Comparative Assessment of the Sustainability Performance of Glue Laminated Timber and Non-Renewable Material-Based Value Chains

LIETUVOS AGRARINIŲ IR MIŠKŲ MOKSLŲ CENTRAS

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2019 m. spalio 25 d.

BENCH VALUE

Introduction

- **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 annual harvest level is exported.**

Introduction

- **Also, Lithuania exports about 80% of glue laminated timber for wooden constructions using only 20% for national house construction.**
- **The production of glue laminated timber (GLT) is rapidly growing in Lithuania.**

Results from Stakeholder interaction

- ***Strengths***
  - **1. Available forest resources**
  - **2. Available biofuel and biomass resources**
  - **3. Cheap and skilled labour force**
  - **4. Good education system**
  - **5. Available export markets within short distance (Poland, Latvia, Belarus, Russia directly by**
  - **land; Finland, Sweden, Denmark, Germany by sea)**

- ***Possibilities***
  - **1. Increased sawmilling and wood gluing industries**
  - **2. Cooperation between science and industry**
  - **3. Review of wood building regulations**
  - **4. New innovative products**
  - **5. Decrease of modern product price or joint ventures between concrete and wood sectors**

Results from Stakeholder interaction

- *Challenges*
  - **1. Bureaucracy, planning at the municipality level, also other political solutions**
  - **2. Bad cooperation between forestry and wood industry**
  - **3. Architects and engineers do not have enough knowledge for the wooden constructions**
  - **4. Strong competitors in non bioeconomy sector**
- *Goals*
  - **1. Education of society via national media channels on bioeconomy, forestry and sustainability**
  - **2. Fast communication across industries**
  - **3. More investments to the new wood-based products**
  - **4. Lobbying for Lithuanian investments**

Results from Stakeholder interaction

- **Stakeholders clarified that policy makers are inclined to get requests from the wood industries how the bioeconomy sector has to be shaped. Yet, wood industries are not eager to express their requests but rather wait for the regulations from the politicians. In this way, the status quo situation arises.**

- **Stakeholders also identified a lack of communication between forestry sector and wood industry.**

„Benchmarking the sustainability performance of value chains“

<u>The aim</u> of the case study was to design two and five floors GLT and RC (reinforced concrete) public buildings' frames and then to quantify and to compare sustainability impacts of value chains for non-renewable materials (concrete and RC) and renewable materials (GLT and sawn timber) used to construct these buildings

Study objectives:

- **Design two and five floors GLT and RC public buildings' frames.**
- **Assess sustainability impacts (social, environmental and economic) of typical public buildings in Lithuania built from RC and GLT.**
- **Benchmark GLT and RC use in the construction sector in Lithuania and provide policy recommendations.**

National resources based Value chains

Reinforced concrete

From raw material extraction

To reinforced concrete products

Timber

From forest logging

To glue-laminated timber products

Cooperation partners

Provide data for **GLT** chain:

- Company **"JURES MEDIS" –** the largest manufacturers of glue laminated timber structures in the Baltic states;
- **„STORAENSO LITHUANIA" –** the largest sawmill that produces sawn timber, required for CLT production.

Provide data for **RC** chain:

- **"DRASEIKIŲ KARJERAS" –** extract aggregates for concrete;
- **KALCITAS" –** extract clay and limestone.
- **„AKMENES CEMENTAS" –** the largest cement producer in Lithuania;
- **"AKSA" –** reinforced concrete beams producer in Lithuania;

Economic, environmental and social indicators, selected for the analysis

Economic indicators	Environmental indicators	Social indicators
Gross value added EUR/unit	Greenhouse gas emissions, kg CO2 equivalent/unit	Employment, full time equivalent/unit
Production price, Eur/unit	Generation of waste, t/unit. calculated as non-hazardous	Occupational accidents, cases/unit
	Water use, m3/unit. Calculated as consumed underground freshwater	Wages and salaries, Eur/unit
	Energy use for production, MJ/unit	
	Non-renewable raw material used, t/unit	
	Carbon inflow in to the pool t of C/unit	

