their citizens – the property tax system. The local tax agency acts as the collecting agent for the repayments. Training is also provided to local contractors.

WHY

For the owner:

Upfront long-term financing: The funding covers 100% of all projects hard and soft costs and frees up disposable income for families and capital for businesses. Low interest rates for terms up to 20 years, while standard bank loans rarely exceed 5 to 7 years. PACE financing instruments aim at selecting energy efficiency and renewable energy solutions in a way that the additional property tax payment is lower than the cost savings achieved, thus aiming at annual net cost savings for the building owner.

For the local government/local authorities:

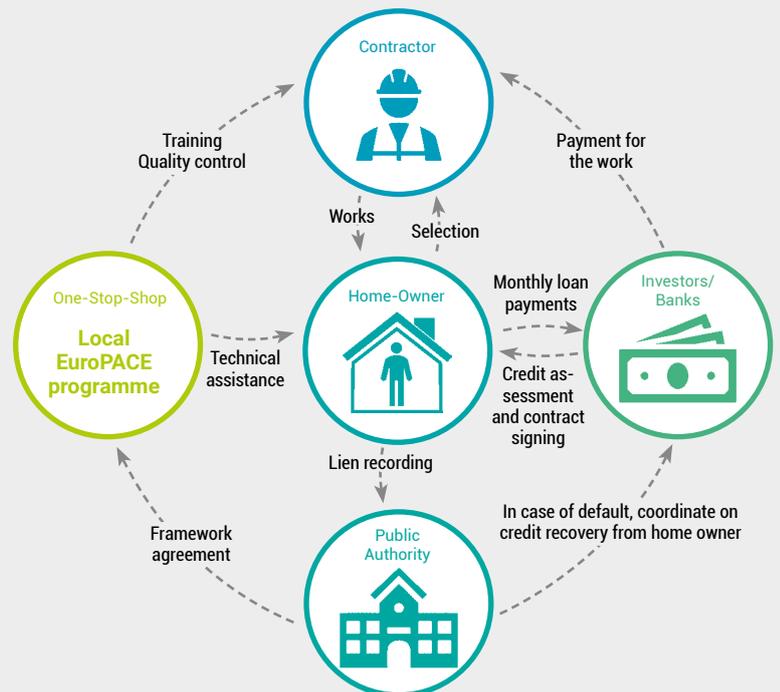
Unlocking of investment in energy efficiency thanks to green bonds.

EXAMPLE

EUROPACE: This home-based financing business model is now being adapted to Europe. EuroPACE project adopts best practices from the US PACE market and intends to further enhance its reach, scope, and overall impact well beyond the American experience. This Horizon 2020 EU-funded project started in March 2018 and will develop, pilot and standardise the PACE financing scheme for residential energy efficiency retrofits in European cities.



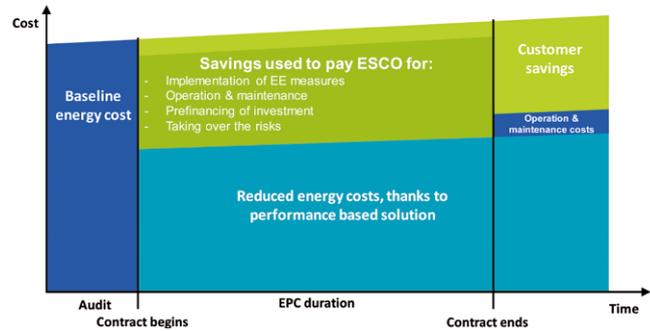
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| <p>Problem addressed Energy refurbishment is considered too complex and costly by home owners</p> |
| <p>The solution Simple, affordable & reliable home renovation for all <u>Home-based financing (attached to the property)</u> Technical support Home improvement packages: family well-being Quality control</p> |
| <p>Target Single family houses, apartments Country: depending on market readiness</p> |
| <p>How EU project, with involvement of local authorities, a network of trained and qualified energy contractors, partnership with banks</p> |
| <p>Achievements First pilots will be launched in 2019. Based on the successful PACE programme from the US (\$2 billion of investment and 90,000 projects completed in California from the launch in 2011 till mid 2019)</p> |



Energy Performance Contracting (EPC)

The EPC model is based on delivering energy savings compared to a predefined baseline. In this model, an Energy Service Company (ESCO) enters into arrangements with property owners to improve energy efficiency of their property by implementing various measures. The ESCO guarantees energy cost savings in comparison to a historical (or calculated) energy cost baseline. **For its services and the savings guarantee, the ESCO receives performance-based remuneration in relation to the savings it achieves.** Generally, savings achieved can only be measured indirectly as difference between consumption before and after implementation of the energy efficiency (EE) and renewable energy (RE) measures (relative measurement: savings= baseline – ex post-consumption).

Most EPC projects focus on the implementation of energy efficiency measures (lighting, HVAC, energy



management and control, envelope insulation). EPC models run under long-term contracts of **typically ten years**, depending on the payback time of the energy savings measures and the specifications of the building owner (i.e. they may last up to 15 years when they include long payback period investments such as wall insulation or window replacements).

WHAT

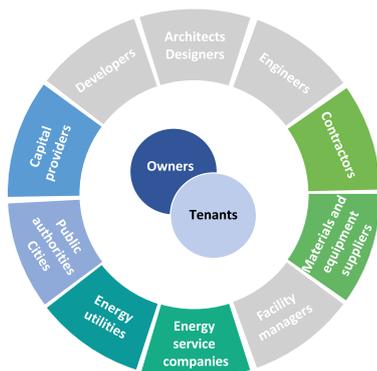
- The ESCO provides a **customized service package** which includes design, installation, (co-) financing, operation & maintenance, optimization and user motivation
- For many customers **financing** is the most attractive part of EPC services for buildings
- Key benefits include **risk transfer**, the ability to modernise a building's energy infrastructure without necessarily having the funds and accessing external expertise and the **performance guarantee**
- The key focus is on saving energy first at the point-of-use before optimizing the respective energy supply

WHO

EPCs are mostly found in the public sector (for e.g. universities, hospitals, swimming & leisure facilities) and to a lesser extent in the industrial and commercial building sectors. This is because **a large project is a prerequisite** (the minimum energy cost baselines are usually at 200,000 €/year). EPCs have also been trialled for large residential building blocks.



HOW



The ESCO acts as a general contractor and is responsible for the implementation and operation of the energy efficiency package at its own expenses and risk, according to the project specific requirements defined by the client and the ESCO. The final energy purchasing (electricity, fuels) usually remains with the building owner.

ESCOs can also finance or arrange financing for the operation (with a third-party financier) and their remuneration is directly linked to the demonstrated performance regarding the level of energy savings or energy service. Finally, to ensure that the building is used in the most efficient way, building occupants receive training on energy efficiency practices.

WHY

Cost structure:

Costs for the ESCO include the implementation of the EE/RES measures, their operation & maintenance, pre-financing of the investment and taking over risks according to the project specifications defined in the contract. **Transaction, measurement and verification costs of EPC projects are high.** Determining and adjusting the baseline is a crucial issue in the EPC business model as it can generate a considerable degree of insecurity and monetary risks for the ESCO and needs to be undertaken for all performance-based billing periods over the entire contractual term.

