BenchValue – Benchmarking the Sustainability Performances of Value Chains

D4.1 Leaflets and other communication material on each case study

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Abbreviations

BER	Building Energy Rating
BIM	Building Information Modelling
CLT	Cross Laminated Timber
CO_2	Carbon dioxide
EFI	European Forest Institute
EPD	Environmental Product Declaration
GHG	Greenhouse gas
Glulam	Glue Laminated Timber
LCA	Life Cycle Assessment
NZEB	Near Zero Energy Building
RC	Reinforced concrete
ToSIA	Tool for Sustainability Impact Assessment

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1 Introduction

Europe aspires to create a thriving bioeconomy. For this, new innovative product value chains need to be developed, but an increased uptake of bio-based products is only possible if they are economic and more sustainable than competitive products. The European Forest Institute (EFI) is coordinating the "BenchValue" (Benchmarking the Sustainability Performances of Value Chains) research project. The project is funded under the framework of the transnational ERA-NET network by the national funding bodies (Austria, Finland, France, Ireland, Lithuania and Sweden). The project aims to provide objective analysis between the sustainability performances of forest biomass-based vs. fossil/mineral-based value chains.

BenchValue describes value chains in a process-based approach aimed at decision making by assessing environmental, social and economic impacts of alternative chains using ToSIA (Tool for Sustainability Impact Assessment). BenchValue focuses on the market place and develops generic indicators covering economic and socio-environmental aspects to be used in a benchmarking method that compares forest biomass-based materials against others. The aim of the project is to develop a versatile benchmarking method to compare between renewable wood-based and non-renewable value chains and to quantify the sustainability impacts and climate change mitigation potential of substituting non-renewable with wood-based materials to support decision makers in policy and market environment.

The construction sector was chosen as the demonstration case to test the BenchValue method, as timber can be a viable and long-term alternative for storing green Carbon in buildings and substituting greenhouse gas (GHG) emissions from more energy intensive materials. Furthermore, the construction sector is one of the leading sectors of the Eurasian economy and vital to the bio-economy. This publication is a part of the BenchValue project and gathers together the leaflets and other communication material on each case study.

Case studies

Carefully selected case studies in Austria, France, Ireland and Lithuania will serve as real-life testing of the new ToSIA benchmarking method and have been selected to cover jointly the full wood construction value chain, while focusing on country specific issues. The case studies have been designated to reflect the diversity of timber usage for buildings among the countries supporting SUMFOREST.

The case studies also offer the opportunity to gain country specific information while international synergies will be stimulated through the BenchValue consortium giving enhanced added value to the project. Moreover, the participating countries were chosen to widely cover the diversity of European bio-economies and policy schemes through representative case countries where house construction and choice of materials plays an important role either because of the strength of the construction sector or because of the housing requirements. Where data is difficult to obtain, subcontracting has been foreseen in specified cases.

2 Austrian case study: The "HoHo" (wooden high-rise) building, Vienna, Austria

http://benchvalue.efi.int/work-packages/case-studies/austria.html

2.1 Background

For many centuries building with wood was natural and almost self-evident in Austria. The first wooden houses which were made of vertical logs driven into the soil, date back to the Young Stone Age. Log houses have always been, and still are, the typical construction type in rural areas. These buildings represent mainly farmhouses. From the beginning of the 20th century, wood has been gradually replaced as a construction material but recently timber construction is being reinvigorated and becoming popular again.

Austria´s building sector is implementing multi-layer wood-based construction houses since the mid 1990´s. In light of climate change adaptation, efforts towards energy efficiency increased on a national level and have gained momentum via the Austrian climate protection initiative "klimaaktiv" that aims to introduce and promote climate friendly technologies and services. It is embedded in the federal climate strategy and fosters market transformation towards energy efficient products and services.

The klimaaktiv building standard is the guiding principle for environmental and energy-efficient design throughout Austria. Several buildings have been assessed via the klimaaktiv standard and allow for comparison along sustainability dimensions, bridging current state of knowledge, practical applications and the legal framework.

