ICT Tools to Foster Small-and-Medium-Enterprise Collaboration in the Energy-Retrofitting Sector

Fabio Disconzi and Arturo Lorenzoni

Abstract Since decades, the European Commission has turned the spotlight on energy efficiency in the building sector. While the technological domain has been investigated achieving interesting results, on the organizational and financial sides there is still a lot of room for new advancements. Especially in certain countries, the construction sector has to face many challenges. The highly fragmented markets, the cumbersome organizational models adopted by big enterprises on the one hand and the lack of knowledge and skills of Small and Medium Enterprises (SMEs) on the other hand, the perpetual variability of supporting schemes, and the plethora of regulation frameworks represent huge barriers in leveraging new ways to collaborate. Focused on SMEs, the NewBEE EU-project sheds light on innovative methodologies to set-up new collaborative business models in the energy-retrofitting sector that may accelerate the transition towards more sustainable buildings and cities. SMEs currently face two main problems: (a) the availability of easy-to-access knowledge and (b) the ineffectiveness of existing organizational and business models. To tackle these issues, NewBEE provides a comprehensive ICT platform to foster innovative methodologies facilitating the collaboration of actors in the energy-retrofitting chain, enabling the adoption of the business models. The paper briefly introduces the NewBEE-project approach followed by the description of the core modules of the tools:

a. Prompt and accessible information about emerging technologies and business model are collected in the information repository.
b. The pre-assessment tool enables buildings' owners to roughly estimate the energy-saving potentials of common renovation processes, receiving in return an order of magnitude of the investment's costs.

F. Disconzi (✉) · A. Lorenzoni
University of Padua, Padova, Italy
e-mail: fabio.disconzi@unipd.it

A. Lorenzoni
e-mail: arturo.lorenzoni@dii.unipd.it

c. The virtual breeding environment is the main module of the tool: it is where SMEs collaborate, putting in place virtual collaborative networks to make a proposal.
d. The financial simulator enables building owners, investors, and SMEs to understand the effects of different financing schemes and the implications of energy-cost variations on the profitability of the investment.
e. The energy assessment module provides a professional tool to simulate the building performance before and after the refurbishment process.

The application of the NewBEE methodology has been tested in four real business cases: Spain, Slovenia, Germany and Finland. Recommendations raised during the demonstration phase are reported. In a mature market like the building one, the NewBEE project shows how innovative ICT technologies may help SMEs to fine-tune their business model, creating opportunities to collaborate both in a virtual and a real way.

Keywords Business models · Energy efficiency · Organizational models · Buildings retrofitting

1 Introduction

More than one third of the total global final-energy use is accounted for by the building sector. The related CO_2 emissions account for approximately one fifth of such emissions, but this figure may double or triple by mid-century, based on several key trends. However, technological solutions to control the increase in final-energy use already exist, even if several barriers hinder the adoption of even of the more cost-effective solutions. Barriers affect many aspects of the finding solutions: imperfect information, split incentives, lack of awareness, transaction costs, inadequate access to financing, and industry fragmentation (IPCC 2014).

The unpredictable cost of energy, the increasing green consciousness of populations, and more severe building regulations are expected to impact the market penetration for low-carbon solutions in the construction sector. While, for large companies and technology providers, it can be relatively easy to adapt their know-how and apply new innovative technologies, materials, and methods, this is not the case for Small and Medium Enterprises (SMEs) which usually have very specific competencies that narrow down to a specific field but don't have prompt access to competitive knowledge and are not used to truly collaborate in networks.

Nevertheless, the role of SMEs in several sectors is not negligible since they are the backbone of the European economy, and the European Commission considers them as "key actors to ensure economic growth, innovation, job creation, and social integration in the EU" (European Commission 2015). Definition of SMEs widely vary around the world: Parker et al. (2009) investigated this in-depth while assessing nearly 50 journal articles and finding that:

European studies mainly use the European Union's (EU) definition of SMEs "fewer than 250 staff", while Australian studies use "less than 200 staff", USA and South Korean studies use "less than 500 staff", and New Zealand studies use "less than 100 staff".

Although the definition of SMEs widely varies among countries, in this article we adopt the European Union's definition that states "enterprises having less than 250 staff and a turnover lower than 50 million euro" (European Commission 2003).

Along with the need to support SMEs in understanding how to implement emerging energy-technologies, new financial, organizational and social-innovation enablers are required to leverage transformation towards more sustainable buildings and cities.

Enterprises are urged to modify their business model in order to be more responsive to the economic environment, and Information and Communication technologies (ICT) may provide a valuable support. The NewBEE project attempts to explore the capability of ICT tools for fostering collaboration among SMEs and providing guidance to generate project-specific business models.

1.1 Collaboration Fosters Innovation

Fostering collaboration is one of the main targets of the NewBEE-project approach. Since decades, the idea that firm alliances/networks improve the results of business has been researched. Dyer and Singh (1998) stated that "competition between single firms, while perhaps still the rule, is becoming less universal, as pairs and networks of allied firms have begun to compete against each other" and "an increasingly important unit of analysis for understanding competitive advantage is the relationship between firms".

Even before the pervasive advent of ICT, establishing sound and reliable networks brought competitive advantages to companies. Baum et al. (2000) showed the impact of network composition in startups' performance during their early stages. The risks of startups are mitigated when they are able to secure relationships and networks with key actors of the sector/industry; in fact, startups that "at the time of their founding formed upstream and downstream alliances and configure them to provide access to more diverse information and capabilities generally exhibited stronger initial performance".

Also during the early growth of the firm, networks should evolve and adapt in response to resource needs and resource-acquisition challenges (Hite and Hesterly 2001). Firm networks evolve from the kind of networks that have a "high proportion of ties where some type of personal or social identification with the other actor motivates or influences economic actions" (identity-based networks) towards networks where "the potential purposes and functions of the network ties become a more predominant theme than the identity of the ties" (namely, calculative networks).