Revenue stream:

In Energy Performance Contracting, the ESCO's remuneration is performance-based:

- It guarantees for the outcome and all-inclusive costs of the services
- It takes over commercial as well as technical and operational risks over the project term

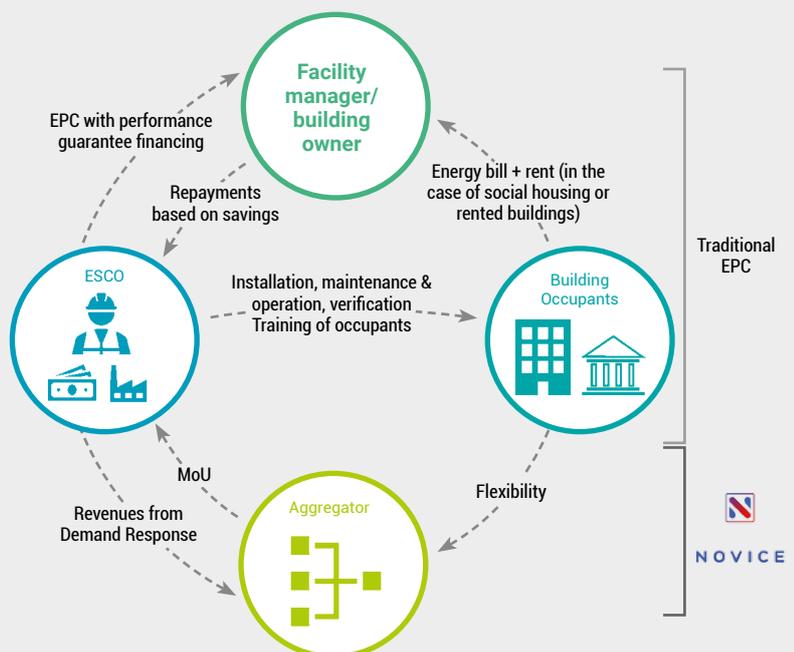
Two options exist:

EPC with shared savings and EPC with guaranteed savings. In the first case, the ESCO shares an agreed percentage of the actual energy savings over a fixed period with the customer. An ESCO's share of savings typically falls within a range from 50-90%, with 65-85% representing the most common range of values. In the second case, if the savings are less than expected, the ESCO covers the shortfall. If the savings are overachieved, the ESCO can recover the excess. After the end of the contract term, the facility owner benefits from the full energy cost savings but all operation and maintenance expenses are on his accounts.

EXAMPLE

NOVICE: The "enhanced" version of the EPC model proposed by NOVICE project and illustrated here consists in consolidating services and subsequent revenue streams from both energy savings and flexibility at demand side by combining the classic EPC model with Demand Response Services.

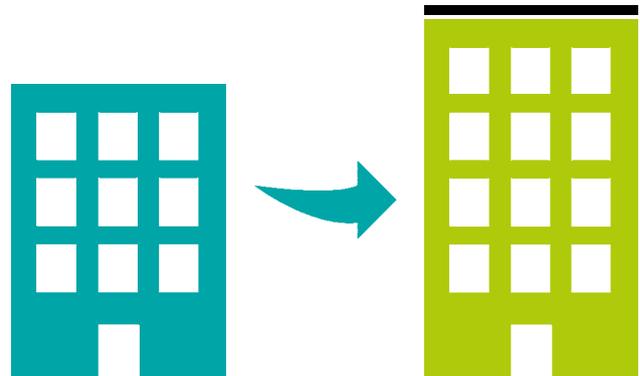
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| <p>Problem addressed Energy refurbishment is considered too complex and costly by building owners</p> |
| <p>The solution Customized service package with energy performance guarantee Investment financed by energy savings In the case of the "enhanced" EPC: shorter payback period and improved comfort thanks to Demand Response Services</p> |
| <p>Target Large public and commercial buildings, also buildings blocks</p> |
| <p>How The ESCO acts as a general contractor, takes over the risk and can provide financing. For the "enhanced" EPC, the ESCO remains the single point of contact for all measures but uses the services of a demand response aggregator to provide services to the grid</p> |
| <p>Achievements EPCs have been used in the EU since the 80s (mostly in the public sector), but the market remains underdeveloped in comparison to the US NOVICE pilots to be launched in Austria, Finland, Germany, Ireland and UK</p> |



Add-on business model

The Add-on business model is a renovation strategy corresponding to the construction of one (or a set of) additional building unit(s) – **which might include besides facade additions also rooftop “vertical” extensions or even a new side building construction** – that are added to the existing building when performing renovation works.

When combined with the adoption of EE or RET measures, volume additions are interesting types of intervention since they instantly produce new, commercially valuable dwelling areas which could compensate the costs of energy-optimisation through the sale or the rent of the new dwellings.



WHAT

- The renovation process is performed through the **addition of volume** to the building being it a rooftop “vertical” extension, a facade addition or even a side building. Usually this type of model utilizes industrialised construction methods and prefabricated elements in order to **shorten project time and reduce the impact on tenants**
- The added building volume and dwelling area generates a **bonus** and is a **complementary economic instrument for investors** (real estate investors, construction companies in conjunction with ESCO, etc.)
- May act as an **attractor for private sector financing**, playing an extremely important role, in particular in contexts of scarce private finance where the search for smart financing of upfront investments is crucial

WHO

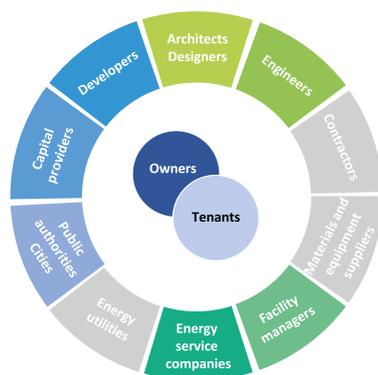
Preferred target buildings for Add-on business model are **large residential buildings** in the need of renovation, in particular traditional building stocks built in the 60s or 70s. Also large non-residential buildings could be targeted by the business model.

It is also worth mentioning the attractiveness of add-ons for **single family houses**. In this case the financial benefit is not the selling point, but rather the gain in comfort, accessibility and value property generated by a home extension. The decision



to extend a home (for instance when a family grows and requires additional space) can therefore be the trigger to carry out a complete energy efficient renovation.

HOW



The Add-on business model usually involves a group of experienced architects and design planners working with a par-

ticular attention to building quality and architecture, and its structural characteristics (i.e. its capacity to support an extension).

The involvement of a capital provider is also required: the Add-on strategy indeed requires high upfront costs. The construction process usually employs industrialized processes and prefabricated elements that will minimize technical issues and disturbance to tenants.

From a social perspective, the proposed approach has to face a major challenge which should not be underestimated: the collection of the consensus from the inhabitants in case of social housing and condominiums.

