



Eco-Innovations in Value Driven Sustainable Building Processes- Need for New Business Models, Opportunities for SMEs

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Abstract: *Sustainable construction business models can support paradigm change in eco-innovation by means of providing a systemic and dynamic approach including Life Cycle Assessment (LCA) and the use of Information and Communication Technologies (ICTs) covering social, environmental and economic aspects in direct collaboration with SMEs. The endorsement of policy makers supports successful implementation of novel and innovative businesses covering the whole value chain.*

SMEs play a very important role in the construction innovation ecosystem. To create new business opportunities for SMEs in a complex and rapidly changing environment, simplicity and agility are key factors to be taken into account. life cycle approach considers a wide perspective, to adapt to different realities while being able to accommodate changes and allow room for innovation. Interactions between information and processes will be in the heart of the expected change and will be an important element of the roadmap for policy makers under development. Efficient use of Building Information Models (BIMs), Product or Project Lifecycle Management (PLM), and flexible LCA tools based on indicators are seen as potential means for success.

The presentations held during this Special Session will address the following issues:

- *Opportunities in managing the life cycle process*
- *How are stakeholder needs addressed to add value?*
- *Tools supporting new business models*
- *Networking platform for eco-innovation*

Findings from this Special Session will be widely disseminated through the various communication channels. This Special Session is organized in an interactive way. The short presentations addressing previously listed key topics are commented by representatives of different sectors (policy makers, building owners, main contractors) that are requested from

Conference delegates from different geographical regions. The audience is also activated to take part in discussion and development of the discussed ideas further.

Keywords: *ecobim project, eco-innovation, sustainable construction business models, eco-indicators, BIM, PLM, SMEs*

1. Introduction

The main objective of ecobim project [1] is to create new sustainable business for SMEs in the construction sector through eco-innovations. The project develops holistic sustainability assessment tools to aid paradigm change to sustainable eco-innovative construction business models. The project has already identified a number of opportunities for eco-innovation within the construction sector (see Figure 1) that are being developed through real case studies in Finland, France and Germany. However, other opportunities not related to BIMs and ICTs are also being explored. One of the project's main outputs expected is the development of a set of guidelines based on indicators for sustainable eco-innovative construction business models. As a result, this process will also provide a roadmap for enterprises, particularly SMEs, and easy-to-understand recommendations for policy makers. This is important since currently existing tools are not simple and agile enough to be easily used by SMEs and do not adapt to their particular features and requirements.



Figure 1. Opportunities for eco-innovation identified by ecobim project. (Pekka Huovila & Carmen Antuña, VTT)

This Special Session presents the main results and findings of the project focusing on the following:

- involvement of SMEs in eco-innovation,
- ecobim construction life cycle process,
- ecobim eco-indicators and business opportunities created within the project with regard to BIM and PLM,
- support provided by ecobim networking platform.

2. Stakeholder involvement

ecobim's targeted stakeholder groups in the construction field are SMEs, policy makers, large companies, users and researchers (see Figure 2).

