10. Азаров В. И., Кононов Г. Н., Горячев Н. Л. Изучение компонентного состава микологически разрушенной древесины // Научные труды МГУЛ. Вып. 358. М., 2012. С. 126–131.
11. Ванин С. И. Древесиноведение. Ленинград : Гослестехиздат, 1940. 460 с.
12. Кононов Г. Н. Химия древесины и ее основных компонентов. М. : МГУЛ, 2002. 259 с.
13. Горбачева Г. А., Уголев Б. Н., Санаев В. Г., Тарасов М. В., Смирнов Д. В., Морозова А. И. Экспериментальное исследование показателей эффекта памяти формы микологически разрушенной древесины // Актуальные проблемы и перспективы развития лесопромышленного комплекса : сб. науч. трудов III Междунар. науч.-техн. конф. / отв. ред. С. А. Угрюмов, Т. Н. Вахнина, А. А. Титунин. Кострома : КГТУ, 2015. С. 9–12.
14. Уголев Б. Н., Галкин В. П., Горбачева Г. А., Баженов А. В. Влажностные и силовые деформации древесины // Материалы всерос. конф. «Дендроэкология и лесоведение». Красноярск : Ин-т леса им. В. Н. Сукачева СО РАН, 2007. С. 163–165.
15. Gorbacheva G. A., Olkhov Yu. A., Ugolev B. N., Belkovskiy S. Yu. Research of Molecular-Topological Structure at Shape-Memory Effect of Wood. Proceedings 57th International Convention of SWST «Sustainable Resources and Technology for Forest Products». 2014. Zvolen, Slovakia. P. 187–195.

УДК 630.8

X. Deglise,
Emeritus Professor, Fellow and former President of IAWS, Full Member of the French Academy of Agriculture, LERMAB/ ENSTIB, University of Lorraine, Nancy, France,
xavier.deglise@univ-lorraine.fr

G. A. Gorbacheva,
Candidate of Technical Sciences, Fellow of IAWS, Associate Professor, Mytishchi Branch of Bauman Moscow State Technical University, Mytishchi, Russian Federation,
gorbacheva@bmstu.ru

V. G. Sanaev,
Doctor of Technical Sciences, Fellow of IAWS, Director, Mytishchi Branch of Bauman Moscow State Technical University, Mytishchi, Russian Federation,
vgsanaev@bmstu.ru

BACK TO THE FUTURE OF WOOD – RETURN OF WOOD ERA

At the beginning of Mankind, wood was the only resource to fulfill the housing and energy needs of the population. After numerous successive periods we are now in the worst situation that we have ever known, with global warming which endangers our life on earth! In this paper we will show that to solve the problem of global warming we need to return to wood Era by using more wood in the construction of houses and buildings and more wood for energy without too much drawbacks like resources and pollution!
Keywords: *forest, wood material, building, wood energy, wastes.*

К. Деглиз,
проф., Академик и экс-президент ИАВС, Академик Французской Академии сельского хозяйства, ENSTIB/LERMaB, Университет Лотарингии, Нанси, Франция,
xavier.deglise@univ-lorraine.fr

Г. А. Горбачева,
к. т. н., Академик ИАВС, доцент кафедры ЛТ8-МФ, Мытищинский филиал ФГБОУ ВО «Московский государственный технический университет имени Н. Э. Баумана(национальный исследовательский университет)», г. Мытищи, РФ,
gorbacheva@bmstu.ru

В. Г. Санаев,
д. т. н., Академик ИАВС, зав. кафедрой ЛТ8-МФ, директор, Мытищинский филиал ФГБОУ ВО «Московский государственный технический университет имени Н. Э. Баумана (национальный исследовательский университет)», г. Мытищи, РФ,
vgsanaev@bmstu.ru

НАЗАД В БУДУЩЕЕ – ВОЗВРАЩЕНИЕ ЭПОХИ ДРЕВЕСИНЫ

На заре человечества древесина была единственным ресурсом для удовлетворения жилищных и энергетических потребностей населения. После нескольких последовательных периодов мы оказались в худшей ситуации, которую мы когда-либо знали, с глобальным потеплением, которое ставит под угрозу нашу жизнь на Земле! В этой статье мы покажем, что для решения проблемы глобального потепления нам необходимо вернуться в эру древесины, используя больше древесины для строительства домов и зданий, для производства энергии без особых недостатков, таких как уменьшение ресурсов и загрязнение!
Ключевые слова: *лес, древесный материал, строительство, древесина как источник энергии, отходы.*

© Deglise X., Gorbacheva G. A., Sanaev V. G., 2021

Introduction

There are many attempts to bring order into human history by defining «ages» or periods with common activities and behavior. The last attempt which is finally commonly accepted defines three different ages, Stone Age, from Paleolithic to Neolithic, Bronze Age divided in Copper Age and Bronze Age, Iron Age, from 1000 BC to now, where this age is Steel Age. Here we are defining differently with humor, a wood age, like the creationists, when Adam and Eve were fired from Paradise and where obliged to find a shelter and some heat! It was the beginning of using wood for construction and energy. Later we were using stones and now concrete and steel. Wood for energy was replaced by coal and petroleum. Now we are coming back to wood as a material and as a source of energy [1, 2]. For sure it's not a serious shortcut, nevertheless it's not too far from the reality! Aim of this study is to present why and how we are returning to wood!

Global Warming and solutions to stabilize or reduce it!

We have directly but mainly indirectly measured an increasing of CO_2 emissions, with a sharp increase since 2000.

There is a very good correlation between mean earth temperature and CO_2 concentration shown in the Fig. 1.