WHY

For the building owner:

- The Add-on business model is usually financed by a third party.
- This model (also in combination with RES measures) can be offered by a commercial bank as future revenues for the loan applicant are expected from either rent or sales.
- Results from the ABRACADABRA project prove that additions are very effective in cities and countries characterized by a high real estate value and by a higher difference among the renovation / construction costs and selling price point per square meter (€) in the reference market. In those cases, the economic gains obtained through the sale can compensate both the investment of the energy retrofit and the cost of renewable energy technologies.

EXAMPLE

ABRACADABRA: The Add-ons business model was studied in depth by the EU funded project Abracadabra: www.abracadabra-project.eu

LIGN2TOIT: The French project LIGN2TOIT, funded by ADEME, investigated the environmental and economic viability of vertical extension to finance deep renovation: www.mecd.fr/lign2toit

One-Stop-Shop category

One-Stop-Shop provided as a complementary business (by e.g. utilities)

WHAT

- Full-service renovation, including financing:
- Qualified advice with energy audit
 - Relevant competitive products and prices
 - One point of contact, coordinating a network of trained and labeled installers
 - "Hassle free" with quality and delivery guarantee
 - Financing (both mortgage loan and unsecured loan)
 - Handling of possible subsidies

HOW

The main service provider is a company, e.g. an energy provider, that decides to expand its business into renovation. The main supplied activities include: marketing, advice (usually on single products to achieve the largest energy savings), contact of network partners (e.g. arranging client visits of auditors and installers), support to obtain financing, offer for renovation and after sales services (i.e. checking customer satisfaction).

WHO



Owners of single-family houses with energy saving potential.

WHY

The service provider benefits from increased customer loyalty. In some EU countries, this model can be supported by white certificates. The costs are related to the administration, support, marketing and training activities.

EXAMPLES: Energieheld (Switzerland); EDF (France)

One-Stop-Shop category

One-Stop-Shop provided by joint venture of retailers with industry and contractors

WHAT

- Easy access to building refurbishment services, all from one trusted vendor as single-point contact retailer
- Flexible funding and benefits for frequent customers based on different purchasing ways (all/partly installed, products-only, flexible project schedules)
- Project management (e.g. assist obtaining approvals from local authorities and application for subsidies, quality assurance, energy certificate, etc.)

HOW

A key partner is the retailer (or the supplier of a building product), which ensures the following activities: marketing, selling of all products needed in home renovation as well as most of the services requested during renovation (e.g. planning, installation by a network of installers, etc.).

WHO



Owners of single-family houses built around 60s or 80s that urgently need renovation.

WHY

Revenues are the payment from customers for the services and products purchased, incl. a commission for the retailer. Costs include material and marketing costs and subcontracting of the renovation work.

EXAMPLES: K-Rauta (Finland); Leroy Merlin (France)

One-Stop-Shop category

One-Stop-Shop provided by contractors' cluster cooperation

WHAT

- Delivered by a cluster of contractors, incl. SMEs, with a very informal structure acting as a big company: This lowers the vulnerability compared to isolated SMEs (faster partner switch in case of a problem)
- Comprehensive approach and integrated design
- Overall project management
- Supervision of retrofit work
- Quality assurance scheme and its implementation
- Commissioning and handover

HOW

The key activities implemented by the cluster include marketing, consultancy on best technologies, cluster set-up and management, negotiation and bidding. Key partners shall be found for financing (ESCO, bank, etc.), investment schemes as well as handling subsidies.

WHO



Individual houses (one owner), non-residential buildings (mix or individual ownership), multi-family buildings (many owners), public buildings (schools, hospitals, offices).

WHY

Direct project costs involved in traditional renovation plus administrative, marketing and commissioning costs. Revenues include payment from customers for renovation work, commission from suppliers.

EXAMPLES: Interreg IVb GREENOV project (Europe); Projekt Lavenergi (Denmark)

New financing schemes

On-bill financing

WHAT

Installation of renewable energy technologies or energy efficiency measures with no upfront cost. Refund of the low-interest loan is made through the home-owner energy bill with 2 possible options:

- On-bill loan: a personal loan is issued to the building owner, repaid as a specific item on the utility bill
- On-bill tariff programme: obligation for payments stays with the property and is transferred to the next owner in case of property sale

HOW

Utility companies are frequently able to finance the programmes themselves as they have enough equity capital and access to debt facilities. However, the utility may also rely on additional partners for financing, such as banks, ESCOs or government bodies through revolving funds. Installers of renewable energy equipment may be involved by partnering with utility companies.

WHO



Owners of single-family houses and small commercial buildings who want to refurbish existing buildings, also owner-occupied and renter-occupied apartment buildings.

WHY

For utility companies, it is a secure way of recovering the loan and leads to higher customer loyalty. They can also disconnect customers from utility services in case of default of payment.

New financing schemes

Leasing of Renewable Energy equipment

WHAT

Use of a renewable energy installation without having to purchase it. The installation is owned or invested in by another party, usually a financial institution such as a bank. The building owner pays a periodic lease payment to that party which enables:

- Flexible leasing terms (in comparison with a loan)
- Optimal use of subsidies and tax deductions

There are two main types of leases: operational and financial lease.

HOW

Usually a building owner takes a lease while a financial institution or bank provides it. Leasing can be a central component of the business model of an ESCO having limited capital (in this case it acts as a facilitator, undertakes the negotiations with the financial institution, provides additional services to the building owner and acts as the tenant of the equipment). Also, a company aiming to introduce a new technology to the market may offer leasing of these technologies to a building owner or user.

WHO



The leasing model for renewable energy equipment can be applicable to all types of buildings.

WHY

For ESCOs, the flexible leasing terms mean more flexibility. For technology providers, they keep the responsibility for maintenance and have the opportunity to distribute a technology that is still too costly to be sold.

New financing schemes

Energy Savings Obligations

WHAT

Energy Saving Obligations are a policy tool obliging energy companies to implement energy savings at the level of end users. It stimulates other business models where financial incentives are offered by the energy suppliers to building owners, renters or energy service companies. For building owners, this reduces the barrier of high upfront costs and can be combined with other services e.g. energy audit, financing, installation.

HOW

Energy Saving Obligations stimulate energy companies to develop new energy efficiency services for end customers. The directly involved actors are therefore energy companies, usually energy suppliers or distributors on whom the obligation is imposed. They often work in partnership with electricians and installers or outsource the obligation and delegate it to an ESCO.

WHO



Can be applied to all types of buildings. Countries where such schemes have been implemented include UK, IT, FR, DK, BG, PL, ES, IE, AT, SI, LU, GR, LV.

WHY

Generally, energy companies transfer the costs of the energy efficiency measures to end consumers through higher energy prices.

EXAMPLES: See "One-Stop-Shop provided as a complementary business (by e.g. utilities)" page 34.

New financing schemes

Crowdfunding model

WHAT

The capital required to finance a renovation project is raised through small collective efforts from a large number of people, friends, family members, customers and individual investors. The crowdfunding of real estate started in the US, it took off in Germany in 2015 and is spreading quickly. Some of the financed projects target the renovations of existing buildings, the installation of renewable energy technologies or the renovation of cultural heritage.