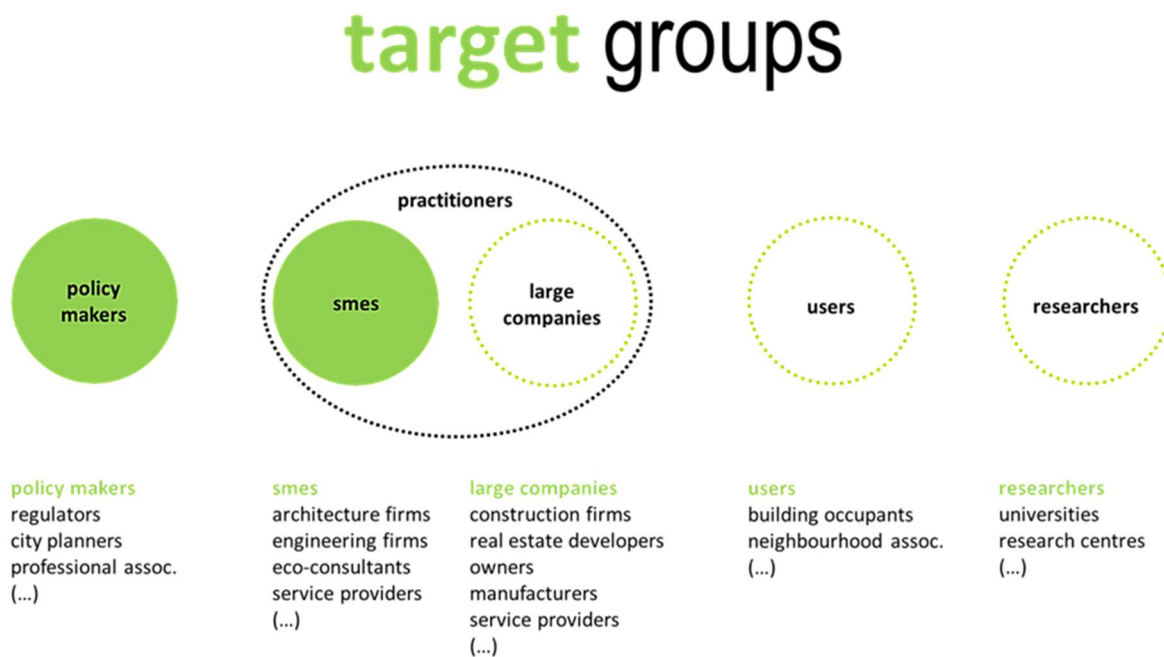


Figure 2. ecobim's target groups.

Within these target groups and business opportunity areas presented in Figure 1, ecobim engages stakeholders from a wide range of professions:

- *BIM checkers and assessment*: designers, architects, engineers, contractors
- *Product life management*: owners, clients, representatives
- *Life cycle assessment and eco-indicators*: consultants, management companies, service providers
- *Monitoring of buildings*: tenants, users

- *Others*: business developers, innovation managers, incubators, product manufacturers, policy makers, universities and associations, software companies

The project has contacted a wide range of stakeholders to collect their views and interests, and more importantly, to define their needs, so that these will guide the development of new services, which in turn are expected to lead to new business opportunities. The stakeholder involvement enables the generation of indicator-based guidelines, which support a paradigm shift towards eco-innovative business models in a sustainable way, and also to provide easy-to-understand recommendations for policy makers.

The scope of the stakeholder process is regional, to trigger engagement and to ensure project management decisions that reasonably consider and integrate perspectives from each actor group. To facilitate their input, the stakeholders are sub-divided into two groups, one for intensive and direct involvement, and one more open and generic panel with streamlined involvement procedures (see Figure 3). To avoid overdue consideration of specific interests, the range of stakeholders needs to be defined to reflect a reasonably wide, but practically manageable, scope of concerns. The addressed stakeholder categories are selected to include actors across the life cycle of a building, but also the decision and management processes.