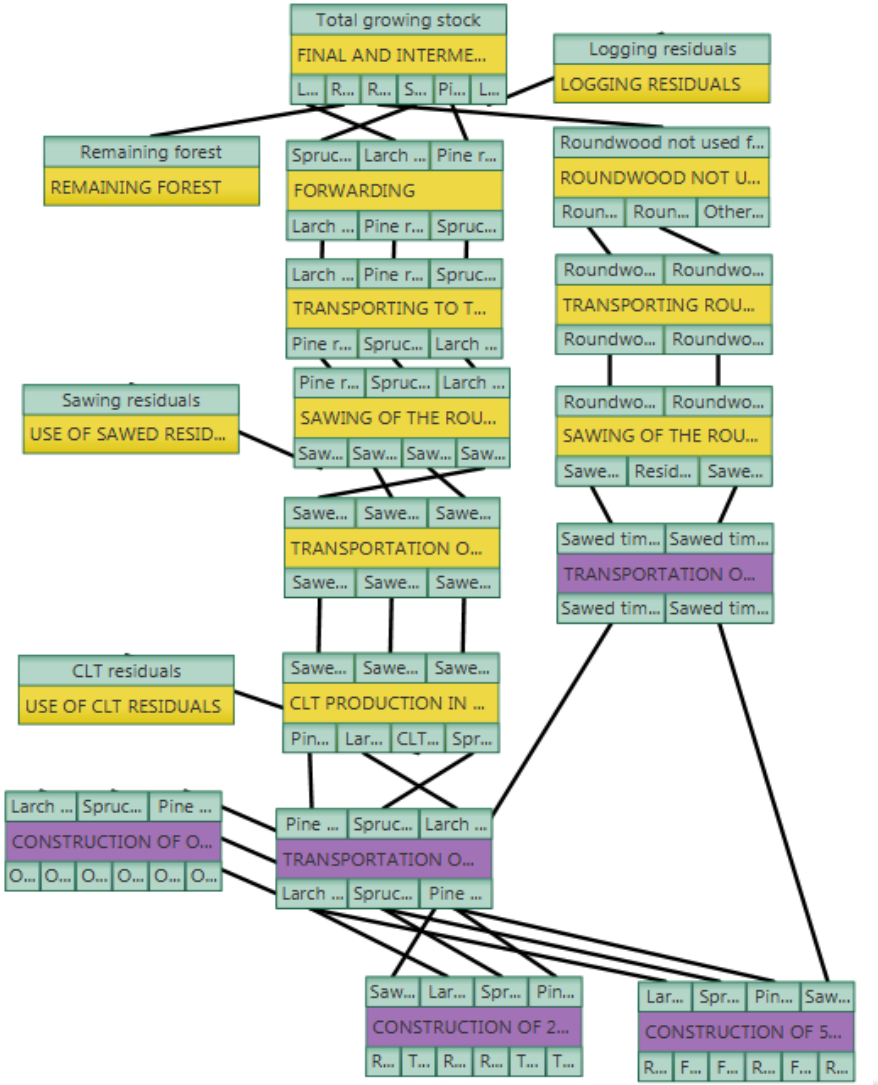
Projected buildings comparison
„Konstrukcijų pasaulis“

Type of building – low-rise office;

Two and five floor buildings for more comprehensive benchmarking;

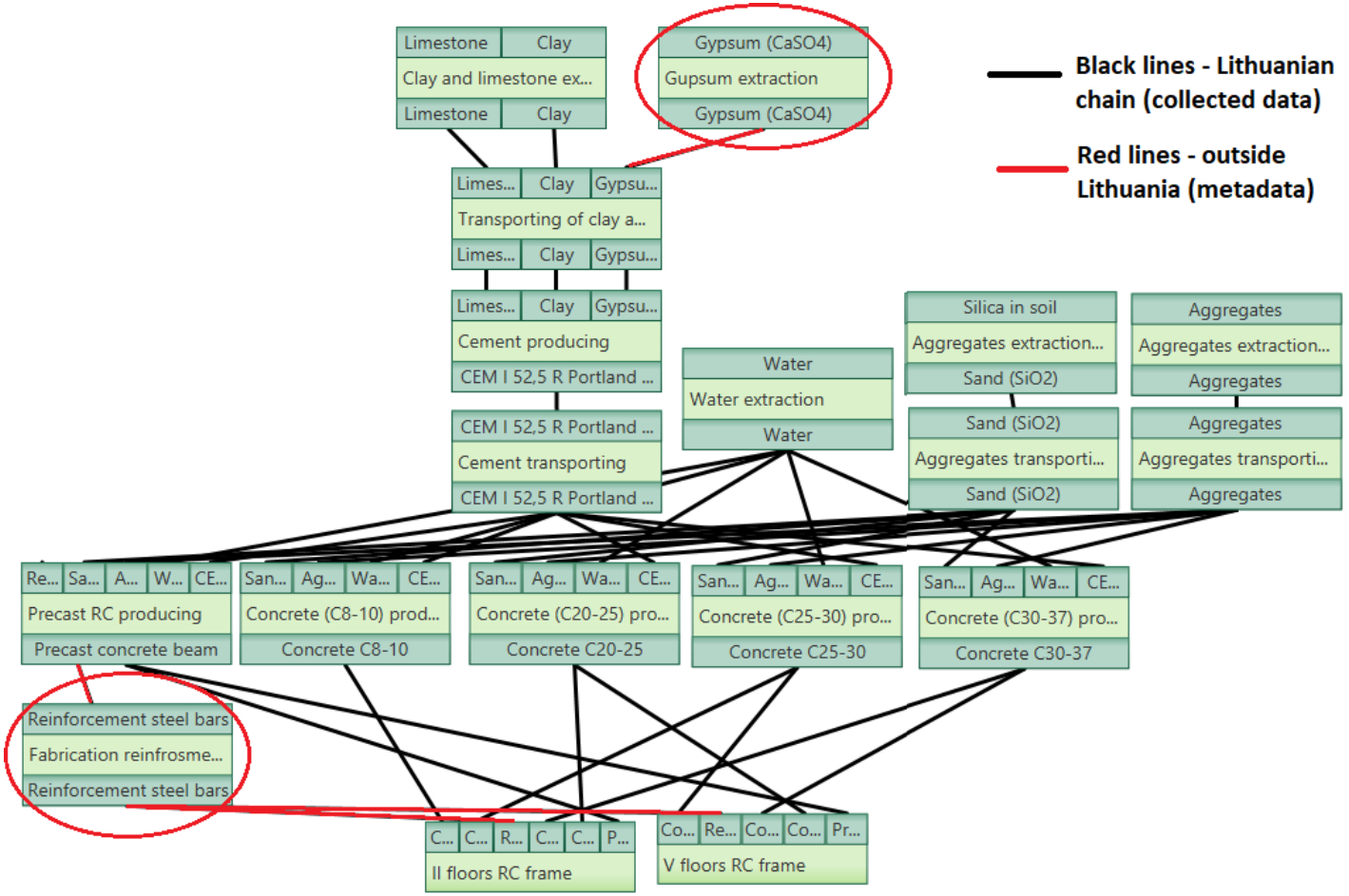
Selected materials:
GLT and sawn wood construction VS reinforced concrete.