2.2 Case study description

The Austrian Case Study builds upon a showcase project in Vienna, embedded in the lake city of Aspern (part of the 22nd district of the City of Vienna).

The "HoHo" (i.e. Holzhochhaus in German) project is to become the world´s tallest wooden high-rise building in the world once it´s finalized (Figure 2.1).

Figure 2.1. The "HoHo" building, Vienna, Austria.

The designers and architects planned for different purposes:

- Ecological integrity
- Functionality
- Adaptability / flexibility
- Energy efficiency

As a demonstration project to pinpoint what might be possible with the use of wood in high-rise buildings, it shall mark a cornerstone to foster increased material use of wood in the building and construction sector at European level (and inspire architects around the globe).

Roughly 3,600 m3 of wood are used in the entire construction, corresponding to 0.6 per mill of Austria's annual surplus timber production. Key to its implementation are innovative products and a high level of prefabrication (Figure 2.2).

Figure 2.2. Innovative design and materials used in the HoHo construction project in Vienna, Austria.

2.3 Results

According to the HoHo designers the use of wood avoids around 2,800 tonnes of CO2 equivalents compared to reinforced concrete construction. In addition, the HoHo Vienna construction method saves some 300,000 megawatt hours of primary energy. As the HoHo Vienna is still in its construction phase further results will be available during Spring/Summer 2019. A simplified model of the value chain is shown below (Figure 2.3).

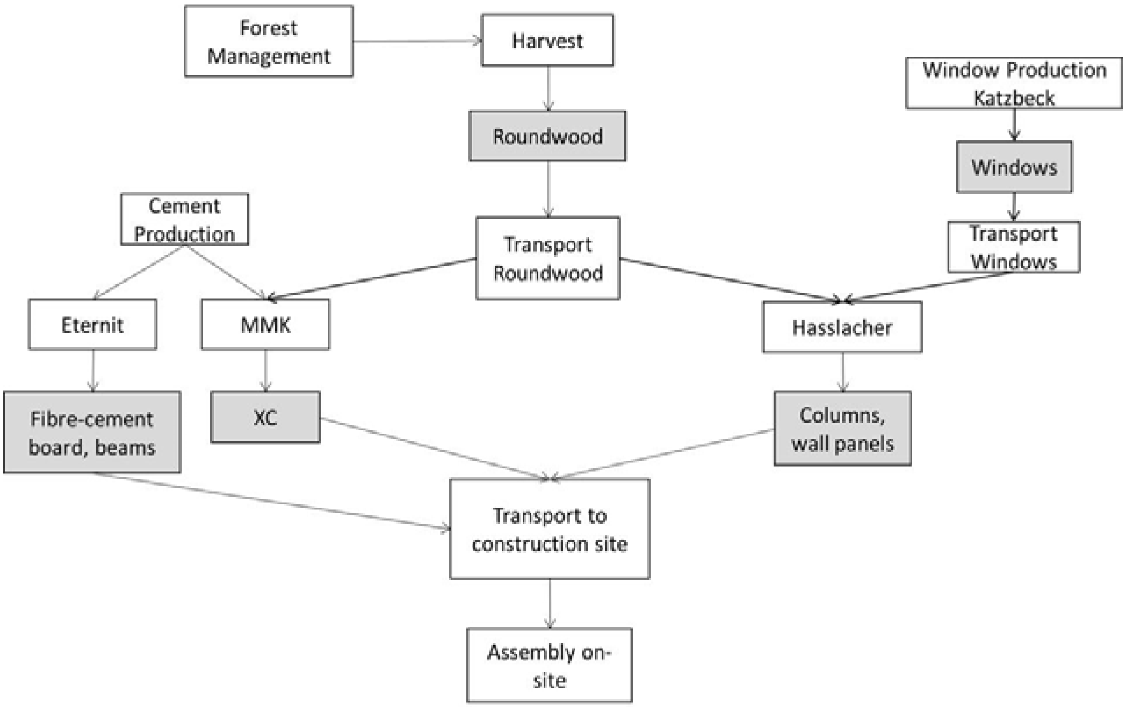

Figure 2.3. Renewable and non-renewable building material value chains associated with the HoHo building construction.