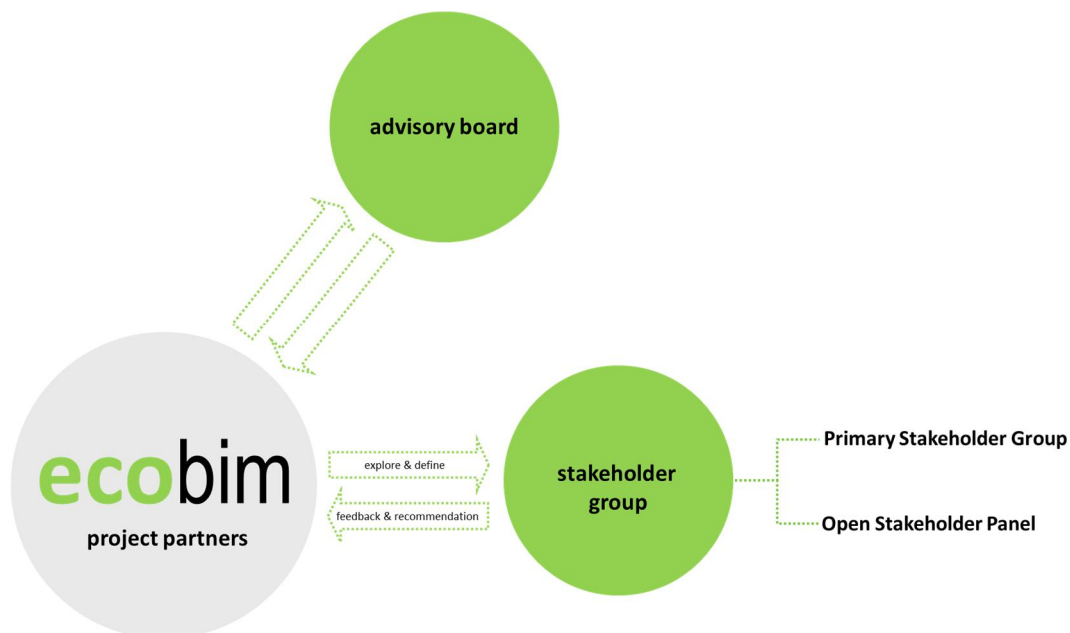


Figure 3. Approach to stakeholder need identification. (Wolfram Trinius, Trinius GmbH)

The analysis of stakeholder benefits and concerns leads to target-group-specific involvement strategies; the means and the questions posed are distinct and specific to each stakeholder category. The first stage of communication with the stakeholders is followed by analysing the information, and to refine and mature the involvement process.

Questionnaires and leaflets are distributed to different stakeholders to gather valuable information and feedback. In order to adjust the work process properly, input and suggestions

from other project partners are taken into consideration to lead to the shared objective of the project. The first stage of communication with the stakeholders is followed by analyzing the information, and to refine and mature the involvement process.

The main principle of stakeholder involvement is the openness and determined engagement of a wider range of concerns, as well as a transparent handling of stakeholder concerns throughout the project.

Networking platform

Early in the project, ecobim established an online networking platform [2] to help discover, together with SMEs, new innovation fields within the construction sector and to develop the required methodologies and tools to serve the whole value chain (see Figure 4). With the same objective, the project has also organized a number of co-creation workshops in Finland and Germany in collaboration with the following external partners: 1) White Lobster GmbH (Germany), an agency for sustainable communication, 2) ARTOVA (Finland), an active neighbourhood association, 3) Mattliden School (Finland), interested in introducing sustainable development as part of their curricular activities, and 4) SYKE (Finland), the Finnish Environment Institute.