Collaboration affects SMEs' innovation process. The innovation process requires direct or indirect access to new pools of information, knowledge, and competencies, some of these being produced only in research-intensive and collaborative environments. The former activities are less diffused in SMEs since they usually have less financial and human resources, less access to advanced sources of knowledge, and shorter time horizons compared to large firms. Thus, to compete in fast-changing markets, they should operate in a collaborative environment: SMEs have to be connected to each other in the most effective way, thus promoting exchange of information and competencies. Benefits generated by collaborative networks (CNs) impact the entire lifetime of an enterprise and empirical studies have confirmed that collaborating firms are more innovative than non-collaborating ones (OECD 2001).

The networking process affects also organizational models, managerial practices, and working methods, pushing firms to cope with the increasingly interdisciplinary nature of today's businesses. This is a complex process often hindered by a lack of motivation to do so, but fostering innovation is a key strategy for success, and collaboration is a prerequisite in order to pursue it (OECD 2004).

Entrepreneurs and stakeholders should clearly understand both the potential and the limits of embracing new business opportunities. The formation of new collaboration networks won't benefit all the companies in the same way: understanding how value is created and shared among partners is of paramount importance. Moreover, the definition of an acceptable business model to adopt by a CN depends on the specific business opportunity to exploit. CN's stakeholders need a systematic approach to use in order to clearly describe the business model of the CN, highlighting the elements that shape it and their correlations. Jimenez et al. (2005) proposes a template which helps enterprises to shed light in this field. The proposed methodology, based on an ontology, with a five-step process provides guidance to set the basis for developing and understanding a project-specific business model. It has been partly adopted during development of the NewBEE project.

1.2 ICT Fosters Collaboration

As seen in the previous paragraph, collaborative networks have a high potential as drivers of value creation. The concept of collaboration is very broad. It has been well analyzed in Camarinha-Matos and Afsarmanesh (2008):

> a process in which entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities to achieve a common goal. […] a process through which a group of entities enhance the capabilities of each other.

In the NewBEE project, the concept of a collaborative network (CN) is strictly linked to the use on ICT tools and follows the definition given by Camarinha-Matos:

> A collaborative network (CN) is a network consisting of a variety of entities (e.g., organizations and people) that are largely autonomous, geographically distributed, and

heterogeneous in terms of their operating environment, culture, social capital and goals, but that collaborate to better achieve common or compatible goals, and whose interactions are supported by computer network.

The advantages brought by ICTs to SMEs not only impact on their collaborative capabilities but affect several aspects of enterprises. Barba-Sánchez (2007) stated that, especially in fast changing markets, an adequate and intensive use of ICTs is crucial in order to make a business more responsive to market opportunities. "ICT can provide a wide variety of benefits to firms, ICT can reduce business costs, improve productivity and strengthen growth possibilities". Moreover, "the adoption and implementation of ICT by firms can improve business cooperation, business relationships, quality and diffusion of knowledge".

In an economy that is increasingly based on information, a sound and efficient knowledge–management system (KMSs) is increasingly becoming a strategic asset of a company. There is a general consensus that the benefits of a robust, user-friendly and ICT-based KMSs have not been exploited by small firms yet. Not only for internal purposes but also for external ones, there is much room for improvements, and entrepreneurs also perceive the potential. Together with the need of a new kind of Knowledge Management System able to improve operational management and to discover market opportunities, empirical investigation (Evangelista et al. 2010) reveals that "The surveyed firms show the need for wider (external) KMSs enabling inter-firm collaboration in developing collaborative projects." The survey was carried out in 2008, on 18 SMEs operating in a network of 25 companies having working mechanisms similar to the envisioned one of the NewBEE project.

The main barriers in adopting collaborative environments concern the protection of intellectual assets, in fact the survey demonstrates that "the unavailability of partners to share knowledge and the need to protect critical information are the most relevant barriers". But there is some information that SMEs are ready to share: "most important information that firms are willing to share are related to linkages with institutions and funding opportunities." Moreover there are also some areas for developing new KMS practices: "KMSs may support relationships with customers in order to facilitate both the exchange of relevant information and improving communication with them"; the NewBEE project embraces these opportunities by developing a platform with user-friendliness characteristics, dedicated to both practitioners and non-professional people.

1.3 NewBEE Platform as a Project-Specific Business-Model Generator

The interest in the renovation of existing buildings has never been so high. In 2011, the renovation sector was responsible for 7 % of EU GDP, with over 11 million people were directly employed in the building sector. It is clear that the construction

sector may play an important role in achieving European targets since "the building stock is the largest single energy consumer in Europe. Its share of total final energy consumption was 40 % in 2012, making buildings responsible for 38 % of the EU's total CO_2 emissions".

In this context, the active engagement of SMEs is of crucial importance: the EU building sector is characterized by a high number of small and medium enterprises, most of them operating at the local level. Indeed, "enterprises with less than 50 employees generated 72 % of the sector's value added, while those with over 250 generated 14 %" (European Commission 2015).

But never before as it has in recent decades, the world is facing deep modifications (e.g., the financial and economic crisis, new needs, demographic variations, etc.), and changes occur at a pace never yet experienced. Also, in the construction-sector advancements in energy technologies for civil buildings (e.g., lighting, ventilation, heating, and air conditioning), the penetration of ICT technologies in control systems (such as remote sensors and remote management), the emerging of new organizational models for enterprises, constantly changing financial incentive mechanisms, social innovations, and new performance-based business models are expected to radically transform the sector.