Value chain developed for the Lithuanian GLT production



„ToSIA“ model (*EFI*) selected for value chain modelling

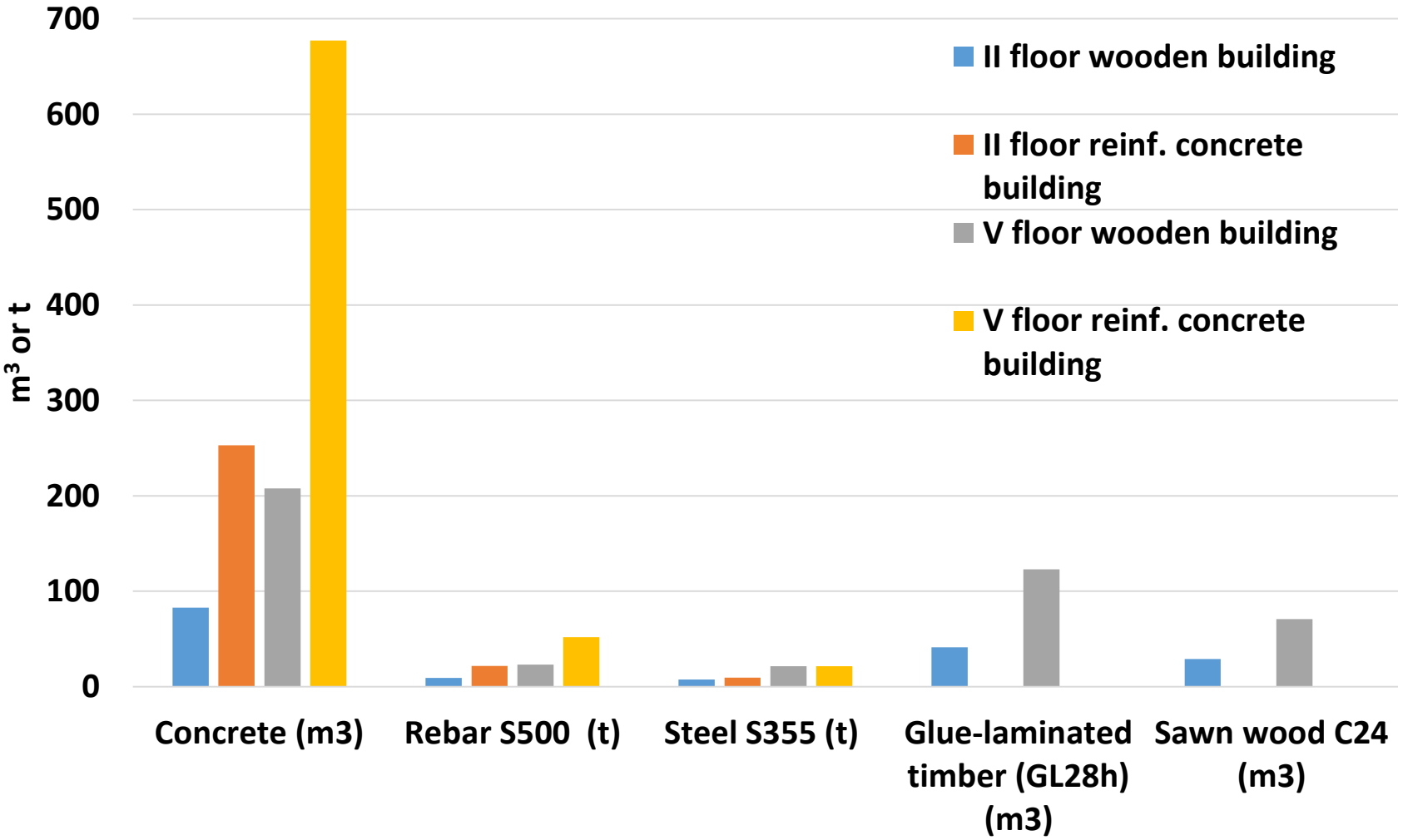
Value chain developed for the Lithuanian concrete and precast reinforced concrete production