2.4 Findings and Recommendations

Results of the ToSIA modeling will be added after further environmental, social and economic indicator analysis has been completed.

3 French case study: Comparison of four versions of an industrial building in France: Imported wood, local wood, steel and concrete

http://benchvalue.efi.int/work-packages/case-studies/france.html

3.1 Background

Historically, wood construction in France was mainly represented by oak roof frames and chalets in mountain areas. Since the end of the 20th century, wood construction has been gaining market share because of technical products such as glulam, wood frame walls and Cross Laminated Timber (CLT).

The law on green growth and energy transition voted in 2016 lead to the creation of the E+C- label in France, which rewards new buildings with low environmental impacts. A first objective of this label is to reduce the use of non-renewable energy and encourage energy production during the use phase of the building. A second objective is to reduce greenhouse gas emissions over the whole life cycle of the building. A test phase of the label is ongoing and will result in a new regulation by 2020.

3.2 Case study description

The building under study is an industrial building located in Pessac, Nouvelle Aquitaine (Figure 3.1). The building is constructed using glulam made from Scandinavian spruce by the Arbonis company in Chemillé, Pays de Loire. The objective of the case study is to compare it with buildings made of local wood from the Limousin area as well as steel and concrete frame buildings. The comparison is carried out based on environmental, economic and social indicators.

Figure 3.1. The Industrial building with glulam beams, located in Pessac, Nouvelle Aquitaine.

The steel and concrete frame buildings were designed by the IUT of Egletons, which is part of the University of Limoges. It was essential that the four buildings under study had the same function, that is to say the storage capacity (Figure 3.2).

Figure 3.2. The French case study building dimensions

3.3 Results

An environmental comparison was carried out by a student from the IUT of Evry supervised by FCBA using life cycle assessment (LCA) data from INIES, the French Environmental Product Declaration (EPD) program. First results show that there is a significant advantage to wood buildings as far as the greenhouse gas impact is concerned (Figure 3.3).

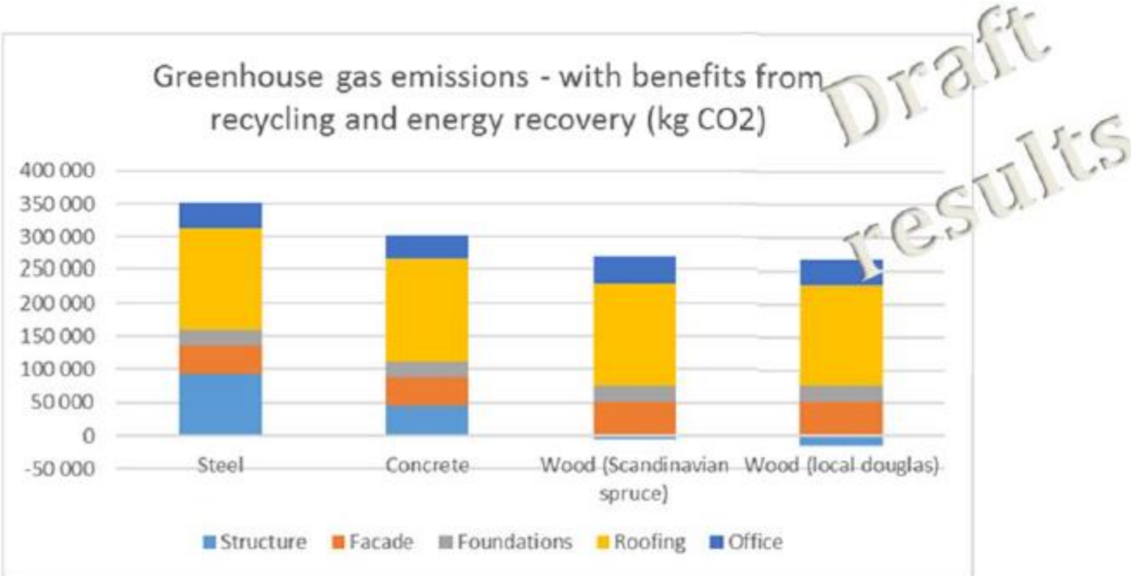

Figure 3.3. Preliminary results from the life cycle assessment study.