From the point of view of enterprises, new business models (BM) able to cope with the aforementioned challenges are needed. Especially in the construction sector, the implementation of successful "greener" business models is strictly linked to the involvement of the actors of the entire value chain. There won't be a real adoption of new business models unless every stakeholder involved in the project commits to their actual adoption. The NewBEE project aimed at developing the framework (i.e., concepts, methodology, and ICT tools) to better address the issue.

Even if large companies have the skills to effectively adopt new technologies since they cover a large span of the value chain, their cumbersome organizational structures generate difficulties in following the pace of changes that new energy technologies, together with ICT advancements, are bringing in all sectors, but also in traditional ones like construction. SMEs, which are characterized by their dimension, small or medium as the acronym says and by a streamlined organization structure, often operate only within a "few rings" of the value chain. This brings into focus two opposite characteristics of SMEs: on the one hand, small dimension causes a lack of capability for widening their knowledge and technical capability, and, on the other hand, a "slim" organization is usually more responsive to external conditions and faster to adapt to project-driven BMs.

But having lighter organizational structures can be a competitive advantage, and the ongoing changes in the construction sector potentially open the door to a larger market that was unattainable until few years ago and only the prerogative of large and structured companies. However, to exploit this opportunity, SMEs need new ways in doing business: they need to collaborate in a new radical way taking advantage of the opportunities offered through collaborative networks.

As stated in the previous paragraphs, both ICT resources (Albesher 2012) and the participation in CNs can be seen as catalyzers of innovations impacting the whole SME business model (Arana and Castellano 2014) affecting also the

enterprises' performance (Gronum et al. 2012). Cooperation and active collaboration is no longer a rarely adopted working method, but an increasing trend that is re-shaping the SMEs business models (Mura and Rózsa 2013).

Adopting the Osterwalder framework for business model generation (Osterwalder and Pigneur 2009), the NewBEE project, focusing on the construction sector, aims at supporting SMEs in fostering the development of new BMs through the dynamic creation of project-based CNs by means of web-based tools, and moreover, testing the approach in real in four real business cases.

2 The NewBEE Project

The belief behind the NewBEE project is that advanced ICT tools could foster the SMEs collaboration through the creation of virtual Collaborative Networks enabling the development of tailored energy performance-based business models. The successful implementation of these models, which could unveil synergies amongst SMEs, is closely linked with all the actors of the entire value chain. Therefore, the main innovative aspect of NewBEE is the support of all actors involved in the energy-efficiency value chain of the construction industry, through innovative working methodologies based on a set of ICT tools.

As said in the previous paragraph, innovation is a key factor for enterprises especially in high technological sector like the energy efficiency one. New project-specific and energy performance-based business models can increase the adoption of energy-efficient technologies. NewBEE tools aims at enabling SMEs to set-up collaborative networks before the execution of the intervention, fostering the share of knowledge, best practices, and experiences.

2.1 Introduction to the NewBEE Platform

The multilingual (English, German, Spanish, and Slovenian) web-based NewBEE Platform presented here aims to integrate a set of tools to support SMEs in collaborating and in defining a project-specific business model for energy-efficiency-retrofitting interventions.

The approach behind this mainly consisted of developing tailored tools, with a user-friendly interfaces and in carrying out an "homogeneous platform" to adopt as a basis for the elaboration of new project-specific business models.

The comprehensive approach of NewBEE is based on ICT solutions that will include a 'Marketplace', enabling building owners to identify and place calls for proposals, and SMEs to find retrofitting opportunities. As a result of sharing knowledge, users will be able to choose the optimal technology for energy-efficient retrofitting. And the comprehensive set of tools will enable building owners to publish their requirements by themselves and SMEs to identify business

opportunities, ultimately supporting cost and energy-efficient construction. The new concept and innovative methodologies have been validated by testing them in four real business cases (BCs). All the results of the project are available at www. newbee.eu.

2.2   NewBEE Consortium and Working Plan

NewBEE is a research project funded by the European Commission under the Seventh Framework Programme, coordinated by "Tecnalia Research and Innovation" (based in Spain), involving organizations spread throughout Europe. Started in October 2012, it is a 3-year project whose overall aim is to help Small and Medium Enterprises (SMEs) in developing "*New* performance based *B*usiness models in *E*nergy *E*fficient construction work with special incidence in retrofitting sector."

Consortium partnership has involved 17 partners from six different European Countries:

- Five Research and Technical Development centers (RTDs): Tecnalia Research and Innovation (Spain), Fraunhofer IAO (Germany), Institute for Applied Systems Technology Bremen ATB (Germany), Valtion Teknillinen Tutkimuskeskus VTT (Finland), and University of Padua (Italy);
- One large construction company in the role of ESCO: Acciona Infraestructuras (Spain);
- Five SMEs involved in construction sector: FinnEnergia (Finland), Rahm (Germany), Teusa (Spain), Eslamaban (Spain), and Gradbeni Institut ZRMK (Slovenia)
- Two SMEs associations: ifA Bauconsult (Germany) and Slovenski Gradbeni Grozd-Giz SGG (Slovenia)
- Two architects' studios: Eriksson Architects ltd (Finland) and KVA Architects (Finland);
- Two IT developers and vendors: Accrosslimits (Malta) and Conclude (Germany).

The overall work plan has been structured in nine work packages (WPs). WPs followed the logic of research and technological development, starting from the structured collection and analysis of end-users requirements up to the testing and validation of real business cases, through the development of new innovative methodologies supported by ICT tools. RTD and demonstrator WPs were complemented by two important WPs focused on dissemination of results and exploitation of the project (WP8) and on project management (WP9).

At the outset of the project, a structured review of existing methods, tools, and technologies was carried out in reference to envisioned BCs scenarios (WP1 and WP2). Since NewBEE has been a strongly end-user-driven project (SMEs, building

owner, ESCOs, architects, and other stakeholders indirectly covered by consortium partners), the key topic of the first phase was to make available a clear analysis of the end-user's requirements to assess both technical and non-technical needs.