Buildings components and materials

Building parts	Wooden building	Reinforced concrete building
Foundation	Site-cast Concrete (C20/25 XC2) + steel bars	Site-cast concrete (C20/25 XC2) + steel bars
Columns	GLT (GL28h)	Precast reinforced concrete (C30-37) columns
Walls shaft for lift and stairs	Site-cast concrete (C30-37) + steel bars	Site-cast concrete (C30-37) + steel bars
Beams	GLT (GL28h)	Precast reinforced concrete (C30-37)
Floor slabs	Sawn wood	Precast reinforced concrete (C30-37)
Steel conections	S355 steel	S355 steel

Material used in the projected buildings



Indicator values per one m^3

	GLT, m^3	Sawed timber, m^3	Concrete C30-37, m^3	Concrete C25-30, m^3	Concrete C20-25, m^3	Concrete C8-10, m^3	Precast RC C30-37, m^3	Steel rebar (S500), t	Steel joints (S355), t
Gross value added (at factor cost), Eur/unit	223.42	64.92	NA*	NA*	NA*	NA*	NA*	NA*	NA*
CO_2eq., kg/unit	266.4	120.6	412.7	356.1	310.4	241.8	576.2	997.6	1753.6
Employment, FTE/unit	0.007543	0.001448	0.000520	0.000496	0.000469	0.000430	0.006762	NA*	NA*
Generation of waste in total, t/unit	0	0	0.000071	0.000061	0.000053	0.000041	0.0059	0.0315	0.0525
Water use (freshwater intake by industry), m^3/unit	0.1260	0.0400	0.451	0.428	0.384	0.272	2.018	12.6	2.65
Production value (price), Eur/unit	470.80	165.00	88.00	85.00	83.00	70.00	241.36	NA*	NA*
Energy use, MJ/unit	1214.50	622.65	1637.90	1426.40	1249.80	991.30	3523.90	14039.20	18899.20
Occupational accidents, cases/unit	0.000093	0.000063	0.000045	0.000045	0.000045	0.000045	0.000045	NA*	NA*
Salary, Eur/unit	100.89	18.83	7.65	7.31	6.91	6.31	96.63	NA*	NA*
Non-renewable raw material , t/unit	0.0105	0.0000	2.4424	2.4675	2.4052	2.3117	2.688	2.90	2.90
Biogenetic carbon storage (carbon inflow in to the pool) tonnes of C/unit	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*** - Data not available**

