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Carbon storage in wood products

Valters Kazulis*, Indra Muizniece, Lauma Zihare, Dagnija Blumberga

Institute of Energy Systems and Environment, Riga Technical University, Azenes iela 12/1, Riga, LV-1048, Latvia

Abstract

Carbon dioxide (CO_2) is the main greenhouse gas causing global warming. The combustion of fossil fuels produces around 21.3 billion tonnes of CO_2 per year. It has been estimated that natural processes can only absorb about half of that amount, so there is a net increase of 10.65 billion tons of atmospheric CO_2 per year. Air pollution monitoring readings across the globe rose at the highest rate on record in 2015 and 2016. If fossil resources are used as energy resources then that means increase of carbon in the atmosphere and increase of CO_2 in the atmosphere; if biomass resources are used as energy sources the amounts of CO_2 in the atmosphere will increase, however the total amount of carbon in atmosphere will remain the same. To find out the actual amounts of CO_2 that can avoided by storing carbon in bioproducts it is important to do an analysis evaluating the amounts of CO_2 avoided by storing carbon in the product versus CO_2 emitted during the production processes. CO_2 emitted during the production processes of the bioproduct should be reduced to minimum. To verify the proposed method of evaluating the amounts of stored carbon versus the emissions during production process three popular wood products were analysed – oriented strand board (OSB), medium density fibreboard (MDF) and particle board (PB).

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Keywords: circular bioeconomy; wood processing; wood products; life cycle analysis; ECO-it

* Corresponding author.
E-mail address: valters.kazulis@rtu.lv

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1. Introduction

IPCC acknowledges that since the middle of the 20th century many observed climate changes have been unprecedented and claims that current anthropogenic greenhouse gas emissions as the highest in history. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850 [1]. Carbon dioxide (CO_2) is the main greenhouse gas causing global warming [2]. The combustion of fossil fuels produces around 21.3 billion tonnes of CO_2 per year. It has been estimated that natural processes can only absorb about half of that amount, so there is a net increase of 10.65 billion tons of atmospheric CO_2 per year [3]. In comparison volcanoes add 645 million tons of CO_2 to the atmosphere per year [4].

The chemically inert in the atmosphere CO_2 is removed by biological uptake and dissolution in the oceans [5]. CO_2 resides longer in the atmosphere than other major anthropogenic emitted heat-trapping gases. Methane (CH_4) emissions convert into CO_2 within a decade and nitrous oxide (N_2O) stay in the atmosphere for about a century. Much of current CO_2 emissions will be gone in a century, but about 20 percent will still exist in the atmosphere approximately 800 years from now [6]. Air pollution monitoring readings across the globe rose at the highest rate on record in 2015 and 2016. Slower but still unusual rate of increase has continued into 2017 even though the reported amount of the gas that people are putting out has stopped rising – could it mean the natural sponges that have been absorbing carbon dioxide are now full [7]?

The presented information indicates that humans should decrease the anthropogenic CO_2 emissions. The major task is ending our current practices of fossil resource use. The already existing carbon and CO_2 amounts in the atmosphere can be managed also with CO_2 and carbon storages: geological CO_2 storage, ocean CO_2 storage, mineral CO_2 storage and carbon storage in products.

Geological CO_2 storage is done in the underground reservoirs, for example where the fossil fuels have been extracted from. The problem with geological storage is that the possible storage locations are usually far away from the CO_2 emissions sources. Approximately 70 % of the surface of Earth is covered by oceans with average depth approximately 3700 meters. Oceans are the greatest absorbers of CO_2 on the planet, therefore it can be considered that oceans affect and participate in the making of climate. Top layers of oceans are saturated with CO_2, but lower and colder layers of water are not yet saturated with CO_2 and the solubility of CO_2 in those layers is greater. It has been estimated that to diminish the possible negative impact the ocean storage has to be at least 1.5 km deep. Yet the long term consequences of such storage method could have dire consequences – CO_2 is causing ocean pH level to decrease and the already observed changes in pH level have strong negative effects on the marine ecosystem. If mineral CO_2 storage is realized then captured CO_2 is reacted with naturally occurring magnesium (Mg) and calcium (Ca) containing minerals. It occurs naturally as the weathering of rock over geologic time periods. Magnesium and calcium minerals are very abundant and are very stable. As a result, the re-release of CO_2 into the atmosphere does not happen. However, these carbonation reactions are very slow under normal temperatures and pressures and to speed it up would need energy. The reaction rate can be made faster, by reacting at higher temperatures and pressures, or by pre-treatment of the minerals. The IPCC estimates that a power plant equipped with CCS using mineral storage will need 60–180 per cent more energy than a power plant without CCS [8].

Carbon storage in bioproducts is a concept that could help to decrease the amount of CO_2 emissions in the atmosphere. Both Kyoto protocol and IPCC reports state plants store significant amounts of carbon and therefore plants can be used as carbon storage pools. Carbon storage in bioproducts is related with sustainable use of biomass resources in the long run. Most current researches state that parallel to increasing the amount of bioproducts, where possible items made from fossil resources have to be substituted with bioproducts [9]. Nevertheless if use of biomass resources would increase significantly impacts on the biosystem have to be evaluated.

When choosing the raw materials for bioproducts the amounts of chemical contents of raw materials must be measured. Moisture content in the raw material can indirectly impact the potential amount of carbon that could be stored in the bioproduct, because in most cases before further processing the raw material has to be dried to certain level and depending on the source of heat energy the drying process can generate significant amounts of CO_2 emissions. Considering bioproducts focus has to be on those resources that are not fully used, for example woody residues left in the forest to putrefy or are used as low efficiency energy sources. Significant is the potential use in the longer run – most common among the products that are used in the long run are the ones used in the construction, as