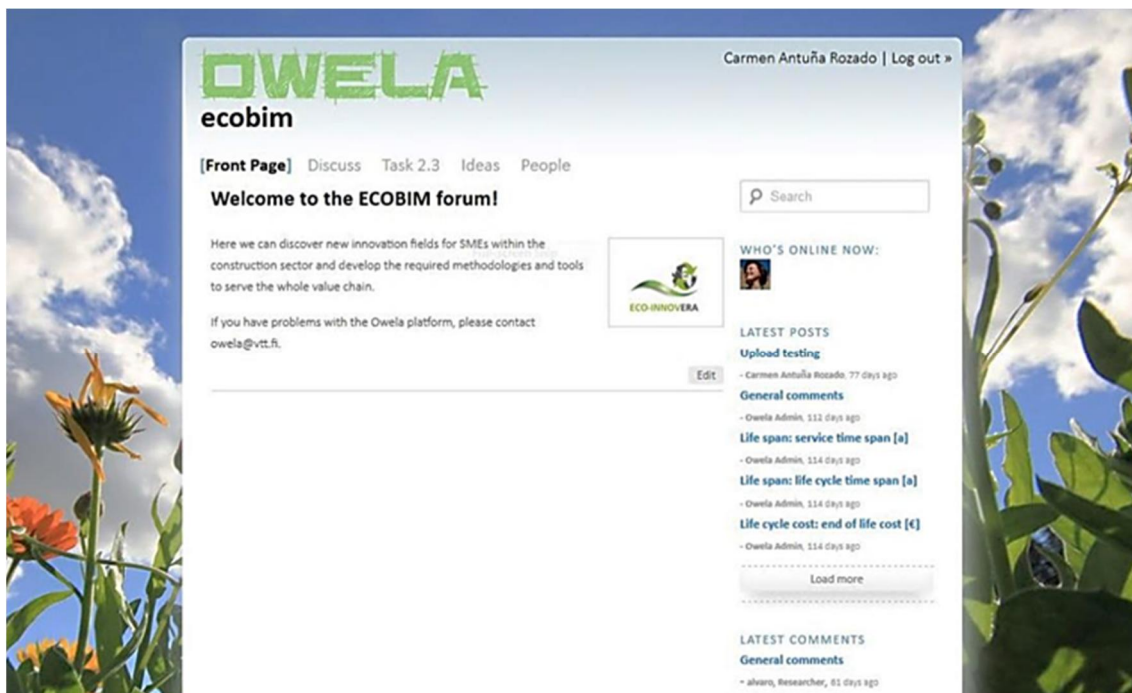


Figure 4. View of Owela for ecobim networking platform frontpage.

The aim of the workshops is to identify and map opportunities for eco-innovation and social development. The workshops are conducted in several phases, face to face and online, and supported by ecobim online networking platform [2]. The ideas proposed are selected, discussed and categorized. The most promising ones are further developed into eco-innovative services along with the corresponding business models, defined with

Osterwalder's business model canvas method (see Figure 5) [3]. The stakeholders taking part in the workshops represent ecobim's main target groups defined in Figure 2. The ideas for new services to support social development identified in the co-creation workshops might inspire also other actors (public or private) in the sector to create eco-innovative business models.

Business model canvas for:

