Таблица 2

Теплофизические свойства пеллет

	Топливная гранула из древесных опилок	Топливная гранула из лузги подсолнечника	Топливная гранула на основе термически модифицированного сырья	Топливная гранула из термически модифици-рованной лузги подсолнечника
Высшая теплота сгорания, Дж/г	19323	19979	22536	23114
Зольность,%	24,8	10,5	25,2	13,4
Продолжительность сгорания 1 гр, с/г	37,4	32,3	32,6	27,8

По полученным результатам теплофизических свойств топливных гранул мы видим, что гранулированное топливо из лузги подсолнечника нисколько не уступает топливным гранулам из древесных опилок, а напротив, по данным высшей теплоты сгорания их превосходят. Также мы видим, что топливные гранулы из лузги подсолнечника гораздо быстрее сгорают и как следствие имеют меньший зольный остаток. Наряду с данными свойствами также наблюдается, что термическая обработка гранулированного биотоплива значительно улучшает показания их теплофизических свойств.

Вывод. На основании проведённых экспериментальных исследований было установлено, что гранулированное биотопливо имеет множество преимуществ по сравнению с традиционными видами топлива. Также мы видим, что гранулированное биотопливо из лузги подсолнечника сопоставимо с топливными гранулами из древесного сырья, оно эргономично и горение его в топке котла более эффективно Помимо этого, топливные гранулы из лузги подсолнечника являются более экономичным способом отопления, так как данное сырье не нашло других путей применения, в то время как древесное сырье активно используется в различных композиционных материалах. Благодаря вышеперечисленным качествам, гранулы из лузги подсолнечника обладают высокой конкурентоспособностью по сравнению с распространенными видами гранулированного топлива и могут быть широко использованы.

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COMPARISON OF CO_2 BALANCE OF WOOD WALL TO OTHER TYPES OF WALL

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Abstract. Nowadays CO_2 emission is an important issue, therefore a lot of effort is taken to mitigate climate change. This study provides some data to the mentioned pursuit. Four different wall structures were examined, such as brick, gas concrete, light-frame wood structure and log homes. Thermal transmittance coefficient of wall structures was chosen to the same value to be comparable. Embodied energy was calculated for all elements of wall layers, this is the energy amount consumed during the manufacturing process. There are materials containing significant amounts of carbon, which was calculated as an equivalent amount of stored CO_2.

The most unfavourable CO_2 balanced structures were silicate based walls which cause a high amount of CO_2 emission in one square meter wall surface. In the wood building group the CO_2 balance were negative, what means the related emitted CO_2 was less than the amount stored in the materials built in the wall structure. It can be stated that the wood frame and log buildings store more carbon than the equivalent energy embodied in the CO_2, consequently this type of building seems to be the most appropriate in regards to the ecological architecture.

Keywords**:** Wood wall structures, carbon storage, CO_2 balance of wall structures, embodied energy, wood frame buildings, log homes,

Introduction. Recently we hear about climate change in every information channel. It is often said that since the end of the 18th century, the concentration of carbon dioxide has increased dramatically. According to the latest information, the majority of scientists agree that climate change is most likely attributable to human activity [1]. The increase of carbon dioxide concentration is primarily the result of the consumption and burning of fossil energy sources such as oil, gas, and coal [2, 3]. The second biggest carbon emission area related to the residential sector is the building and demolishing of homes. The energy emitted during the production of construction materials is called embodied energy, which consequently means carbon dioxide emission. The purpose of present study was to compare different wall types, and estimate their carbon dioxide emissions. This investigation was not taking into consideration the other parts of the buildings such as roof, foundation, windows or floors.

Materials and Methods. Four different wall types were selected to compare the embodied energy amount. The four structure types are: brick, concrete wall insulated on two sides, light wood frame wall and log home. Table 1 shows the order of the layers of four different walls.