HOW

Individuals, companies, local authorities or associations seek financial assistance from third parties to finance their project through a specialised crowdfunding platform. Participation can take place in several forms:

- Donation with or without reward
- Participative investment with the acquisition of shares in the supported project
- Loan giving with or without interest

WHO



Residential buildings, public buildings, educational and historical buildings. The projects should create public value.

WHY

The cost and revenue model depends on the type of building and the type of participation, e.g. from donation without reward for a historical building to a loan with interest for a multi-apartment building.

Innovative revenue models

Feed-in remuneration scheme

WHAT

- Support scheme allowing the producer of renewable energy to receive a direct payment per unit of energy produced.
- Predictable long-term source of income from a usually reliable counterpart (typically 8–20 years)
- Can cover the financial gap between the generation costs of renewable energy and conventional energy
- Opportunity to combine it with available support mechanisms

HOW

The two main actors are the organisations that make the payment available (government, network operator, energy supplier) and the recipient (home-owner, building manager or energy service company). In the case of building refurbishment, feed-in schemes can be used by households and SMEs who want to generate their own energy using renewable sources. Such business models can be focused on production for own use or for the sale of energy to the grid.

WHO



New and existing buildings, public, commercial/industrial and residential buildings.

WHY

The level of remuneration is based on the category specific generation costs (usually estimated through the size of the installation, e.g. installed capacity in kWp for PV), but the actual payment is based on production.

Innovative revenue models

Properties certified with green building label

WHAT

Increase of the property value after renovation thanks to a "Green Label" and an improved Energy Performance Certificate:

- Guarantee of building performance
- Lower operating costs and additional benefits such as increased comfort for building users
- Ability to get a premium price for property certified according to a green standard

HOW

In addition to the stakeholders from the construction value chain that are usually involved, this business model also includes certification providers.

They provide building inspection and energy audits, post renovation information plus application for approval of certification bodies. An alternative to a certified green label is the Energy Performance Certificate, which needs to be provided when selling a property.

WHO



All market segments for new and existing buildings, for commercial/residential/public properties and for rented and owner-occupied properties.

WHY

In addition to gains from energy savings, the cost of renovation can be partially recovered when selling the property through a price premium associated to the green value (from 5 to 30% depending on countries and regions).

EXAMPLES: DINAMIC study, 2015 (France); ADEME Preliminary analysis of the green value for housing, 2011 (France)

Innovative revenue models

Financing through rent increase

WHAT

- Financing of the renovation through an increase of the rents (including for buildings of the regulated rental sector)
- Reduced operating costs of renovated buildings
- Enhanced levels of comfort and satisfaction for building tenants

HOW

Directly involved actors are property owners (housing associations, individuals, corporate or institutional investors) and tenants.

In the case of the regulated rental sector, the business model also involves governments which set the rental regulations.

WHO



Renter-occupied residential buildings and social housing associations.

WHY

The building owner finances the renovation (usually with the support of a bank) and recovers its investment (or repays its loan) thanks to the reduced operating costs and the rent increase.

ESCO models

Integrated Energy Contracting (IEC)

WHAT

Hybrid of Energy Supply Contracting (ESC) and Energy Performance Contracting (EPC):

- "Energy efficiency first"
- Combination of comprehensive energy-efficiency measures with energy supply in one service package
- Flexible and case-by-case approach to measurement and verification, the "deemed savings" approach is used to reduce transaction costs and the implementation of Quality Assurance Instruments

HOW

The ESCO is responsible for the implementation and operation of the energy efficiency package. In some cases a joint venture with construction companies and energy consultants can be created, also financing can be included.

The purchasing of final energy (electricity, fuels) usually remains with the building owner.

WHO



Commercial and public buildings (universities, campuses, hospital sites and larger schools, etc.) as well as the residential sector.

WHY

The ESCO is remunerated for the energy actually delivered, in combination with a flat rate for operation & maintenance. It is financially responsible for the implementation and operation of the energy supply package agreed with the client at its own expenses and risks.

EXAMPLE: Landesimmobilien-Gesellschaft mbH (Austria)

ESCO models

Energy Supply Contracting (ESC)

WHAT

- Reduction of final energy demand with performance based long-term contracts of typically 10–15 years, clear and optimized operational costs
- Usually limited to the energy supply, with the provision of heat, cold air, compressed air or electricity
- Often includes supply of final energy through the ESCO

HOW

- The Energy Service Company (ESCO) supplies useful energy, such as electricity, heat or steam under a long-term contract to a building owner or building user
- This complete service package encompasses the entire process: Financing, engineering & planning, construction, operation and maintenance of the energy supply system

WHO



New and existing public, industrial, commercial and large residential buildings (for which minimum project sizes have been specified to be economically viable).

WHY

The ESCO is remunerated for the energy actually delivered, in combination with a flat rate for operation & maintenance. It is financially responsible for the implementation and operation of the energy supply package agreed with the client at its own expenses and risks.

EXAMPLE: Frequently used by large public buildings for the installation of CHP or biomass boilers.

Case studies



Residential buildings in Munich

Description

The rejuvenation and redensification of this residential buildings located in Munich was implemented thanks to the E2Rebuild project, funded by the Seventh Framework Programme (FP7) of the European Union.



The residential multi-storey buildings in the suburb of Sendling, Munich (Germany), owned by the public housing company GWG München and made up of uniform standard concrete brick blocks, was built in the post-war decade of the 1950s. The building

has been fully retrofitted, including the replacement of the attic by an additional floor to create more rental space, increasing the total ground floor area to 3,323 m² (originally 2,012 m² or +65%, in phase 2 +155%).

Involved stakeholders

Funding/Research: Kreditanstalt für Wiederaufbau (KfW, German state-owned development bank); Deutsche Energie-Agentur (dena, German federal owned energy company); LH München (municipality)

Architecture + Management: Kaufmann.Lichtblau.Architekten

Engineering: MKP Merz Kley Partners

Building Physics: bauart Konstruktions GmbH

Building services, HVAC: IB EST Energie-System-Technik



Sendling district,
Munich
Germany

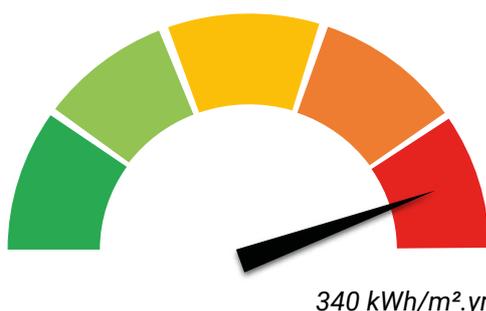
Local constraints/regulations/incentives

- **Climate:** Southern
- **Local constraints:** The tenants were mainly elderly people with varying social backgrounds. As the complex renovation proposal of the Munich Demo Project required empty buildings, all tenants were relocated to other GWG dwelling houses in the vicinity at an early stage.