Once requirements had been clearly stated, the project elaborated the overall concept specification (WP3) for the new NewBEE methodology, the ICT platform, and services. WP4 dealt with identification of optimal BMs for the energy-efficient-buildings retrofitting, and, together with previous end-user requirements (WP1, WP2), concept terms (WP3) provided specifications for the NewBEE ICT-platform-development phase (WP5). The platform prototype developed during the first phase of the project had followed an iterative approach of testing and improving (WP6), arriving at the integration with the BCs' existing infrastructures.

WP7 had a very important role in the project since it involved several industrial partners from four countries to demonstrate the methodology and ICT tools, and which served as showcases for dissemination and exploitation activities (WP8).

3 The NewBEE Platform: The Set of ICT Tools

The NewBEE set of tools has been developed to foster an early involvement of SMEs and stakeholders of the construction value chain, fostering them to generate the most appropriate BM for each specific project. This is facilitated by the provision of highly accessible knowledge related to several competitive aspects such as best available technologies, organizational models, financial mechanisms, and performance based contracts.

The NewBEE platform is composed of a heterogeneous ICT tool which helps SMEs in dealing with the majority of the challenges described in paragraph 1.2. It consists in six web-based software tools accessible through internet connection and therefore no installation is mandatory for the users.

It includes the following tools:

- *Wiki-based knowledge repository (WIKI)*: the purpose of this tool is to give building owners and professionals access to structured information on retrofitting technologies, organizational, and business models;
- *pre-assessment tool (PTA)*: the purpose of this tool is to support building owners to make a first estimation of needed refurbishment (in terms of technologies and costs) and the magnitude of energy savings;
- *financial calculation tool*: the purpose of this tool is to support building owners and SMEs to compare different financial alternatives for a retrofitting project;
- *marketplace (MP)*: the purpose of this tool is twofold: (i) to support SMEs to find business opportunities (BO) and to search for partners to create a project-driven, virtual, collaborative network to elaborate an offer that satisfies the building owner requirements; (ii) to support building owners to publish a call for proposals, to choose an offer from those received, and to find service providers;

- *energy-performance assessment tool (E-PASS)*: the purpose of this tool is to support SMEs (and advanced building owners) to assess the potential savings of alternative refurbishment projects. It is not intended for standard building owners;
- *business-model assessment tool*: the purpose of this tool is to provide a brief assessment to CEOs and management staff of small companies which are interested in reviewing their business model.

Particular efforts were made to develop the Graphical User Interface (GUI) and the User Experience (UX). It was designed to be used by a wide variety of users, also by people with low knowledge about energy-related topics.

Table 1 summarizes the web url and target groups for each tool of the NewBEE platform.

3.1   Wiki-Based Knowledge Repository

The increasing pace of energy-related technological innovations, the expected global market increment of low- carbon solutions for energy-efficiency retrofitting and the pressing need to handle the knowledge generated by previous projects brought the consortium to design an effective knowledge-management system called the NewBEE wiki-based knowledge repository. The NewBEE wiki gives building owners, practitioners, and experienced professionals access to organized and updated information on the construction sector. The tool is highly usable since it is a media wiki application based on the same software and engine used for the well-known "Wikipedia" portal.

Table 1   Tools and end-users target group

Name of the tool and url	Building owners	SMEs
Wiki-based knowledge repository url: http://www.newbee-wiki.eu/wiki/index.php/Main_Page	X	X
Pre-assessment tool url: http://www.newbee-wiki.eu/step1.php	X	X
Financial calculation tool url: http://www.newbee-wiki.eu/finance/new.php	X	X
Market place url: http://www.atb-bremen.de/marketplace/index?1	X	X
Energy-performance assessment url: http://cic.vtt.fi/epass/vtt/step_1.php		X
Business-model assessment tool url: http://plm.iao.fraunhofer.de/newbee/homePage1.aspx		X

3.2 Pre-assessment Tool (PAT)

Building owners can use the pre-assessment tool to receive a first idea on retrofitting measures and to identify the most appropriate retrofitting technologies based on their requirements. It allows the generation of different technology scenarios that might be appropriate to address the building problem at hand (taking into account, e.g., building characteristics, local climatic conditions, etc.). The tool is useful for getting an estimation of the costs and the magnitude of energy savings. Building owners, after the rough cost and savings analysis are allowed to publish a "call for proposal" in the marketplace or use the data for the evaluation of the project's economics by passing the data to the Financial Calculation Tool.

SMEs might as well use the PAT as a tool for communicate with building owners or to facilitate the transfer of concepts during the initial phases of a renovation project.

3.3 Financial Calculation Tool

The financial calculation tool is a service for users who want to analyze the cash flow generated by a retrofitting project. The main purpose is to improve the building owners' level of awareness in the field of energy economics.

The module enable users to simulate several ways of how to finance a project and provide schematic annual cash flows comprising expenses and savings generated by intervention. Users can simulate effects on cash flow of several finance opportunities (as incentives, loans, taxes reductions, etc.) and generate different scenarios assuming various patterns for annual cost of energy. It also enables users to graphically visualize annual cash flow both in tabular and interactive graphical ways.

3.4 Marketplace

Marketplace can be considered the kernel of the platform and works in connection with PAT. It acts as a catalyzer of business opportunities and translate the NewBEE methodology advancements into features that facilitate SMEs to generate new project-driven CNs and BMs.

The purpose of the marketplace is manifold and depends on the user.