3.4 Findings and Recommendations

Results of the ToSIA modeling will be added after further environmental, social and economic indicator analysis has been completed.

4 Ireland case study: Sustainability Assessment of Modern Methods for Constructing Irish Residential Buildings

http://benchvalue.efi.int/work-packages/case-studies/ireland.html

4.1 Background

To transition Ireland to a low carbon, climate resilient and environmentally sustainable economy by 2050, the Irish Government considers mitigating the environmental impact of the Irish built environment and agriculture sectors, in addition to becoming a global leader in the bio-economy, as important objectives in this transition. During this transition to 2050, Ireland is forecast to increase its production of wood materials from 3.2 million m^3 to 8 million m^3 per year by 2035. Additionally, the population of Ireland is expected to increase by around one million people to almost 5.7 million people by 2040 requiring at least an additional half a million new homes.

Bricks, blocks and concrete have been the main material choices for the superstructure of residential buildings in Ireland since the pre-1900s. Timber frame houses have become more common in Ireland since the 1990s. Light weight steel frame houses and insulating concrete formwork frame houses are starting to become a more common superstructure option for Irish housing. The aim of this research is to establish which of four modern methods for constructing Irish residential buildings is the more sustainable from an economic, environmental and social perspective.

4.2 Case study description

The Irish case study building is based on a theoretical semi-detached house. After detached houses, which are predominantly built outside of urban areas, semi-detached houses are the second most common housing typology in Ireland (Figure 4.1).

Figure 4.1. Theoretical semi-detached case study building and the four modern methods for constructing Irish residential buildings to be examined.

The four methods are shown above, clockwise from top left: i) concrete cavity wall frame, ii) timber frame, iii) insulated concrete formwork frame, and iv) light weight steel frame. The building design elevations, floor plans and cross section of a typical Irish 3-bed semi-detached house (**Error! Reference source not found.**(a)-(f)) are used for the purpose of data gathering.