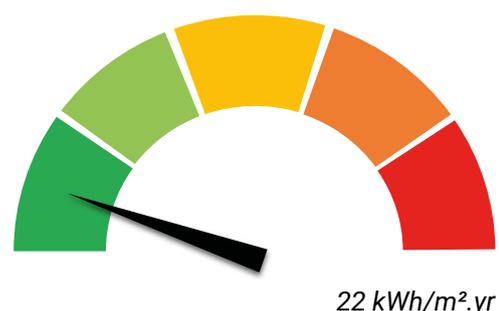
Building characteristics

- **Use:** Residential
- **Type:** multi-storey buildings (36 flats)
- **Construction date:** 1950s
- **Total ground floor area:** 2,012 m²
- **Ownership:** Public ownership (GWG 'Städtische Wohnungsgesellschaft München mbH' is one of the two big public social housing companies, owned by the City of Munich)

Performance before



Performance after



Refurbishment package

The main refurbishment actions performed included:

- TES Energy Timber-Facades, prefabricated with cellulose insulation added to existing outside walls, U-wall 0.12 W/m²K. Painted timber windows with triple glazing, U-window 0.9 W/m²K and outside solar control fixtures.
- The roof consists of visible timber beam construction, highly insulated with U-roof 0.11 W/m²K and greening on top. Accessible terraces and thermal solar collectors occupy the whole surface area.
- Central heating system (CHP combined heat + power, planned before: wood pellet boiler plant), two central heat storage tanks (20 m³) with dual piping system and fresh hot water substations
- Space heating and domestic hot water assisted by two solar thermal collector systems (208 m²) over green roofs, (solar photovoltaic system proportionally provided over green roofs of building phase 2)
- Controlled ventilation of flats (fresh & waste air) with heat recovery, distributed system for flats (cheaper & facilitated fire safety) centralised in new building for the district office and habitations



Associated business model

Add-On business model
» p. 32

Financing

The total renovation costs amounted to 950 €/m² (gross cost groups 300+400) of gross floor area. The funding was provided by KfW, dena, LH München and Europe in the framework of FP7.

Lessons learnt and guidelines for replication

Technical

From a technical point of view, the planning team and the building contractor noted that the theoretical innovation potential of construction methods and processes is absolutely case-specific and can only succeed if done Step-by-Step, depending on the competence, willingness and potential of the contractors.

Together, the owners, tenants and planning partners have to improve in:

- arranging and developing innovative methods with partner companies and craftsmen
- measurement sequences in complex conversion processes
- finding ways to establish new regulations in order to get the right partners, not only regarding competence but also professionalism

Environmental

Bird nesting season and the protection of existing trees were taken into account when designing and planning the renovation.

Social

A fundamental change in awareness and quality of communication plays a vital role in accomplishing the



desired standards for the future. Tenants therefore need to be at the heart of the renovation of their building and the interests of the inhabitants have been a central concern in the planning stage. A high degree of prefabrication of construction elements and building envelope (TES Energy Facades) reduced the construction times and stress of all participants to a minimum.

Finally, a tenants operation manual and recommendations (edited by the architects), simple and low maintenance technologies, efficient lighting system etc. contributed to an easy understanding of the living environment and low operating costs.



www.smartcities-infosystem.eu/scis-projects/demo-sites/e2rebuild-site-munich
www.smartcities-infosystem.eu/sites/default/files/e2rebuild_demonstrator_munich.pdf

Sneinton district in Nottingham

Description

The renovation of Sneinton district was implemented in the framework of the EU H2020 funded REMOURBAN project.

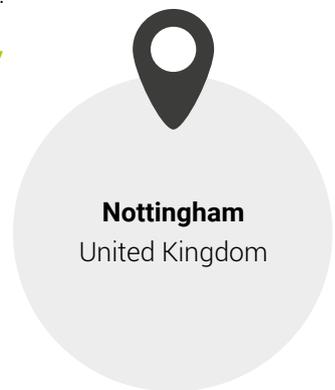
The project included the renovation of a variety of property typologies in Nottingham within the Sneinton area ranging from single-family to multi-family houses, and in age, from 1900 to the 70s. A large number of the properties (65%) in the area are social housing, owned by Nottingham City Council (public owner) and managed on their behalf by Nottingham City Homes. The project included both energy efficiency measures (mainly walls insulation) and the connection to district heating.



efficiency measures (mainly walls insulation) and the connection to district heating.

Involved stakeholders

- Public owner:** Nottingham City Homes
- Municipality:** Nottingham City Council
- Research:** Nottingham Trent University
- Energy advisory agency and management:** Nottingham Energy Partnership
- Funding:** Nottingham Credit Union
- Contractors:** INFOHUB Ltd.; SASIE Ltd



Local constraints/regulations/incentives

- **Climate:** Western
- **Local constraints:** The mixed public/private ownership of buildings was a barrier because it affects decision making processes. The inefficient communication and confusion over sharing the responsibility between the different departments of the municipality resulted in delays.
- **Incentives:** The H2020 funding for these measures will be maximized with national Energy Company Obligation (ECO) funding. To help householders pay for their contribution, NEP and Nottingham Credit Union introduced a zero interest loan.

Building characteristics

- **Use:** Residential
- **Type:** Single family and multi family
- **Construction date:** from 1900 to the 70s
- **Total Ground floor area:** 23,318 m²
- **Ownership:** Mixed Private and Public ownership
- **Building management:** 65% of the properties in the area are social housing, owned by Nottingham City Council (public owner) and managed on their behalf by Nottingham City Homes

Performance before



97 kWh/m².yr

Performance after



43 kWh/m².yr



Refurbishment package

As this project was also part of the Energiesprong UK programme, an “Energiesprong-type” package (with prefabricated façade) has been implemented.

Financing

Each home owner/private landlord received a Remourban grant towards the work, leaving a contribution of between 1,400 € and 2,536 € (£1,260 – £2,280) to pay, depending on the property type. Without the grant, this home improvement would normally cost upwards of 8,900 € (£8,000).



Associated business model

One-Stop-Shop provided by a multi-disciplinary team

» p. 20

Public Private Partnerships and semi-public entities

» p. 26

Lessons learnt and guidelines for replication

Technical

In the framework of the REMOURBAN project, a series of technologies were implemented including photovoltaic panels, local micro generation systems, insulation and ventilation measures and sustainable heating systems.



The main lesson learned concerned the importance of an integrated approach to the planning and management of technical solutions to adopt at district level from the beginning of project development.

a cross-cutting smart city department was created in the municipality, designed to aid the implementation of these projects. The department did not function perfectly, but it has proved helpful in dealing with the administrative burdens.

Social

Owners/tenants have been consulted throughout the project, in both planning and implementation stages. The team has worked to develop good relationships with the residents, holding consultations within homes in the area and encouraging community champions to support the developments. The financial costs and benefits have always been discussed with the residents and their opinions sought. As the project requires their permission to be able to move ahead with the implementation, it has been essential to provide open and honest consultation throughout the project. This has been achieved through community consultation meetings as well as printed information.

Financial & Economic

The most important lesson learnt regarding financial and economic issues is the importance of combining EC and national fundings for the economic feasibility of innovative large-scale solutions.

The main financial risks of the project have been around matching the internal funding with the rising costs of project delivery. This issue was solved thanks to a constant costs reworking by the project team, in order to ensure that the project can be delivered whilst also working under budget pressures.