From SMEs point of view it helps them (i) to find BO in refurbishment market and (ii) to search for partners to create a network to elaborate an offer that satisfies the building owner requirements. The marketplace supports SME that provide specific services for energy efficiency refurbishment enabling them to:

- register and participate in a stimulating environment, with high level information and knowledge, with favorable conditions for improving their business model;
- search for business opportunity (proposed by single building owner or by building associations);
- search for partners in order to create a network, able to develop a project-oriented business model;
- provide an offer to the business opportunity proposer as member of an SMEs network

From the building owners' point of view, marketplace is useful to find service providers, in form of single SME (for small projects) or network of them. The market place enables building owners to:

- publish a call for proposal (from scratch or more detailed with the help of the Pre-Assessment tool);
- search for service providers;
- receive refurbishment offers (i.e., building owners can see all offers SMEs' networks made according to their published requirements).

Users' workflows within the marketplace are very complex and interconnected; they cannot be sketched by a step-by-step process. However there are some processes, summarized in Table 2, that represent the functional blocks of the tools.

3.5   Energy Performance Assessment Tool (E-PASS)

With the support of this tool, SMEs and advanced owners can assess the potential energy, cost, and carbon savings resulting from different refurbishment actions broken down into a high level of detail.

Table 2   Main marketplace functionalities

SMEs' functional blocks	Building owners/institutions/business proposers' functional blocks
• Register and log-into the platform; • Filter opportunities • Search for partners • Invite partners • Accept/reject partners • Compose a team • Partners collaboration to create an offer • Team leader send an offer • Get in contact with business proposers	• Register/log-into the platform • Search for service provider • Publish a call for proposal • Select/accept/reject an offer • Get in contact with a network of SMEs

The tool is available for exploitation by SMEs that do not have much resources of their own to develop and learn other professional energy performance assessment tools, but that need energy-performance assessment tools for implementing consultancy, design, product development, marketing, and renovation project management.

The tool makes automatic and "intelligent" assumptions for the analyzed building. Assumptions are based on basic data of the building such as location, building type, construction year, etc. Once the user has inserted a few parameters, the E-PASS tool fetches all necessary details (e.g., the U-values, window-types, water consumptions, electricity consumptions, electric appliances, etc.) from the building-representative databases. Building characteristics and energy systems details can be specified afterwards as needed, enabling more accurate calculations.

3.6 *Business Model Assessment Tool*

The objective of the business-model assessment is to provide a quick assessment to CEOs and management staff of SMEs that are interested in reviewing their BM. The assessment tool is based on Osterwalder Canvas Model and is deeply connected with the Wiki-based knowledge repository.

The tool itself is a guided questionnaire that gives users the opportunity to do a qualitative rating of their company performance concerning different aspects of their BM. Answers are multiple choice, i.e., the users will tick the box with the answer that reflects the actual performance of their company concerning each aspect that is scrutinized in the questionnaire. Each major building block of a BM (like customer relationship or value proposition) is screened by means of at least two different questions.

4 Demonstrations

Since the NewBEE project outputs, on one hand rely upon new services still not widely adopted and accepted in many working environments, and on the other hand introduce new cooperation paradigms and innovative collaborative models never tested before, real demonstration phase has been extremely important. Activities entered into WP7 served to validate the RTD results in industrial contexts facilitating their dissemination within the retrofitting industry and wider industrial community.

Moreover, the demonstration phase has also enabled the consortium partners to better prepare the conditions for the product development and future commercialization (exploitation of the results), and hence facilitating the envisioned penetration in the market.

The overall target of the demonstrations activities was to operate the NewBEE platform in realistic workspaces, addressing stakeholders' collaboration in the planned scenarios. Industrial partners with the support of RTDs have specifically analyzed business benefits brought by the platform which provide valuable feedback for future developments.

4.1 Business Cases and Sub-business Cases

The comparison between the current retrofitting approaches with NewBEE project functionalities has been tested through their adoption in a set of real situations, called Business Cases (BCs) and feedback have been collected from the stakeholders involved in the value chain.

Each BC has been split into sub-business cases (SBC) with the aim to cover all the most common situations that could emerge in Europe within the energy-retrofitting sector. Geographically, BCs spanned from Spain to Slovenia and from the south of Germany to Finland. Involved stakeholders ranged from the single-building owner who wants to retrofit a little flat to the technical office of a region in charge of retrofitting a dozen multi-flat buildings.

In each business case, stakeholders tried to adopt and to integrate NewBEE project features into the real cases, highlighting obstacles and evaluating innovations and improvements brought by the NewBEE approach to traditional processes.

Four different BCs and twelve SBCs have been studied, in each one of them testing different applications of the NewBEE platform modules.

The following paragraphs summarize the planned targets of sub-business cases and describe how the usage of the platform helped stakeholders in cope with them. Since each BC presented significant differences, a common approach to describing the results is not possible. Each paragraph describes the outcome raised from each BC.

4.2 BC1—Spain

4.2.1 Introduction

The Spanish BC demonstrated the validity of the platform in the retrofitting activities for a block of residential buildings. BC1 planned to adopt the NewBEE methodology and web-tools in four different sub-cases. The targets and the planned activities of each sub-business case can be summarized as follows.

SBC1 target was to investigate the behavior of those *responsible for the building's neighborhood (Neighbors Commission)* that, at the beginning of the retrofitting process, wants to analyze the energy-efficiency potential of the building, to identify the most appropriate technologies, and to obtain support for the

refurbishment deployment. In particular, the demonstrator simulates the retrofitting of the facades of a multi-apartment building.

By SBC2, *a group of SMEs* collaborate to participate in a tender for a large project. The target was to evaluate the capability of the platform to enable the setting up of new CNs between SMEs with specific knowledge and competencies, i.e., for complementing their individual expertise in order to facilitate an innovative joint approach to tackle the subject of the tender.