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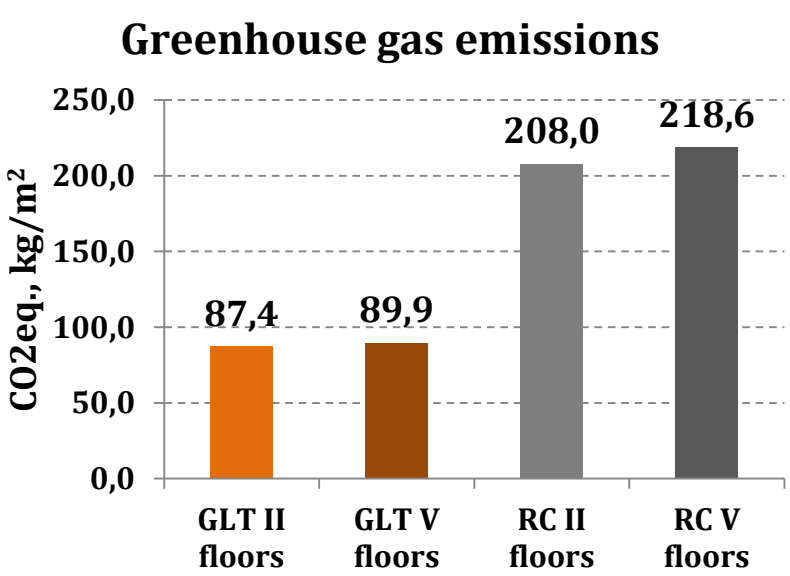
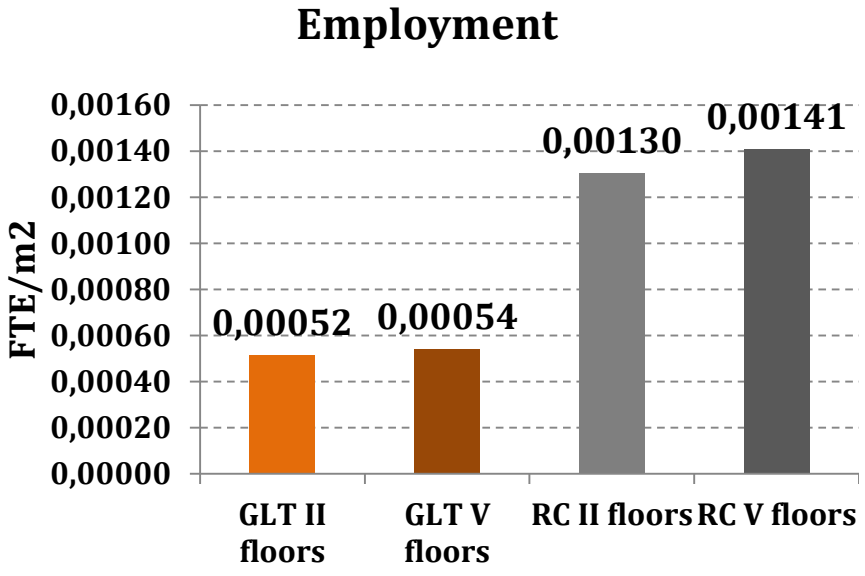
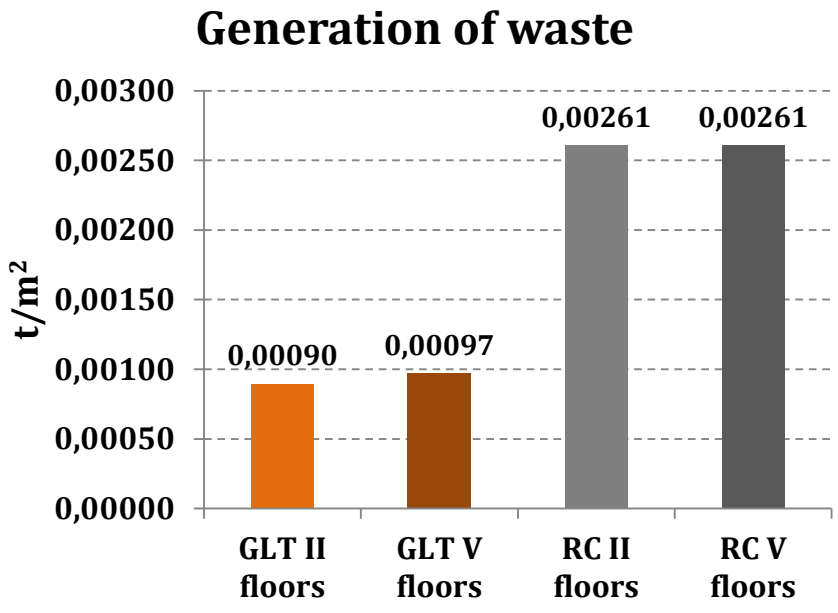
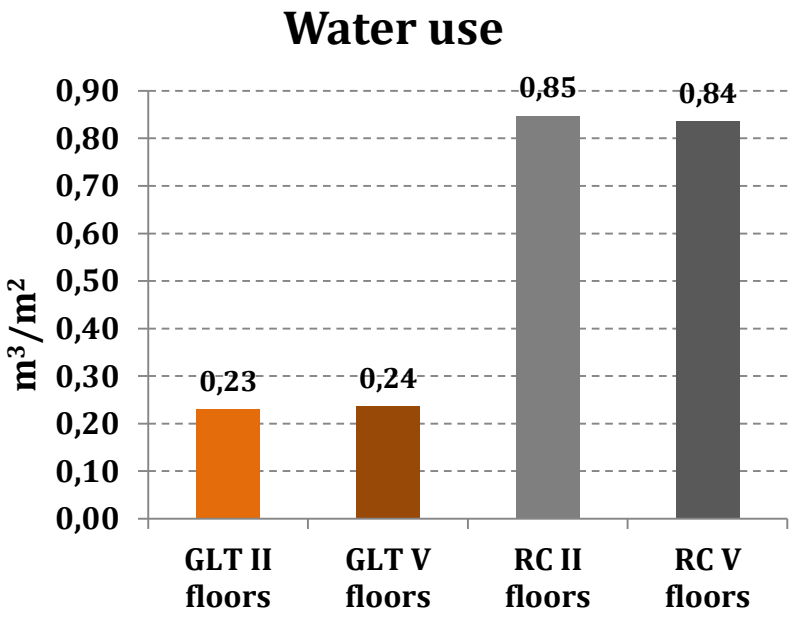
Comparison of II and V flours house, per 1 m^2 of produced area