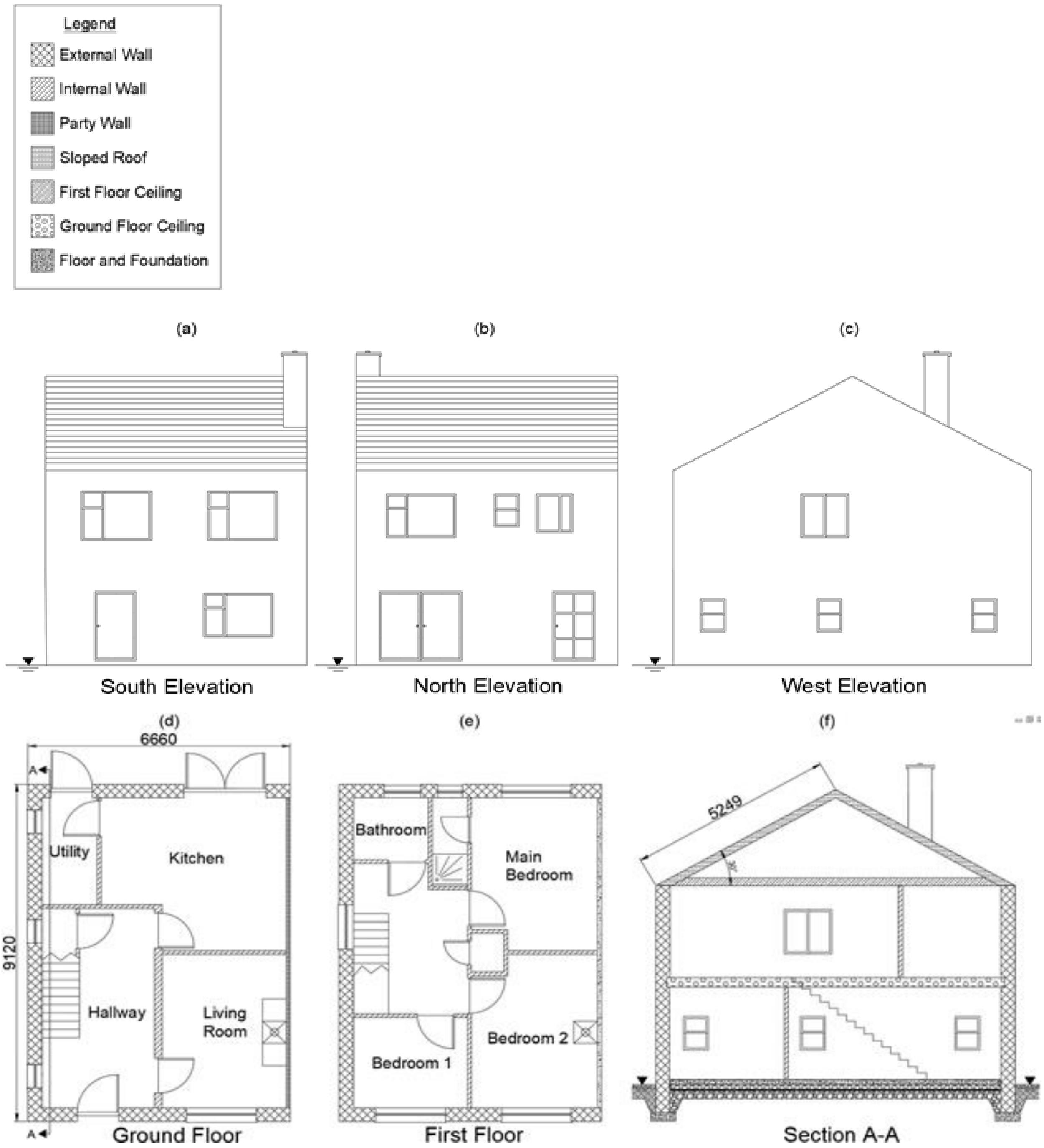

Figure 4.2. Plans for a 3-bedroom semi-detached house a) Front Elevation, (b) Back Elevation, (c) End Elevation, (d) Ground Floor, (e) First Floor, and (f) Cross Section view.

The semi-detached building is to be designed and constructed to meet an ‘A3’ building energy rating (BER) performance standard with the U-value of the wall achieving a value of 0.18 W/m^{2}K. Questionnaires have been distributed to material suppliers and construction companies in Ireland associated with the construction methods asking for information in relation to the design and construction of each building’s external walls, internal walls, windows, doors, roof structure, foundation and floors.

4.3 Results

Three of the four modern methods for constructing an Irish residential semi-detached house have been preliminarily evaluated from a “cradle to gate” life cycle environmental and total construction cost perspective (Table 4.1). When global warming potential emissions and the abiotic depletion potential for fossil resources are evaluated, which are two of the most commonly considered environmental impacts, the timber frame construction is the best performer. The increased use of wood in timber frame construction means that its carbon footprint is reduced by the CO_2 absorbed in trees during their growth.

Table 4.1: Environmental and economic impact of a steel frame, timber frame and concrete cavity wall frame semi-detached house.

Indicators	Concrete Cavity Wall Frame	Timber Frame	Steel Frame	Units
GWP	-26.472	-108.225	53.47	kg CO2 eq/m2
ODP	1.80E-06	1.66E-06	5.48E-06	kg CFC11 eq/m2
AP	0.333	0.322	0.237	kg SO2 eq/m2
EP	0.055	0.056	0.024	kg PO43- eq/m2
ADPE	8.84E-04	1.48E-05	7.35E-03	kg Sb eq/m2
ADPF	763.06	693.681	814.165	MJ/m2
WC	0.933	0.877	0.542	m3 water/m2
Waste	14.258	9.049	10.522	kg/m2
Construction Cost	1,105	1,107	1,097	€/m2

This analysis does not consider what happens to the construction materials at the end of their life cycles. Any timber used can be taken to a biomass plant and burned to produce energy. This advantage of energy production is offset by the CO_2 and other greenhouse gases that would be released. As the timber frame construction contains the most timber products, the results of the end of life cycle process would have the biggest global warming potential increase the most. However, the abiotic depletion potential for fossil resources would decrease when the energy created in biomass plants is considered.