SBC3 dealt with an actual need of a retrofitting project. The demonstrator simulated how a retrofitting intervention can be done by *analyzing the workflow from different users' perspective*. It investigated the usability and the user experience of private building owners and SMEs. An association of homeowners, united in a housing association, was seeking help from various local construction companies, looking to contract directly with companies, without outsourcing or intermediaries. Local companies were looking for other construction companies to create a temporary alliance (CN) with all the needed competencies to solve the problem.

The target of the fourth Spanish sub-case SBC4 was to demonstrate how the NewBEE project can be useful to provide in-depth technical and economic data *to customers* who wanted to know beforehand the energetic behavior they can expect from a specific retrofitting project. The comparison between the results given by the MEEFS technology developed in EU MEEFS Project (http://www.meefs-retrofitting.eu/) and the results delivered by the E-PASS (Expert Energy assessment tool of the NewBEE platform) provided outcomes on the validity of the methodology and platform.

4.2.2 NewBEE Platform Usage

SBC1: Four different modules of the NewBEE Platform have been used and demonstrated: the Wiki-based knowledge repository, the Pre-Assessment Tool, the Financial Calculation Tool, and the Marketplace. The wiki module has been used by the responsible neighborhood community to get general information about different technologies that can be applied in the buildings. PAT provided a rough idea of the energy savings, the magnitude of costs, and the payback period of three different scenarios. The responsible parties investigated the economics of specific scenarios by exploiting features of the financial calculation module. This encouraged those responsible to continue using the platform. Each had have two different possibilities to follow at the same time: to ask for proposals in the Marketplace or to contact an energy consultant.

SBC2: in this scenario, the marketplace features were tested by fostering the creation of virtual collaborative networks in order to make an offer for a big project (the sub-case considered a hospital retrofitting: changing the roofs and improving the energy performance of the walls). Public administration representative registered on the platform and entered the business opportunity. The business opportunity was found by a group of SMEs that could make an offer on the platform. The

method for conforming the relations and the formation of the group was managed by the NewBEE platform in a specialized manner that is proper for the retrofitting sector.

Once the NewBEE platform has become a commercial product, the consortium will invite various large organizations to participate, but also groups of smaller organizations that can be constituted as a virtual CN, a temporary union of organizations (also called by end-users as a cluster or joint venture). The NewBee plaftorm facilitated the creation of that kind of network in an innovative fashion, and this sub-case provided valuable hints on the usability of the marketplace, improving the user experience of the processes.

SBC3 tested the usage of marketplace from the point of view of two different actors: building owners and networks of local SMEs. The owners of a building needs were (i) finding a new way to contract companies at minimum costs (especially to avoid outsourcing, the company-searching phase, and intermediary costs), (ii) gaining knowledge about the construction sector, and (iii) making a business proposal. Local SMEs adopted the platform to (i) establish a virtual collaborative network able to be technically complaint with building requirements and (ii) finally make contact with those responsible parties for the business opportunity.

Again, the sub-business case demonstrated that building owners who proposed the business opportunities received several offers from various project-oriented SMEs networks. Once owners have decided to choose one SMEs-network, negotiations began until a common point was achieved; at this point, a new business model was formed, and the retrofitting project would have been started.

SBC4 aims were to test the NewBEE platform comparing the result of a renovation that occurred in Spain (an apartment building located in Merida) with the figures provided by E-PASS tool. The calculated values demonstrated that the E-PASS tool calculated the energy savings related to the insulation work in a convenient way for advising the owner what to expect from this work. The economics of the renovation project had been estimated by using the financial calculator module. Both results were compared with the ones obtained in the real case, and the discrepancies were small, around 10 %, so that the platform demonstrated the accuracy of the fast calculations made by the NewBEE platform.

4.3   German BC

4.3.1   Introduction

The German BC tested the NewBEE methodologies and platform for the most common building type in rural areas, single and multi-family houses. Moreover the methodology and the platform were tested by adopting some modules of the project during a professional working group on energy efficiency.

For this business case, the coverage of the entire value chain has been demonstrated: first contact of the building owner and building users; identification of the

most appropriate retrofitting technologies; linkage and collaboration between building owner and construction SMEs; and project management support and testing of the business model assessment.

The German business case investigated three specific sub-cases:

SBC G1: Support of a working group on energy-efficient construction and refurbishment: this business case investigated the adoption of the wiki-knowledge repository within a working group of practitioners in the construction industry practitioners.

SBC G2: Application of NewBEE platform to support the retrofitting of a German single-family building: this scenario validated the NewBEE methodology for the communication and collaboration between building owners and SMEs (specifically Rahm) due to the features provided by NewBEE.

SBC G3: Application of the Business-Model Assessment to support the business development of a SME in the construction industry: this sub-case shows, especially for the company Rahm, how they had conducted the BM assessment and which results/recommendations they achieved.

4.3.2 NewBEE Platform Usage

For each German sub-case, the following tools were tested:

- *SBC G1 sub-case demonstrated the application of the wiki within a working group for the construction industry.* The scenario tested the potential use of the NewBEE platform for companies focused on consultancy (e.g., ifABau Consult) as well as on providing knowledge transfer in the construction industry. Compared to former (traditional) ways of providing the acquired knowledge, like distribution of information by mail or providing a paper-based summary of working group meetings, the NewBEE wiki proved more attractive for working group members. Its perceived advantages were: better information structuring; flexibility concerning continuous adaptations of the content; and the semantic features (like semantic search).
- SBC G2 sub-case demonstrated the adoption of the pre-assessment tool for involving potential customers at early stages of the project. This sub-case highlighted the potential of the pre-assessment tool as a communication helper between the customers and the SMEs, especially during the first phase of the project. After the first meeting, calculation tools were used autonomously by the potential customer to identify various potential raw scenarios for the retrofitting projects. Customer used the wiki to understand the energy technology in detail. The sub-case also tested the marketplace from the point of view of a single SME: Rahm identifies the NewBEE marketplace as an optimal environment for finding business opportunities and partners.
- *SBC G3 sub-case: an SME tested the business model assessment.* The initial idea of the tool was improved with the support of various SMEs in Finland, Germany, and Spain. A working version has been tested with a German SME.