Regulatory & Administrative

The inefficient communication between the different departments of the municipality resulted in delays. In addition, there was administrative confusion over sharing the responsibility, especially between the financial and urbanism departments. For this reason,



www.smartcities-infosystem.eu/scis-projects/demo-sites/remourban-site-nottingham
www.nottingham.remourban.eu
www.remourban.eu



Torrelago district in Laguna de Duero

Description

The renovation of Torrelago district was implemented in the framework of the FP7 funded CITYFIED project. Torrelago district has 31 private multi-property residential buildings (1488 dwellings) that were constructed in the 1970s – 80s, with more than 140,000 m² and 4000 residents involved. Former conditions of the district were very low in terms of efficiency, comfort and costs, which fostered the intervention. Main energy measures implemented at the building scale are building external insulation (Composite System-ET-ICS, ventilated facade), connection to district heating



(12 new heat exchange substations) and individual metering to raise user awareness.

Involved stakeholders

Management and research: Fundación Cartif
Funding and engineering: Veolia
Contractor and technical supplier: 3IA



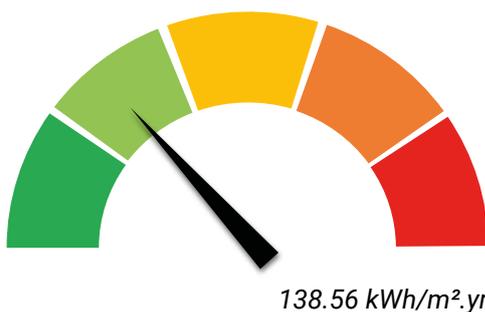
Local constraints/regulations/incentives

- **Climate:** Southern
- **Local constraints:** Private building ownership was a challenge because it affects decision-making processes and hinder reaching an agreement. The Spanish regulation indeed requires that the renovation has to be approved by a minimum of 60% of the owners.
- **Incentives:** 50% of the investment was funded by the European Commission.

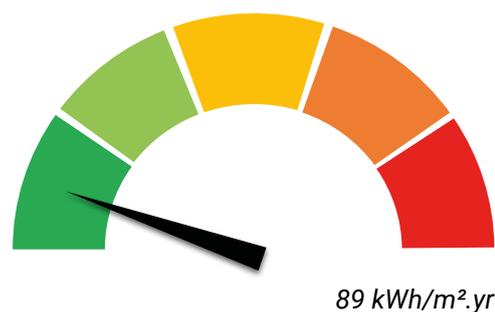
Building characteristics

- **Use:** Residential
- **Type:** Apartment block
- **Construction date:** 1977, 1979, 1981
- **Total ground floor area:** 140,000 m²
- **Ownership:** Private ownership, with multiple owners
- **Building management:** The owners are organized into Communities which charge energy bills to the home owner through monthly Community fees

Performance before



Performance after





Associated business model
Energy Performance Contracting (EPC)
» p. 30

Refurbishment package

Related to the "standard envelope insulation – 'deep', with ETICS" (in the Renovation Hub renovation-hub.eu/refurbishment-solutions/etics). A connection to district heating was also implemented.

Financing

- For the building renovation: 3IA and its subcontractor carried out the construction works. Investment costs were covered by 3IA, thanks to a loan contracted with Triodos Bank. 3IA is then refunded through a long-term contract (20 to 25 years) with the Community of Owners
- For the connection to the District Heating: Veolia Contracting covered the initial investment needed for the renovation of Torrelago district heating with equity, offering then a sustainable long-term financing scheme (15 to 20 years) to the owners.
- An EC grant also covered part of the investments.

Lessons learnt and guidelines for replication

Technical

From a technical point of view, existing technologies were integrated and implemented, so the most important lesson was the need to work in a truly cooperative approach.

Since the very beginning, CITYFIED representatives carried out a number of workshops with the residents about the actions deployed for the district's regeneration. Participants had the opportunity to address various technological and non-technological solutions designed to cut energy consumption and improve comfort, as well as the effects these could have on residents. During the workshops, partners were able to capture the needs of residents, and look into how to deliver the appropriate technical solutions, together with the most suitable business models, for them while remaining true to the broader aims of the Smart Cities and Communities Initiative.

Financial & Economic

The most important lesson learnt regarding financial and economic issues is that the contribution of the EC grant has been an essential part of the funding, without which the project would not have been feasible in the same conditions, due to the high investment costs that such a number of dwellings entail in the case of Laguna de Duero.

On the other hand, CITYFIED demonstration site in Laguna de Duero shows the economic and social benefits as well, with 50 unemployed local residents who received technical training and were hired to work on the renovation of the building facades

Regulatory & Administrative

The involvement of the Municipality has been essential not only for the communication campaigns with the residents but also easing the administrative and legal processes.

Environmental

A key learning of the project was that technologies should be selected not only in terms of energy savings and CO₂ emissions, but also a throughlife cycle cost analysis, especially for retrofitting project limited by the initial investment (as it was the case of Laguna de Duero's demonstration site).

Social

One of the most important lessons learned while defining the Laguna de Duero business case was the social acceptance, because it is one of the biggest district renovation projects in Europe in terms of conditioned area, investment volume and residents involved. On account of the information campaigns that were organized, it was possible to transform one of the main barriers at the beginning of the project into a success factor. Although there was an initial opposition of a minor group of people that wanted to stop the project, the project continued and



finished in record time with the acceptance of the majority of the neighbours. The results that were achieved caused a very favourable evolution in the opinion of those owners who were more reluctant and sceptic at the beginning.

In a truly cooperative approach, CITYFIED managed to take into account the perspectives of users and places residents at the heart of the decision-making process.



www.cityfied.eu/demo-sites/sezione_uno_uno/laguna-de-duero.kl
www.smartcities-infosystem.eu/scis-projects/demo-sites/cityfied-site-laguna-de-duero



Social-housing in Hem

Description

EnergieSprong is a new refurbishment standard developed in the Netherlands to massify high-performance energy refurbishments, starting with the social housing stock. The idea: long term guaranteed net zero energy and high quality and comfort refurbishment (up to 30 years), with a minimum disruption for tenants thanks to the off-site construction of large components, and an overinvestment financed by the money saved on energy bills and maintenance.

In the frame of the E=0 project (INTERREG North-West Europe), Vilogia, a social housing association in France, tested the EnergieSprong approach for the first time on 10 individual houses in the french northern city of Hem to demonstrate the replicability of the project. This first refurbishment comes with a 25-years performance warranty on the energy performance.



Thanks to the integration of photovoltaics, the renovated dwellings have a net production of 1 kWh/m².y in this case study (primary energy need: 74 kWh/m².y, local RES production: 75 kWh/m².y). The retrofit was non-intrusive esthetic and completed within six weeks, and there was no need for the resident to move out.