Table 1

The layers of the walls from inside to outside and the CO_2 equivalence of them

Layers	Brick wall	Bilaterally insulated concrete wall	Light wood frame wall	Block house with aux inner insulation
1	15 mm lime cement plaster	15 mm lime cement plaster	12.5 mm gypsum board	20 mm wooden boarding
2	440 mm brick	50 mm graphitized polystyrene	30 mm air gap, 30 mm lathing	30 mm air gap, 30 mm lathing
3	10 mm mortar	150 mm cast concrete	Vapor barrier (paper sheet)	12 mm vapor permeable chipboard
4	50 mm polystyrene	200 mm graphitized polystyrene	80 mm cellulose ins., 80 mm trusses	210 mm blown cellulose insulation, 210 mm spacer
5	2 mm plaster	5 mm breathable plaster	12 mm vapor permeable chipboard	180 mm glulam spruce
6			160 mm cellulose insulation 160 mm studs	
7			50 mm cellulose based insulation board	
8			5 mm breathable plaster	

To make the different wall structures comparable, they must have the same thermal property, U = 0.13 W/m^{2}K was chosen in this experiment. The calculations of layer thickness in the wall has been performed by WinWatt building physics and energetics software. The desired U value was insured by altering the thickness of insulation layer in wall structures until the whole structure reached the target value. The reason we chose this quite low value is the pressure of European legislation points for passive houses in the near future. One of the conditions of passive houses, the net specific heating energy consumption is max 15 kWh/m^2/year which needs a really high thermal insulation resistance [10].

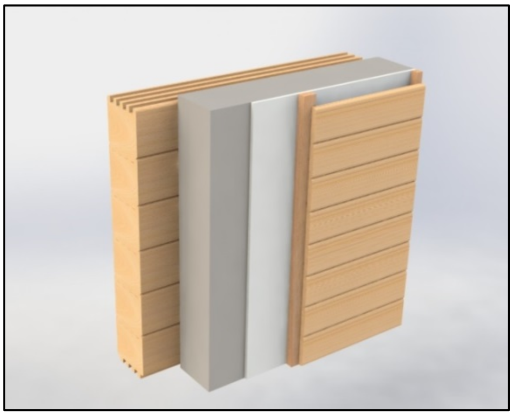

Image. Insulated solid wood wall

There are building materials that can store significant amounts of carbon by sequestering this amount during their life cycle. In case of wood this carbon was deprived from the atmospheres, decreasing the CO_2 content in the air [4. 5].

Oven dried wood comprises around 50 percent carbon. The oxygen content of the carbon dioxide bound by living trees was released during the biological process of the tree. 500 kg carbon bound in wood body means around 1850 kg carbon dioxide abstraction from the air. It can be calculated from the molecule weight. In other words 1850 kg CO_2 is necessary to be deprived from the atmosphere to build around 1 ton of wood. There are several studies on the embodied energy of houses [6–8].

Results and Discussion. The energy consumed during the manufacturing process, embodied energy was also expressed in CO_2 equivalence. In this case the equivalent stored CO_2 was calculated then the final CO_2 equivalence (CO_2 kg/wall m^2) was determined by subtracting the equivalent stored CO_2 from the embodied energy expressed in CO_2 equivalence.

Table 2

CO_2 amount in different wall types

Layers	Brick wall	Bilaterally insulated concrete wall	Light wood frame wall	Block house with aux inner insulation
kg CO_2/wall m^2	+84.449	+65.546	-25.479*	-67.785*

* minus values show that the structure can store more carbon than the amount emitted during manufacturing

Brick wall manufacturing consumed a great amount of energy, and that's why constructing these types of walls will emit a high amount of carbon dioxide. Silicate based materials have a relatively high density, especially the concrete, which partially explains the high energy consumption during manufacturing. These materials are not able to store significant amounts of carbon which could raise the CO_2 equivalence. Of the walls were manufactured from renewable wood, the balance would be negative because of the favorable carbon storage capacity of wood, and the lesser amount of energy required in wood processing [9, 10]. Of course log homes contain more wood than frame works. By this logic the stored carbon amount in log homes makes for better CO_2 equivalence in this type of wall. Although the thermal effectivity of a wood frame wall is considerably better because the space between frame studs is filled with insulation materials. Consequently the same U value can be achieved in the thinner wall thickness of a frame wall.

Conclusions. As it was concluded, the more wood is used in the walls of a house, the less carbon dioxide is emitted and more carbon is stored. In some cases – especially when a large amount of wood is built in – more carbon is stored than emitted during the manufacturing. Traditionally in Hungary brick buildings are wide spread, consequently the additional carbon storage potential is high. It would be advisable to find methods to encourage the usage of wood in buildings, based on the example of North America or Scandinavia.

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