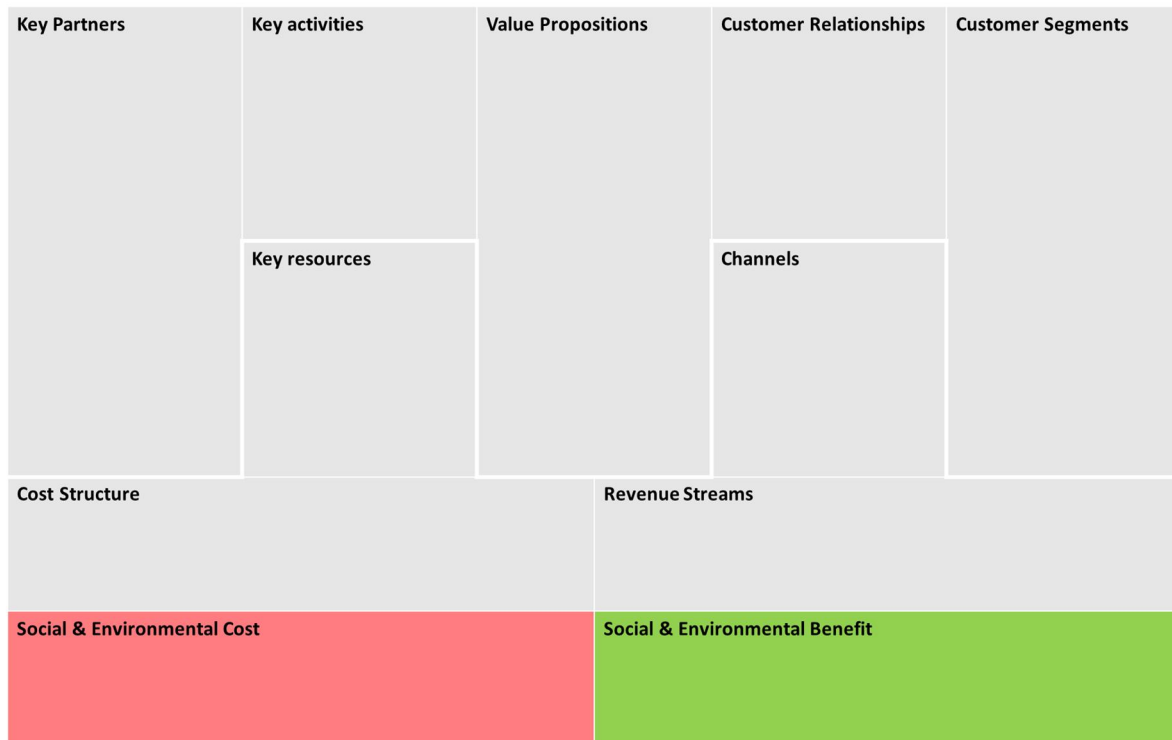


Figure 5. Osterwalder's business canvas adapted to ecobim project. (Aapo Huovila & Carmen Antuña, VTT)

3. Life cycle based process

Building life cycle process includes several concurrent activities (see Figures 6 and 7). Value driven, life cycle based process re-engineering leads into new processes that can be supported by e.g. Building Information Models, Product Life Management and Life Cycle Assessment based on a set of core indicators. New processes and new ICTs open opportunities for eco-innovative services. Sustainable business models can be developed based on these innovations and new earning logic.

BIM supported life cycle based sustainability assessment is based on a value driven process, including IFC based assessment, concurrent stages within the BIM/IFC/Test process and ecobim indicators (presented in next chapter). The ecobim tool is a stand-alone BIM/ IFC model life cycle analysis tool which evaluates the given IFC model through a set of performance indicators. The ecobim tool provides possibilities for evaluating different

approaches and solutions for different stages of the building process. The basic requirement for the ICT environment is a standard BIM capable 3D CAD modelling tool which is able to export a standard IFC model for assessment purposes. The IFC file will be used in common assessment throughout the designing process.

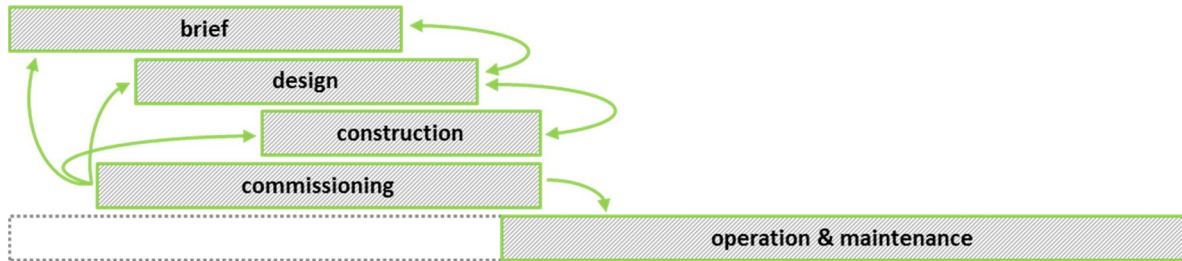


Figure 6. Concurrent activities set challenges. (Pekka Huovila, VTT)

The life cycle based and BIM/IFC assisted design process requires expertise and services that can offer business opportunities for different actors involved. The required tasks and expertise are identified for different stages of the process. They include know-how; provision of tools, accurate data, analysis, evaluation and calculation; processing of data; storing of data, analysis and information.

The pre-design stages (area planning, zoning and site planning) can also be brought to the ecobim assessment process. This can be a helpful tool for area planning on different levels. The tool can provide numerical information for comparison and assessment purposes. The strength of the ecobim tool lies in its fast adaptability and response to different options and changes, thus easily giving answers and directing towards the desired result.