The tool itself is a guided questionnaire that gives users the opportunity to do a qualitative rating of SME performance concerning various aspects of their business model. The NewBEE wiki also provides follow-up information after submitting the assessment. Several business models and business cases are described that are typical for the construction industry and a handbook. It has to be emphasized that the company had no problems to perform the assessment by itself. Feedback provided: "the assessment uses the right language and assesses the critical aspects of an SME business model." After the review of the current business model, in a second step, the business model handbook in the wiki was adopted to improve the business. SMEs, who did the business model assessment, reported some benefits from the structured walk-through of the various aspects that are important for the company performance. They stated they had gained a detailed understanding of the most important aspects of a BM. The BM assessment, due to the organized analysis, also provided clues and suggestions on measures to implement to impact the performance of business model in general. After dealing with the obtained recommendations, a repetition of the assessment helped SMEs to understand the impact of the taken actions.

4.4   Finland BC

4.4.1   Introduction

The Finland demonstration phase investigated mainly the usability of the NewBEE tools especially from the viewpoint of the Finnish partner SMEs. It extracted functional requirements based on three cases studies. The Finnish SMEs partners are two architectural offices and one energy consultant. The Finland BC focused on demonstrations of the following tools: the NewBEE Marketplace and E-PASS energy assessment. For the Marketplace, the purpose of the demonstration was to validate the features that help SMEs to find BOs in the refurbishment market and for building owners to find service providers.

The platform was demonstrated in sessions where the Finnish SMEs investigated two different points of view for each tool: the point of views of the building owner and of the SMEs.

4.4.2   NewBEE Platform Usage

The Finnish demonstration sub-cases focused mainly in providing feedback about the usability of the Marketplace and the E-PASS tool. To achieve this aim, several sub-cases have been tested:

MP Case 1: House manager of a housing association creates a business opportunity.

MP Case 2: Energy consultant or architect searches for a business opportunity.

E-PASS Case: Energy consultant or architect uses E-PASS to support a house manager to find sensible opportunities for energy refurbishment.

The BC demonstration was designed so that a house manager in Kuopio supported by the FinnEnergia used the E-PASS tool for an actual building in Kuopio. Together, they followed the steps of a case where a consultant used E-PASS to support a house manager to find sensible opportunities for energy refurbishment. Three house managers participated in the demonstration.

On the basis of the demonstration, the NewBEE tools were useful in principal and might support the work of SMEs in energy-refurbishment markets. The NewBEE platform and Marketplace tool may find their places as a portal that supports building owners to find potential SMEs for energy refurbishment and for SMEs to find partners in order to realize various kinds of refurbishment projects.

4.5 Slovenia BC

4.5.1 Introduction

The Slovenian demo was about the use of the NewBEE platform in the case of large-scale retrofitting project (retrofitting many buildings in the same period).

The proposed case derives from experiences gained during the renewal of the Posočje region after the earthquakes in 1998 and 2004. As more than 3.000 buildings were damaged in the 1998 earthquake, the state organized help to reconstruct the area by securing funds for subsidies to residents in order to reconstruct their damaged homes. The government established the *State Technical Office (STO)* with the role of administrating the governmental financial help and of handling the after-earthquake reconstruction.

According to this context, the Slovenian Business Case demonstrates the adoption of the NewBEE approach by STO for large-scope retrofitting of apartment buildings.

4.5.2 NewBEE Platform Usage

In the case of Slovenian BC, there were three scenarios to demonstrate the NewBEE system in a real environment:

- *SBC1: motivate for retrofit*; use of the NewBEE platform to show to owners of residential multi-apartment old/damaged buildings the potential of energy-efficiency retrofitting; like in the German business case, this sub-case

demonstrate the valuable potential of the platform as a communication tool; its usability coupled with an user-friendly interface enabled experts to explain complex concepts to potential stakeholders;

- *SBC2: finance for retrofit*; use of the NewBEE financial calculator tool for owners "to play" with different scenarios for financing the retrofitting of their building; this sub-case demonstrated the adoption of the financial calculation module by stakeholders;
- *SBC3: connect for retrofit*; test the response of SMEs to published inquiries by using the NewBEE marketplace; SMEs tested the features to create a project-driven network in order to themselves initiate calls-for-proposal related to big-retrofitting works.

5 Conclusions and Considerations

The NewBEE project has been a first attempt introduce into a traditional sector such as the construction sector, an innovative web-based collaborative paradigm such as those already established in the information-and-communication industry. SMEs that embrace the NewBEE methodology are empowered to create "project-driven and tailor made" collaborative networks with other SMEs, developing a project-specific business model in order to compete with large companies.

The portfolio of ICT-tools covers the entire value chain of the construction sector, from information research to financial planning, and proposes a rather new way of doing business for SMEs.

A web-based knowledge management system—The issue of imperfect information flows and the SMEs' lack of ability to learn how to adopt new energy technologies have been the common goal that have guided the development of the wiki-repository. The demonstrator phase showed that this tool has great potential to inculcate the basics for knowledge transfer into SMEs and among them.

Collaboration could start even from customers—The pre-assessment tool has been considered by several interviewed SMEs to be one of the most interesting modules in the platform because it achieves two important goals: it provides a usable "first energy-saving-potential assessment" and provides a "project-cost magnitude" to enable commercial departments to avoid wasted effort. Moreover, the demonstration phase established that the "what happen if…" approach is a powerful marketing tool that encourages the customers to continue investigating the energy-efficiency opportunities, even by themselves, leading them to get in touch with an SME or a network of SMEs (established within the Marketplace).