Involved stakeholders

- Management:** Vilogia; Rabot Dutilleul Construction
- Architects:** Redcat Architecture
- Design and installation of energy solutions:** Pouchain
- Engineering:** Symoé; Nortec
- Manufacturer:** Smart Module Concept



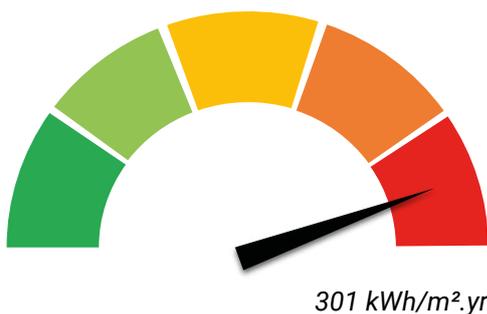
Local constraints/regulations/incentives

- **Climate:** Western
- **Local constraints:** Respect the local architectural chart (northern brick house)

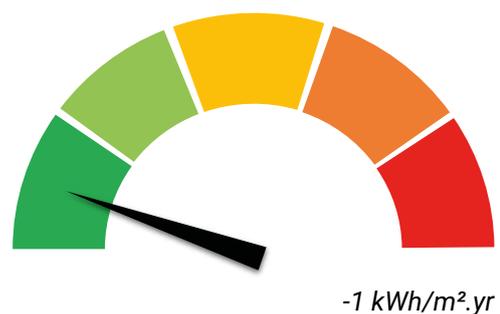
Building characteristics

- **Use:** Residential
- **Type:** SFH
- **Construction date:** 1952
- **Total ground floor area:** 84 m²/house
- **Ownership:** Social housing association – Vilogia

Performance before



Performance after



Refurbishment package

The main refurbishment actions performed included:

- 40 cm-external prefabricated façades were added. The initial façades were digitally scanned and then reproduced in utilities. The roof was insulated and triple-glazing windows were installed.
- Kitchen and bathroom were refurbished
- A dual flow ventilation was installed enabling uniform heating during winter and a cooler house in heatwave periods
- A heat pump was installed to provide hot water
- Solar panels were installed on roofs to provide energy
- An energy module was integrated in the façade which gathers heat, hot water, ventilation and cooling systems to facilitate maintenance
- A monitoring device was installed to enable the tenants to follow their energy consumption



Associated business model

One-Stop-Shop provided by a multi-disciplinary team

» p. 20

Financing

The total cost amounted to approximately 1.3M € in total (design: 10,500 €/house, construction works: 121,000 €/house) – which corresponds to 1,525 €/m². Annual maintenance costs are estimated at 1,100 €/house. The cost of this first EnergieSprong demonstrator was high as it was a first trial in France. The long term objective is to achieve these refurbishments at standards costs or at least at a cost of about 70,000 € per home for individual houses and 55,000 € per dwelling in multi-apartment buildings, which will be possible as the demand goes higher and the sector gets structured. It took nearly 1000 homes in 5 years in the Netherlands to reduce costs by 50%.

Before the renovation, the global electricity bill for each of the ten dwellings amounted to 1,500 € per year and each tenant had to pay 400 € in charges. After renovation, the electricity bill stands at 600 € and the charges have been set at 700 €. The rent remains fixed.

Incentives/grant received: 51,000 €/house for the construction work (Interreg NWE). This project also received a cofunding from ADEME/Caisse des Dépôts & Consignations to performed preliminary studies.

Lessons learnt and guidelines for replication

Technical

The design phase was crucial, making up 80% of the project. Due to the tight deliverable deadline, everything had to be anticipated, sequenced, planned and programmed in advance. This operating mode required adaptation and modification of working methods, as well as co-construction and cross-functionality of the entire group (technical and tenant management parts).

In addition, the approach depended largely on the landlord who represented the demand side. The terms of co-operation between landlords, industries, project managers, engineers, architects need to be set in the early stage of the project.

Construction time was at least twice as short as usual thanks to the pre-industrialized process: In the long

term, it is expected to decrease even further from 6 to 3 weeks.

Environmental

Indoor comfort and a sense of well-being facilitate behaviour change and the integration of eco-gestures.

Social

The success of the E=0 project depends on reasonable usage behaviours. Vilogia had to define the objectives of the project (zero energy over the year and tenant satisfaction), and ensure the group met the target. Particular importance must be given to supporting tenants and training tenants in new equipment and mastering their energy consumption in a simple way. Moreover, since the tenant is involved in the renovation of his dwelling, it is important to be attentive to his needs.



www.energiesprong.org

www.nweurope.eu/projects/project-search/e-0-desirable-warm-affordable-homes-for-life/#tab-4

www.vilogia.fr



"St. Kiril and Methodius" school in Gabrovo

Description

The renovation plan for the primary school "St. Kiril and Methodius" was developed in the framework of the EuroPHit project co-funded by the Intelligent Energy Europe Programme of the European Union. The renovation plan follows a Step-by-Step Business Model approach, aiming at achieving the EnerPHit standard, based on the Passive House principles.

The building was constructed in 1970. It has a concrete structure with external brick walls and a concrete flat double ventilated roof, and no insulation was installed. Since 2013, the school has been connected to the central gas heating.



The renovation work included improvement of the building envelope with new thermal insulation on the roofs, on the external walls, on the ground walls and the slabs on the ground. Furthermore, the windows were exchanged when their lifespan was over.

Involved stakeholders

Public owner: Municipality of Gabrovo
Architects and designers: EnEffect Group



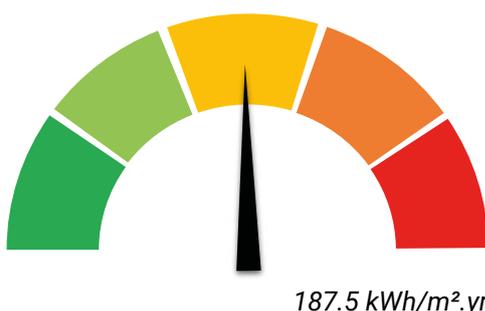
Local constraints/regulations/incentives

- **Climate:** Eastern
- **Local constraints:** Bulgarian National Standard describes maximum value of the heat transfer coefficient on elements in building envelope. It does not limit the maximum value of the energy use.

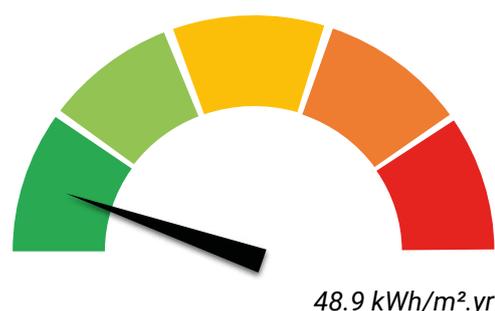
Building characteristics

- **Use:** Non residential
- **Type:** Educational facility
- **Construction date:** 1970
- **Total ground floor area:** 7,312 m²
- **Ownership:** Public ownership (municipality of Gabrovo)
- **Building management:** The building was managed by the owner itself, the Municipality of Gabrovo. The last retrofit dated back to 2005.