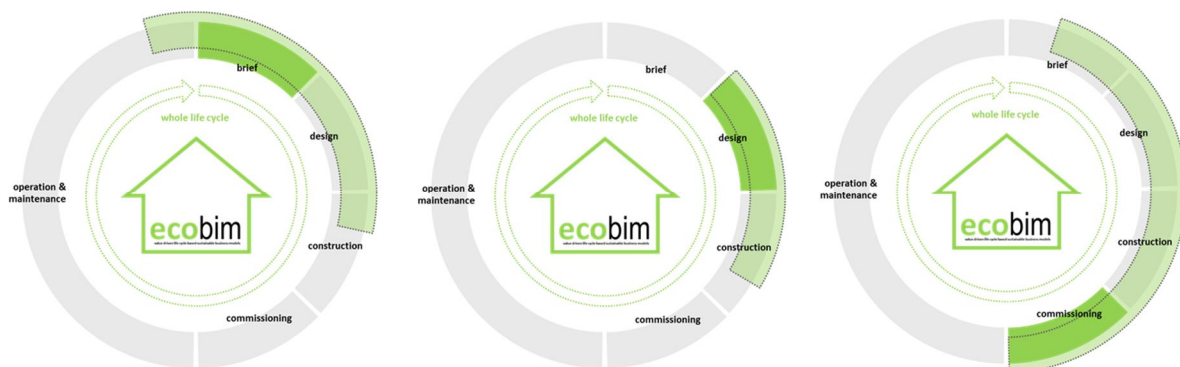


Figure 7. Concurrent activities overlap during ecobim building life cycle. (Pekka Huovila & Carmen Antuña, VTT)

4. Eco-indicators in design and monitoring

ecobim indicators have been developed based on the needs and experience of the SMEs involved in the project. First, the Finnish SME (architectural firm) suggested a list of 28

indicators based on long experience from the practice. Those indicators were then prioritised and weighted by the different stakeholders involved in ecobim. Based on the results a list of 16 indicators has been suggested (see Figure 8). Their descriptions have been developed using VTT's strong experience on the development of sustainable building indicators; see e.g. [4-7].

The final list of indicators will be validated in a workshop with policy makers and SMEs. The results of the workshop will also help to make recommendations on the use of the indicators. Indicators are used through the whole building process to set sustainability targets, adjust those and monitor as well as validate the achieved performance. In the BIM based process, indicators are also important to communicate sustainability features between different stakeholders involved and to justify decisions in defined points during the life cycle process. In principle, the party responsible for the assessment should also be responsible for collecting the correct data and storing the results.

ENVIRONMENT	Energy consumption	Embodied energy [kWh/m ²]
		Operational energy consumption [kWh/m ²]
	GWP	Embodied GHG emissions [kg (CO ₂ eq)]
		Operational GHG emissions [kg (CO ₂ eq)]
Waste production	Embodied waste production [kg]	
	Operational waste production [kg]	
Water consumption	Embodied water consumption [m ³]	
	Operational water consumption [m ³]	
INDOOR ENVIRONMENT QUALITY	Thermal comfort	Operative temperature [C]
		Air humidity [%]
		Air velocity [m/s]
	Visual comfort	Illuminance [lux]
		Daylight factor [%]
Acoustic comfort	Noise levels [dB]	
IAQ	CO ₂ concentration [ppm (CO ₂)]	
COSTS	Life cycle costs	Life cycle costs [EUR]

Figure 8. ecobim core indicators.

At this point, it has become clear that the suggested list of indicators is a compromise of core indicators relevant in all contexts. However, in different context (e.g. geographical situation, stakeholder group, building type), the importance of the indicators is different and additional indicators might be needed. Also when assessing a project by using the ecobim indicators, many of the values of the indicators are subject to local variation. These are due to differences that vary from place to place such as legislation, climate zone and materials, technology and construction systems available.

5. BIM and PLM in construction and process management

Enabled by ecobim project and making use of the approach and findings of the project so far, the French partners CSTB and LASCOM have developed a new solution for BIM projects, presented in [8] and launched in [9]. It has already raised a lot of interest in France and brought them two big contracts used for case studies in ecobim. The developed commercial product is a web based platform named “Lascom AEC-BIM Edition” that improves the collaboration between different stakeholders of a construction project. It combines all the existing know-how of the Lascom’s PLM solution called “Lascom AEC” and the CSTB’s viewer module for IFC called “eveBIM”.