SMEs networks can compete for big renovation projects by adopting specific business models—the NewBEE project tried to overcome the difficulties of SMEs in participating in big and complex renovation projects due to their lack in knowledge and competencies. The Marketplace, as a network-formation facilitator, can be seen as the tool which could answer to these needs. The guided generation of project-driven networks and "tailored" business models may remove the obstacles that usually hinder SMEs' participation in large construction projects. The demonstration phase has shown that it is possible to create solid, although temporary, collaborative project-driven networks in which SMEs complement their specialties and competences for competing with large companies in the new construction-market sector, like for instance, a city renovation plan.

ICTs help authorities to manage large retrofitting projects—The platform could be easily adopted by technical city offices to promote, organize, and manage renovation plans for cities. Experience gained in the Slovenian demonstrator phase has shown that the NewBEE platform could be adopted as a central virtual hub from which the national/regional/local authorities in charge can conduct the retrofitting process of large areas of cities.

Further developments—Despite the fact that it is clear that the current NewBEE platform is not yet a commercial product, feedback from potential users and SMEs could position it at the readiness level TRL7 that defines it as a "System prototype demonstration in an operational environment (Technology Readiness Level scale)". The two technological levels that remain yet to be made ready can be covered with only a small investment, and the system can already serve as an example of how this goal can be reached.

Acronyms

See Table 3.

Table 3 List of acronyms

BC	Business Case	KMS	Knowledge Management System
BM	Business Model	PAT	Pre-Assessment Tool
BO	Business Opportunity	RTD	Research and Technical Development
CN	Collaborative Network	SBC	Sub-business case
E-PASS	Energy Performance Assessment tool	SME	Small and Medium Enterprise
ESCO	Energy Service Company	UX	User Experience
ICT	Information and Communications Technology	WP	Work Package
GUI	Graphical User Interface		

References

Albesher, A. (2012). *The impact of information technology resources on SMEs' innovation performance*. Cambridge: DRUID Academy, 19–21 Jan 2012, University of Cambridge/The Moeller Centre.

Arana, J., & Castellano, E. (2014). *The role of collaborative networks in business model innovation*. Collaborative networks for a sustainable world, vol. 336, IFIP Advances in Information and Communication Technology. ISBN 978-3-642-15960-2.

Barba-Sánchez, V., Martínez-Ruiz, M., & Jiménez-Zarco, A. (2007). Drivers, benefits and challenges of ICT adoption by small and medium sized enterprises (SMEs): A literature review. *Problem and Perspectives in Management, 5*(1), 103–114.

Baum, J. A. C., Calabrese, T., & Silverman, B. S. (2000). Don't go it alone: Alliance network composition and startups' performance. *Canadian Biotechnology, Strategic Management Journal, 21*, 267–294.

Camarinha-Matos, L. M., & Afsarmanesh, H. (2008). *Collaborative networks: Reference modelling*. Springer. ISBN-13: 978-0-387-79425-9.

Directive 2012/27/EU of the European Parliament and of the Council on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC, (2012) O.J. L 315/1.

Dyer, J. H., & Singh, H. (1998). The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of Management Review, 23*(4), 660–679.

Evangelista, P., Esposito, E., Lauro, V., & Raffa, M. (2010). The adoption of knowledge management systems in small firms. *Electronic Journal of Knowledge Management, 8*(1), 33–42.

European Commission. (2003). Commission Recommendation of 6 May 2003 concerning the definition of micro, small and medium-sized enterprises. *Official Journal L, 124*, 20/05/2003 P. 0036–0041.

European Commission. (2015). Growth—internal market, industry, entrepreneurship and SMEs. Retrieved October 02, 2015 from http://ec.europa.eu/growth/smes/index_en.htm.

Gronum, S., Verreynne, M., & Kastelle, T. (2012). The role of networks in small and medium-sized enterprise innovation and firm performance. *Journal of Small Business Management, 50*(2), 257–282.

Hite, J. M., & Hesterly, W. S. (2001). The evolution of Firm Networks: From emergence to early growth of the firm. *Strategic Management Journal, 2001*(22), 275–286.

Jiménez, G., Galeano, N., Nàjera, T., Aguirre, J. M., Rodrìguez, C., & Molina, H. (2005). Methodology for business model definition of Collaborative Networked Organizations. Collaborative Networks and Their Breeding Environments—IFIP TC5 WG 5.5 Sixth IFIP Working Conference on Virtual Enterprises, 26–28 September, 2005, Valencia, Spain. Springer US 2005 186, pp. 347–354.

IPCC. (2014). Climate Change 2014: Mitigation of Climate Change, Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

Mura, L., & Rózsa, Z. (2013). The impact of networking on the innovation performance of SMEs. In *The 7th International Days of Statistics and Economics, 19–21 September 2013, Prague*.

National Energy Efficiency Action Plans and Annual Reports—European Commission Online. Retrieved October 23, 2015, from https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficiency-directive/national-energy-efficiency-action-plans.

NewBEE official website Online. Retrieved October 23, 2015, from http://www.newbee.eu/.

OECD. (2001). *Innovative networks. Co-operation in national innovation systems*. Paris: OECD Publishing. ISBN 9789264195660.

OECD. (2004). Networks, partnerships, clusters and intellectual property rights: Opportunities and challenges for innovative SMEs in a global economy. In *2nd OECD Conference of Ministers Responsible for Small and Medium-sized Enterprises (SMEs), 3–5 June 2004 Istanbul, Turkey*.

Osterwalder, A., & Pigneur, Y. (2009). *Business model generation*. Self-published. ISBN: 978-2-8399-0580-0.

Parker, C. M., Redmond, J., & Simpson, M. (2009). A review of interventions to encourage SMEs to make environmental improvements. *Environment and Planning C: Government and Policy, 27*(2), 279–301.