The steel frame construction has an advantage at the end of its life cycle, in that it can be fully reused or recycled. If it were to be put straight back into the construction industry, the environmental impacts would be lessened as the need for steel production from raw material would be lower. Concrete blocks can be recycled after use but are often ‘down-cycled’ for use as fill material, thus, offsetting the material with a lower environmental impact than the original block itself.

All three technologies for constructing a semi-detached house in Ireland have similar costs. This is only the case for when comparing the steel frame as a modular build to the timber frame as a panel build. If the methods were both panel builds, then the timber frame would be the least expensive method.

The four construction methods to be examined in this research will be evaluated from an environmental, economic and social perspective similar to research that has been carried out on Irish Near Zero Energy Building (NZEB) residential buildings.

The Irish stakeholders meeting "Enhancing the Forest Bioeconomy: Material Substitution in the Construction Sector" took place in Limerick, Ireland on 25th January, 2018, and discussed their expectations for sustainable buildings constructed using timber based products (Figure 4.3).

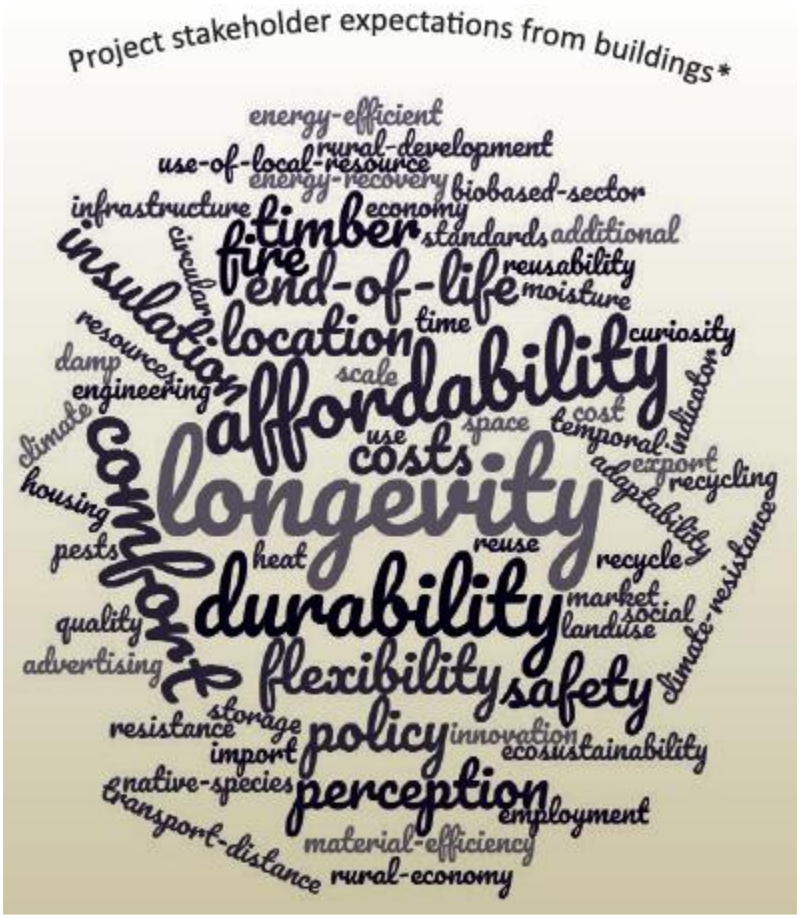

Figure 4.3. Irish stakeholders meeting "word cloud" from their discussion on topics related to timber-based construction. *Font size indicates order of importance.

4.4 Findings and Recommendations

Results of the ToSIA modeling will be added after further environmental, social and economic indicator analysis has been completed.