“Lascom AEC – BIM Edition” contributes to the control of all the data of construction projects (BIM model, documents, drawings, calculation notes etc.) throughout their lifecycle. The solution gives a better opportunity to manage, centralize, organize and share all the data of a project around a proven collaborative solution. It formalizes and facilitates exchanges between several companies involved in a BIM based construction process. It gives a new space to share a BIM representation of the building through the Web. Everyone shares accurate data while the solution ensures the rights management of the various stakeholders.

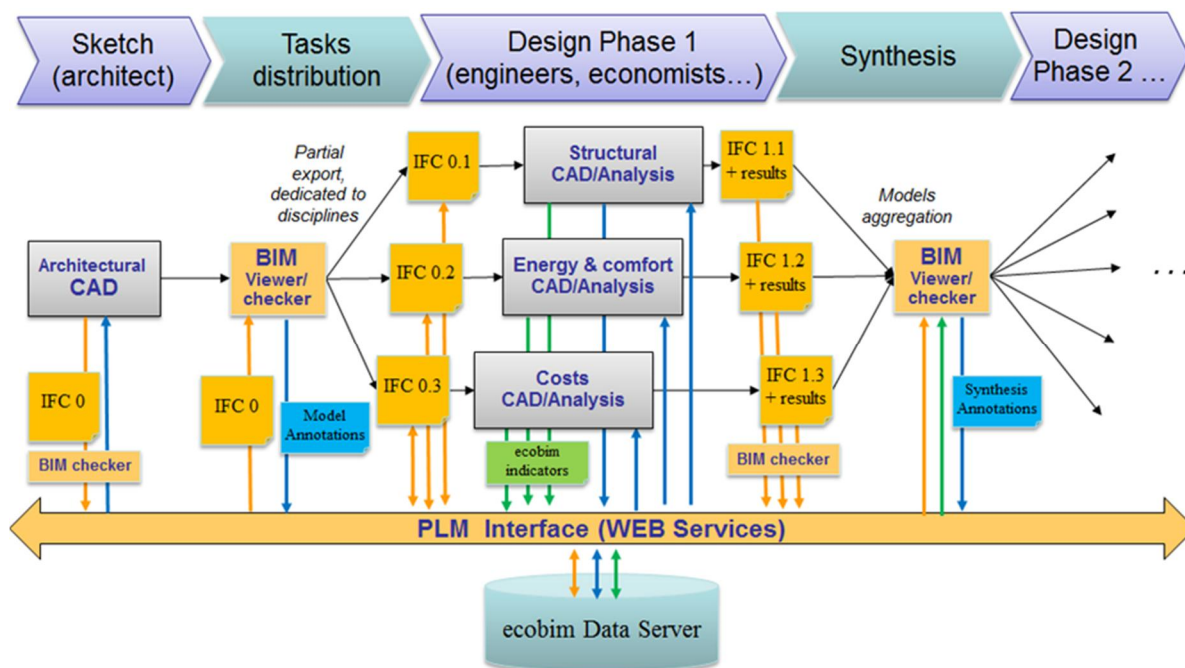


Figure 9. General design process with BIM, IFC and PLM. (Eric Lebègue, CSTB)

Sharing a 3D BIM model for the construction of a building is a key issue for the future (see Figure 9). AEC (Architecture and Engineering Construction) is not the only sector using 3D models. Also e.g. car manufacturers and aerospace industry are regular users. However, the AEC sector has specific constraints regarding the "traditional" way 3D models are shared. Indeed, in the world of construction, the number of potential players (single consultants or



contributors) explodes. More importantly, each actor is responsible for its part based on its business with very different tools sometimes. Then, the collaborative process becomes difficult to control when all the challenges associated to data security, accessibility and the diversity of all available formats that support this rules of collaboration have to be taken into account. To address some of these problems, a standard format for 3D files has been developed: the IFC format. It will become the standard exchange format and will simplify the implementation of the data in each business tool. Lascom AEC-BIM Edition is a fully web-based solution that allows access to structured data, documents, contracts and any other information that is managed in an AEC project using BIM. The solution is available as a hosted solution (SaaS) and provides a rapid implementation to a controlled budget.