Comparison of II and V flours house, per 1 m^2 of living area





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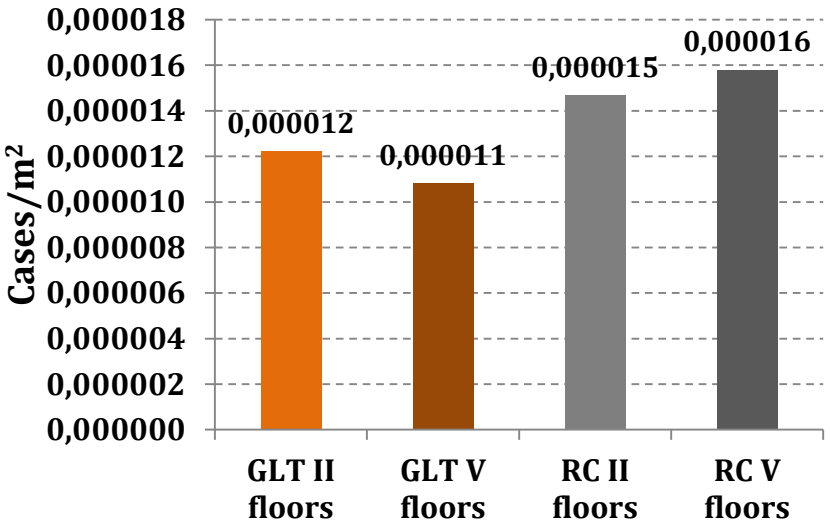
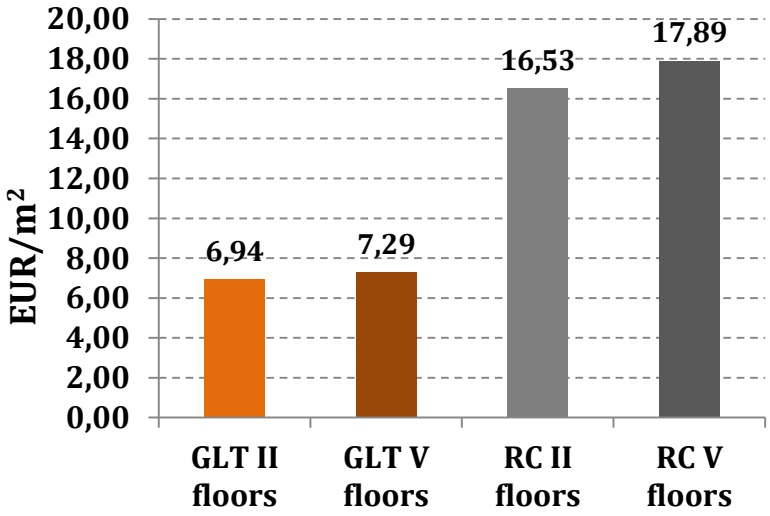
Comparison of II and V flours house, per 1 m^2 of living area