5 Lithuanian case study: Sustainability of multi-floor buildings using renewable (glulam) & non-renewable (concrete) materials in Lithuania

http://benchvalue.efi.int/work-packages/case-studies/lithuania.html

5.1 Background

Mitigation of climate change, carbon sequestration and low carbon economy are some of the corner stones of the European bioeconomy strategy. Lithuania has sufficient forest resources and a competitive wood industry, and more than 20% of the annual harvest level is exported. Also, Lithuania exports about 80% of glue laminated timber (glulam) for wooden constructions, while using only 20% for national house construction. As a result, Lithuania losses the possibility to develop its low carbon economy based on high value-added products.

As with many other construction products, glulam, structural timber, structural laminated veneer lumber, wood based panels, etc., are regulated with regard to their marketing rules. There are national requirements for structural design of timber structures. These set the minimum framework conditions for the use of wood products in construction. However so far, in Lithuania there is no political decision on special promotion of wider use of wood in construction. The influence can be done by public sector as a main client of design and construction services, for example, by application of Green Public Procurement criteria, as well as application of Building Sustainability Assessment Schemes, Building Information Modelling (BIM).

5.2 Case study description

The production of glulam is rapidly growing in Lithuania. The aim of the case study is to quantify and to compare sustainability impacts of national value chains for non-renewable materials (reinforced concrete (RC)) and renewable materials (glulam) used in the construction sector. The glulam value chain involves: forest logging, transporting, timber sawing, and glulam production; the RC value chain involves: raw material extraction for cement and concrete, transport, cement production, and RC production.

The glulam value chain is based on the processes of the “Jures medis” company, the largest manufacturer of glulam structures in the Baltic states, and sawn timber company “Stora Enso Lithuania”. In order two compare the sustainability impacts of glulam and RC constructions in practical application, material procurement and production processes for two floor (765 m^2) and five floor (1,913 m^2) glulam and RC buildings were modelled (Figure 5.1).

Figure 5.1. The projected two floor (left) and five floor (right) building designs used in the Lithuanian case study.

A stakeholder conference titled “The Forest Bioeconomy in Lithuania, obstacles and opportunities for a strong and vibrant wood construction sector in Lithuania” was held on 6th September, 2018 in Kaunas, Lithuania. Stakeholder interaction and feedback is an integral part of the BV project (Figure 5.2).

The Lithuanian BenchValue project meeting was attended by the following partners and stakeholders :

- Jures medis – GLT production
- Stora Enso Lithuania – sawmill
- Akmenes Cementas – cement production
- Aksa – reinforced concrete
- Ministry of Environment of Lithuania
- Forest owners association of Lithuania

Figure 5.2. Stakeholder interaction at the Lithuanian BenchValue project meeting, 6th September, 2018.

5.3 Results

To-date the Lithuanian case study has analysed the quantities, in m^3 or tonnes, of the materials used in the two and five story buildings (Figure 5.3). The quantities of these materials will form the basis of the ToSIA analysis using the following indicators.

Selected sustainability indicators

Environmental
- Volume of non-renewable material
- Energy use
- Generation of waste
- Water use
- Greenhouse gas emissions