The indicators developed in ecobim still need to be implemented in the platform. However, shared 3D models give the opportunity to have new data and new models to complete goals of eco-innovation. Throughout the lifecycle of the buildings, it is possible to extract all the files from the stakeholders' work, make calculations, project specific choices or simulations to ensure that the chosen goals for sustainability are in line.

Main features

- *Collaborative platform:* The collaboration platform unifies the documents, data, IFC models, etc. in a common repository that is available at all times and gives valid and up to date information.
- *IFC models sharing:* In a single repository for the project, each actor can deliver its contribution in IFC format. Each stakeholder can access to the latest applicable version and make their own changes in their own native tools.
- *Management of drawings and documents:* Lascom AEC has all the classic features needed for EDMS projects: versions, revisions/storage, publishing multiple copies of documents, etc. The solution allows archiving all versions of a drawing or a document and traces all the needed elements such as the modification date, the identity of the modifier and the subject of the update of each version.
- *Records management and deliverables:* Lascom AEC BIM - Edition allows creating documentary trees or folders, seeing instantly all the applicable documents at a given time, or producing own deliverables easily.
- *Integrated IFC viewer:* By integrating the eveBIM viewer designed by CSTB within its platform, Lascom AEC BIM - Edition offers a visualization tool for the IFC files downloaded from the client. Easy to use, multiple files can be overlaid to have a complete view of own projects according to each stakeholders need.
- *Links between documents and IFC models:* It is possible to bind documents or drawings stored on the platform to the different IFC files that compose the BIM model.
- *Annotations and comments:* Each authorized user can at any time annotate the BIM model and share his comments with the stakeholders and take earlier remarks into account.
- *Process validation:* The validation of documents, drawings, part of BIM, etc. with traceability of different actions is essential to any construction project.

Case studies

These ICT activities have been aligned with the other components of the project, e.g. the life cycle process described earlier in this paper and a case study in Finland comparing different ICT solutions.

The first operational utilization of the “Lascom AEC-BIM Edition” solution is the ongoing design and construction of the new Ajaccio’s Hospital in France, for which, energy efficiency is one of the major topic. This Ajaccio’s Hospital (a 4 years’ project with a budget of 85M EUR that started in the beginning of 2014) [9] involves all the design and construction actors around the Lascom-AEC BIM Edition Platform: Architects, structural engineers, energy engineers, environmental impact engineers, constructors under supervision of a BIM manager, but also the owner and his assistants. Each actor works with dedicated tool and share data with others thanks to the platform in IFC format. The main interest of the “Lascom AEC-BIM Edition” is managing the collaborative business activities, roles, timing, properties and data sharing of the different actors.

6. Conclusions

- Some of the main outcomes of ecobim will be: A roadmap for enterprises, particularly SMEs at a European level, summarising the ecobim vision and describing an action plan considering drivers and barriers how to reach it. Stakeholder feedback is collected in workshops and through Owela networking platform to be complemented by interviews. Finally, easy to understand recommendations are drawn to policy makers.
- Use of common language is important in a sustainable building process which is complex due the variety of stakeholders, their aims and tools used. Indicators help to manage the sustainability assessments of BIM based building life cycle process, set targets, monitor results and communicate decisions.
- The fact that new business opportunities have been not only identified, but also developed, during the development of the project, as it is the case of the new product launched by the French ecobim partners (LASCOM and CSTB) is somehow an outstanding achievement. So much so if we consider the elusive nature of the ECO-INNOVERA topic where ecobim belongs: Paradigm change towards eco-innovation.
- The synergies between the French case studies and the Finnish one which in practice support each other show the soundness of the approach taken and the potential of the opportunities identified.
- The methodology used for the co-creation workshops with stakeholders, aimed at identifying other opportunities for eco-innovation related to social development enabled by the built environment, has proved to be quite effective, not only in generating new ideas, but in defining business models realistic enough for their implementation.



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