Performance before



Performance after



Refurbishment package

The project proposed the following refurbishment steps:

- **STEP 1:** Roof insulation – placing 30 cm. glass wool insulation on the top of the lower slab of the ventilated double roof
- **STEP 2:** Mounting 20 cm EPS with graphite insulation on the walls, reduction of the radiator dimensions, improving the airtightness layer, implementation of the ventilation with heat recovery systems
- **STEP 3:** External underground wall insulation, perimeter insulation, insulation above the ground floor slab in the gym
- **STEP 5:** Replacement of windows: the PVC windows will be replaced in 10 years, when they will be 20 years old. The aluminum windows will be replaced in 20 years, when they will be 30 years old
- **STEP 6:** Implementation of Renewable Energy Sources (Photovoltaic panels)



Associated business model

One-Stop-Shop supported by a Step-by-Step approach
» p. 22

Financing

The total investment cost for the retrofit of the building was 1.25 M €. 70% of the investment was funded by the European Commission, within the EuroPHit Project.

Lessons learnt and guidelines for replication

Technical

The renovation of the buildings according to the EnerPHit standard can increase the effect of energy efficient refurbishment by more than 25%. In addition to improved energy efficiency, better air quality can be achieved: the initial air change rate was 0.61/h, which led to uncontrolled use of the natural ventilation, high heat losses and low air quality, especially in schools and kindergartens. Mechanical ventilation with heat recovery improves air quality and energy efficiency at the same time.



Social

The municipality of Gabrovo aimed to be a leader in defining NZEB criteria. In 2013, the first Passive House in Bulgaria was built in Gabrovo – kindergarten Sun. With this project, the local authorities intended to create

a model for refurbishment of an old building to the level of the new NZEB standard. Choosing a school as pilot project, the municipality wanted to set an example to be followed and to raise the awareness of the community.



www.europhit.eu/cs10-%E2%80%9Cst-kiril-and-methodius%E2%80%9D-primary-school-gabrovo
www.europhit.eu/sites/europhit.eu/files/EuroPHit_D3.9_CS10_EnEffect_Overall_Refurbishment_Plan.pdf



List of abbreviations

| | |
|---------------------|---|
| ADEME | Agence de l'environnement et de la maîtrise de l'énergie |
| BM | Business Model |
| CBA | Cost Benefit Analysis |
| CHP | Combined Heat and Power |
| DRS | Demand Response Services |
| ECO | Energy Company Obligation |
| EC | European Commission |
| EE | Energy Efficiency |
| ELENA | European Local ENergy Assistance |
| EPBD | Energy Performance of Buildings Directive |
| EPC | Energy Performance Contract |
| ESCO | Energy Service Company |
| ETICS | External Thermal Insulation Composite System |
| EU FP7 | European Union's 7th Framework Programme for the funding of research and innovation |
| EU H2020 | European Union's Horizon 2020 funding programme for research and innovation |
| GDP | Gross Domestic Product |
| GWG | Grundbesitz und Wohnungsverwaltungs GmbH |
| HVAC | Heating, Ventilation and Air Conditioning |
| ICT | Information and Communications Technology |
| IEC | Integrated Energy Contracting |
| IEQ | Indoor Environmental Quality |
| Interreg NWE | European Union's Interreg North-West Europe Programme for the funding of European interregional cooperation |
| KfW | Kreditanstalt für Wiederaufbau |
| LCA | Life Cycle Assessment |
| LHTES | Latent Heat Thermal Storage Energy System |
| MoU | Memorandum of Understanding |
| NEP | Nottingham Energy Partnership |
| NZE | Net Zero Energy |
| NZEB | Nearly Zero Energy Building |
| OSS | One-Stop-Shop |
| PACE | Property Assessed Clean Energy |
| PPP | Public Private Partnership |
| PV | Photovoltaic |
| PVC | Polyvinylchlorid |
| R&D | Research and Development |
| RE | Renewable Energy |
| RES | Renewable Energy System |
| RET | Renewable Energy Technology |
| SFH | Single Family Home |
| SME | Small and Medium-Sized Enterprises |
| TES | Timberbased Element Systems |
| TPF | Third Party Financing |

Picture sources

EU H2020 BRESAER, Acciona Construcción (p.10)
 EU H2020 E2VENT, NOBATEK (p.11)
 GAP³ solutions (p.11)
 EU H2020 BERTIM, TECNALIA (p.12)
 E=0/Energiesprong France, Vilogia (p.12)
 EU FP7 iNSPIRe, Eurac Research (p.13)
 EU H2020 P2ENDURE, DEMO Consultants (p.13)
 EU FP7 E2Rebuild, photographer: Stefan Müller-Naumann (bestand s/w ,lichtblau'), ©kaufmann.lichtblau.architekten, <https://www.competitionline.com/de/projekte/52120> (p.41 and p.42)
 EU H2020 REMOURBAN, Nottingham City Council (p. 43 and p.44)
 EU FP7 CITYFIED, Fundación Cartif (p.45 and p.46)
 E=0/Energiesprong France, Vilogia (p.47)
 EU IEE EuroPHit, EnEffect Group, SolAir (p.49 and p.50)

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 Assistant Buildings' addition to Retrofit, Adopt, Cure and Develop the Actual Buildings up to zeRo energy, Activating a market for deep renovation

BERTIM
 Building energy renovation through timber prefabricated modules

BRESAER
 BREakthrough Solutions for Adaptable Envelopes in building Refurbishment

BetterHome
 Industry-driven One-Stop-Shop model and platform

CITYFIED
 RepliCable and InnovaTive Future Efficient Districts and cities

E2Rebuild
 Industrialised energy efficient retrofitting of resident buildings in cold climates

E2VENT
 Energy Efficient Ventilated Façades for Optimal Adaptability and Heat Exchange enabling low energy architectural concepts for the refurbishment of existing buildings

EuroPACE
 Euro Property Assessed Clean Energy

EuroPHit
 Follow-up project of EnerPHit – Quality-Approved Energy Retrofit with Passive House Component

GAP3 solutions
 Providing complete multifunctional prefabricated solution for buildings refurbishment

iBroad
 Individual Building Renovation Passport

Île-de-France Énergies
 Formerly Energies POSIT'IF, created by the Île-de-France Region as specialist for the energy renovation of condominiums

iNSPIRe
 Development of Systemic Packages for Deep Energy Renovation of Residential and Tertiary Buildings including Envelope and Systems

IEA ECBCS Annex 50
 International Energy Agency's Programme for Energy Conservation in Buildings and Community Systems, Annex 50 "Prefabricated Systems for Low Energy Renovation of Residential Buildings"

LIGN2TOIT
 Méthode d'analyse pour la faisabilité technico-économique d'une surélévation de bâtiments urbains exploitant les procédés industrialisés

NOVICE
 Innovation in building retrofits for energy efficiency and demand response

Oktave
 Integrated Service for Energy-Efficient Renovation launched by the region Alsace Champagne-Ardenne Lorraine

P2ENDURE
 Plug-and-Play product and process innovation for Energy-efficient building deep renovation

REMOURBAN
 REgeneration MOdel for accelerating the smart URBAN transformation

RenoBIM
 Renovation Building Information Modelling

TRANSITION ZERO/E=0 project in Hem (France)/Energiesprong
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 - For further references concerning this section, please read the STUNNING Deliverable 5.1 Report on the scenario identified, published on the STUNNING Renovation Hub: renovation-hub.eu/downloads

The Partners



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RINA Consulting

www.rinaconsulting.org
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Solintel 

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www.solintel.eu
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