Economic
- Total production
- Production cost
- Productivity

Social
- Employment
- Wages and salaries
- Occupational safety

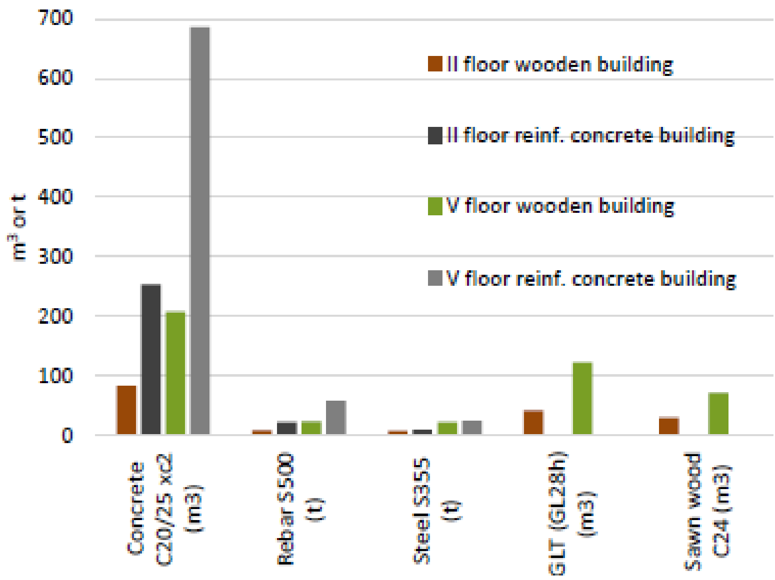

Figure 5.3. Material amount used in the projected II floor (765 m^2) and V floor (1913 m^2) buildings.

Also, key findings from Lithuanian stakeholder interaction “Wood use in Lithuanian bioeconomy”, based on KETSO method, are summarized in Table 5.1. The most important factors for vital bioeconomy development in Lithuania identified – forest resources, public perception, investments, innovations, wood construction sector, markets and biomass energy sector.

5.4 Findings and Recommendations

More detailed results of the ToSIA modeling will be added after further environmental, social and economic indicator analysis has been completed.

Table 5.1. Lithuanian stakeholders KETSO results.

	Main factors						
	Forest resources	**Public perception**	**Investments**	**Inovation**	**Construction**	**Markets**	**Energy**
Strengths	Resource management		European funds	Human capacity		Export markets, GLT	
	Resources' accumulation		Location, close to Belarus	Support from forest oriented industry		Close to markets	
	Large harvest		Competitive work force			Foreign markets	
Possibilities		Public procurement	Increased sawmilling industry	Innovative composite materials	Wooden construction increase	Clean end production	Replace fossil energy with biomass
		Increase harvest	Increased wood gluing industry	Cascade use of wood	Building house wooden living	Export of wooden prebuilt houses to Sweden	Increased use of country residuals
		Wood mobilization		Development and export of technologies	Public buildings	Improve trade balance	Green energy
Chalanges and barriers	Local restrictions	Bureaucracy	Investors' attitude	Youth emigration	Perceptions against wooden buildings	Strength of carbon based industry	
	International restrictions	Political green populism	Company internal strategies	Science and industry limited cooperation	Planning at municipality level	Wood exports	
		Unfavorable political solutions	Lack of international standards for cost moderes	Competition from steel and concrete industry		Access to the bioproducts technologies and markets	
Who and how	Cooperation of Science and Industry	Highlight benefits of wood use	Scientific initiatives	Joint ventures between concrete and wood	Promote use of wood for the construction	Market development	
	use 80-90% of wood annual increment	Eliminate unnecessary Bureaucracy	Lobbying for Lithuanian investments	Scientific investments			
	Address barriers to wood mobilization	Tap into existing legal governance	Lobbying for wood based houses	Work with other sectors			

6 Conclusion

The outlines of the BenchValue case studies, presented here by country, represent some of the important timber-based bioeconomy developments currently underway across Europe. At present each of the teams in Austria, France, Ireland and Lithuania are finalising their data gathering efforts with their case study related partners. That work is based on the completion of surveys of each case study's architecture and engineering teams, their building material suppliers and construction companies, and other material and logistical process related databases (e.g. EPDs, ecoinvent). The relevant data is used to model the required materials and energy inputs and environmental emissions of each construction project in ToSIA. Data related to several economic and social indicators are also built into the ToSIA modelling to enable the benchmarking of the timber-based projects against concrete or steel based construction materials and methods.

Regular conference calls are ongoing across the BenchValue case study teams to review progress and share learnings from each country. Face-to-face project teams meetings, which also include interactions with local and national stakeholders, have already taken place in Limerick, Ireland and Kaunas, Lithuania. The next such project meeting is scheduled to happen in Limoges, France in May, 2019, with the final meeting due to take place in September 2019 in Vienna, Austria. The results from the ToSIA modelling of the case studies and the benchmarking exercises will be delivered in the final stage of the project, which is due for completion in November, 2019.

7 Contacts

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