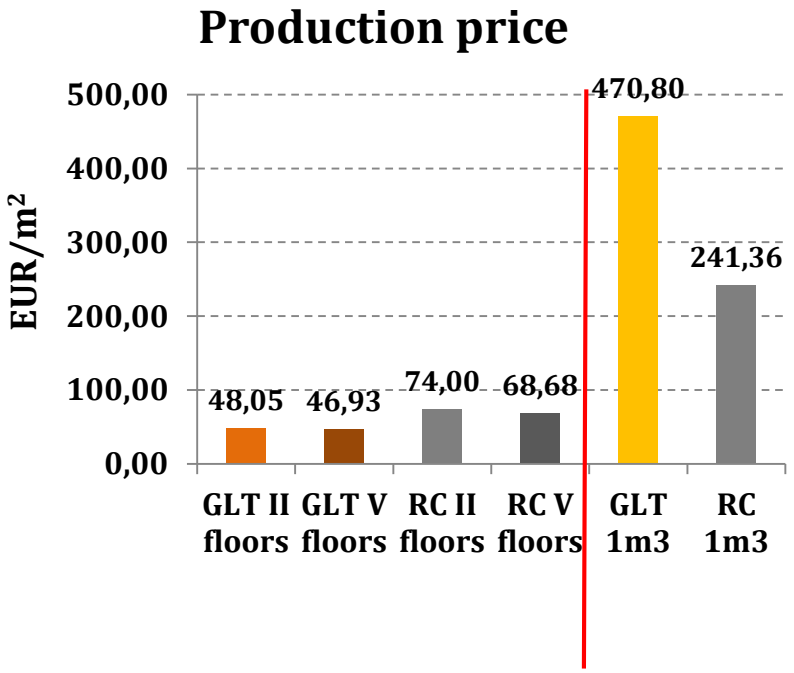
Occupational accidents

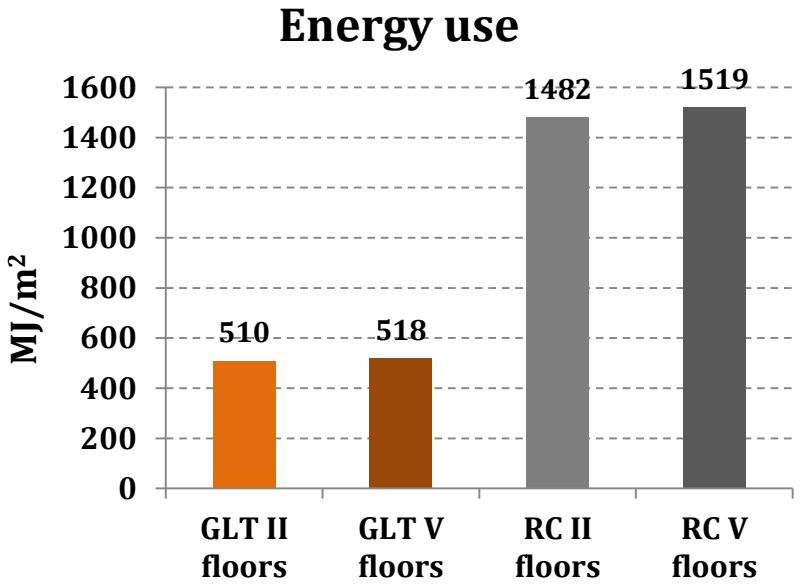


Wages and salaries



Comparison of II and V flours house, per 1 m^2 of living area





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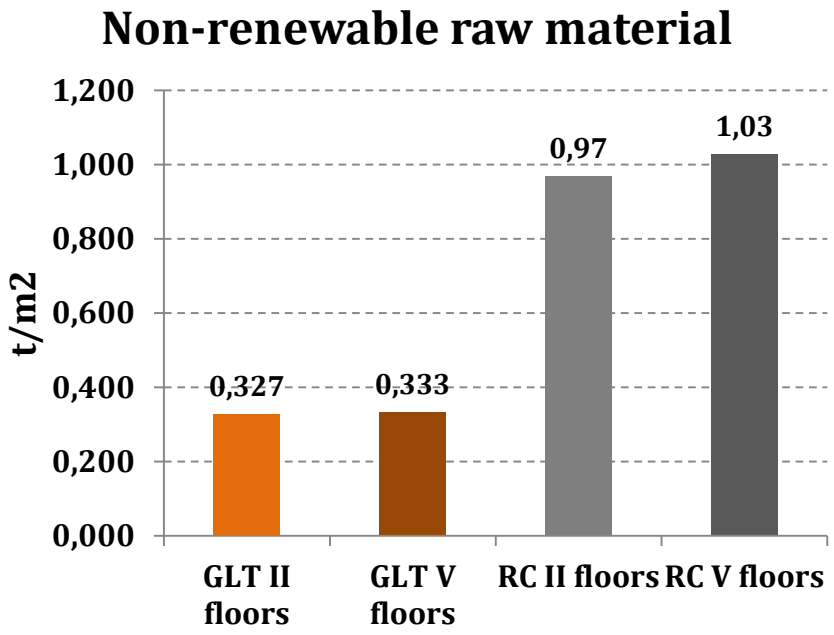

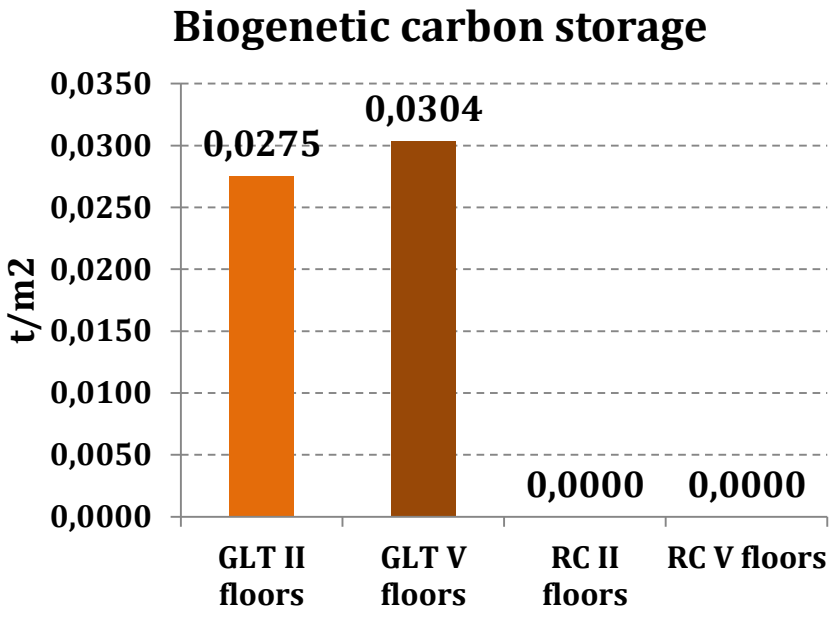

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Displacement factors

Building type	Displacement Factor	CO2 emissions producing concrete building material, tC	CO2 emissions producing GLT building material, tC	C contained in the wood building, tC	C contained in the concrete building, tC
II floors building (765 m²)	5.25	159.12	66.89	17.55	0
V floors building (1,913 m²)	5.09	418.18	171.98	48.39	0

Displacement factors calculated according to – Sathre R. and O'Connor J. 2010. Meta-analysis of greenhouse gas displacement factors of wood product substitution. *Environmental Science &Policy*. 104-114

Conclusions

Gross value added (GVA) (at factor cost) (Eur/unit). The data for this indicator was available only for GLT frames. The most efficient frame regarding this indicator was two floors GLT frame that generated 14.5 EUR/m^2.

Greenhouse gas emissions of CO2 equivalent, kg/unit. The highest emissions of CO_2 equivalent, kg/m^2 where estimated when constructing five floors RC frame. When constructing GLT constructions emissions were about three times lower.

Employment, FTE/m^2. The most efficient frame regarding this indicator was two floors GLT frame that required 0.00052 person/m^2.

Generation of waste in total, t/m^2. The most efficient frame regarding this indicator was two floors GLT frame. It is important to note that this amount of waste comes when the foundation materials (concrete and steel) is produced. All the wooden wastes that are produced in sawn timber or GLT chains are further consumed for bioenergy or other products fabrication. When constructing RC frames, 3 times higher amounts of wastes are produced compared to GLT frames.

Conclusions

- **Water use.** The most efficient frame regarding this indicator was two floors GLT frame 0.23 m^3/m^2. When constructing RC frames, four times more water is consumed. Also most of the water, used when constructing GLT frames, comes from the production of foundation materials.

- **Production value (price), Eur/m^2.** The most efficient frame regarding this indicator was five floors GLT frame 46.93EUR/m^2. Production of one GLT cubic meter that is used in these frames is as twice expensive as the production of reinforced concrete used to produce RC frames. However, production price of two and five floors GLT frames is lower compared to the same RC frames. It happens because the amount of materials needed to produce GLT two and five floors frames is three times less compared to the same RC frames.

- **Energy use, MJ/m^2.** The most efficient frame regarding this indicator was two floors GLT frame with 510 MJ/m^2. When constructing RC frames, 3 times higher amounts of energy is consumed compared to GLT frames.

Conclusions

- **Occupational accidents, cases/m^2**. The most efficient frame regarding this indicator was five floors GLT frame with 0.000011 accident/m^2. There were no remarkable differences regarding occupational accidents when producing analysed frames.

- **Wages and salaries, Eur/m^2.** To construct RC two and five floors frames, about three times higher amounts of salaries were needed compared with two and five floors GLT frames.

- **Non-renewable raw material, t/m^2.** To build two and five floors RC frames much higher amounts of non-renewable raw materials is needed compared to two and five floors GLT frames. Also, all non-renewable raw materials, used to produce two and five floors GLT frames go to construction of its foundations (concrete and steel).

- **Biogenic carbon storage (carbon inflow in to the pool) t/m2.** Only GLT frames has a capacity of biogenetic carbon storage. It was estimated that produced V floor GLT frames stores 0.0304 t/m^2 of carbon that is slightly more than II GLT frames.

Recommendations

- **Construction projects in Lithuania (especially public procurement projects) should be evaluated taking in to account economic, environmental and social impacts of the main material use for the construction.**

- **Collaboration and communication with stakeholders impose following recommendations: decision making on bioeconomy development in Lithuania shall include consultation with various stakeholder groups including forestry sector, wood industry, building sector and scientists with the clear aim to promote use of local renewable resources in the construction sector. Also it is important to strengthen the communication between various stakeholder groups.**

Thank you for your attention !

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