Warming is caused by increasing concentrations of greenhouse gases (GHG: $CO_2 + CH_4$) produced by human (and cattle!) activities:

– burning of fossil fuels and agriculture
– deforestation (~ 25 % of total CO_2 including forest fires!)
– permafrost thawing (~ 50 % fossil fuels perhaps more) which is a real problem in Siberia.

The main contributors are China and USA and some countries like Japan and Germany which have stopped the production of electricity by Nuclear power plants. We must point out that USA will probably decrease its CO_2 coming back to the Paris agreement setting out, in 2015, a global framework to avoid dangerous climate change by limiting global warming to well below 2 °C and pursuing efforts to limit it to 1.5 °C!

It's absolutely necessary to reduce and trap the GHG emissions to reach this objective. There are 4 main strategies of Carbon sequestration are:

– Sequestering carbon dioxide in second-growth forests
– Sequestering carbon (dioxide) in forest products.
– Substituting for non-renewable raw materials.
– Substituting for non-renewable energy.

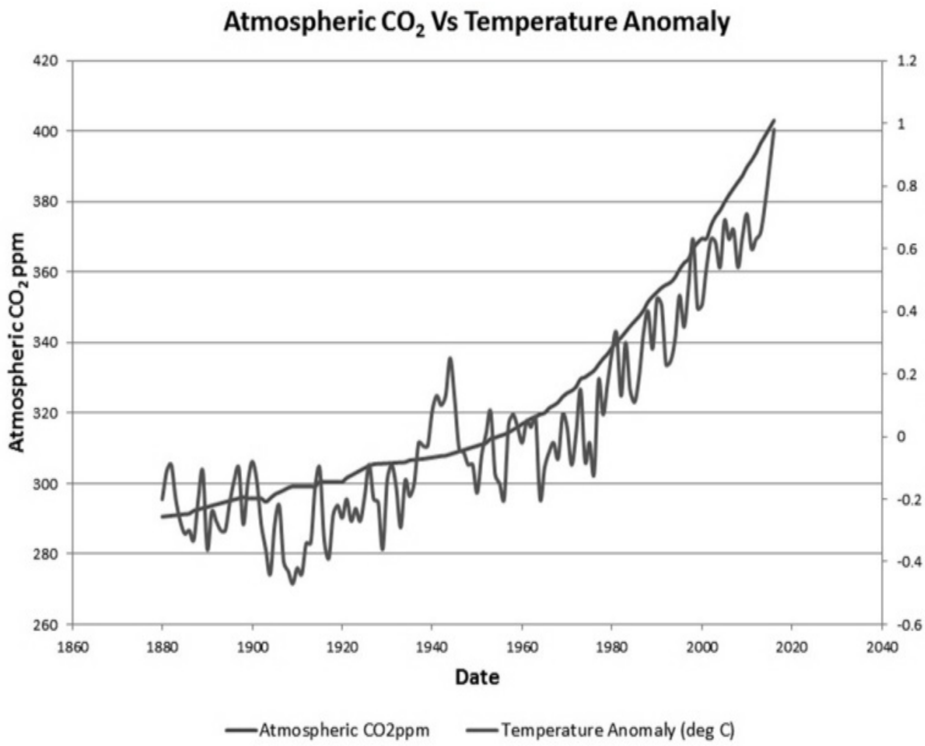

Fig. 1. Atmospheric CO_2 Vs Temperature Anomaly [3]

1 – Sequestering carbon dioxide in second-growth forests (Carbon sink) is possible by extension of the resource, increasing the productivity, limiting harvesting to the biological production, reducing losses in forests by protection against fire and insects (Beetle killed Lodgepole Pine is 15–17 million ha in British Columbia) and new silvicultural approach.

Natural Forests (old-growth or primary), without management, are Carbon Stock and not Carbon Sink. Secondary Forests (second-growth forests), harvested with management plan are initially a Carbon stock and then Carbon sink.

Temperate forest, managed and harvested sequester, in vegetation and soil, around 3 tons C $ha^{-1}.year^{-1}$, boreal forest, 2 tons C $ha^{-1}.year^{-1}$ and tropical forest, managed and harvested around 5 tons C $ha^{-1}.year^{-1}$.

2 – Sequestering carbon in forest products

This sequestration accounts for only 10%* of the CO_2 sequestration by Forests [4]and occurs in sawn wood, engineered wood products (EWP), boards, furniture, paper, cardboard until end of life …the latest possible.

Increasing the durability of the forest products by wood protection contributes to the sequestration of carbon.

In factthe main forest products are in buildings where Engineered Wood Products (CLT, Glulam, LVL…) manufacturing uses much less energy than in building with concrete, steel… and avoids the emissions of GHG (CO_2). The wood buildings have a lower carbon footprint [5,6].

The manufacture of concrete and steel accounts for 8 % of annual GHG in the world.

Buildings have a strong effect on the environment: 60 %of global resources consumption, 50 % of global waste production, 35 % of global energy consumption and 35 % of global CO_2 emissions. Up to 10 % of annual global carbon emissions are stored in wood buildings.

Carbon remaining locked inside wood products, for a long time it's Carbon Stock, becoming Carbon Sink with the increase in wood construction (5–10 %/ year) in many countries, actually!

There are other benefits to build with wood:

– Timber-based buildings take less time to build with prefabricated mass timber panels and beams. Smaller crews assemble structures more safely and quickly, saving time and money.

– The greatest amounts of wood are used in mid-rise buildings (4 to 10 stories: residential apartments, commercial buildings and hotels; any new building, extension, additional story); not in high-rise buildings.

– Wood is healthy by its presence, scent and touch and has positive effects on people's wellbeing, stress levels, blood pressure, communication, learning and healing.

And most important remark, EWP (Engineered Wood Products) use smaller pieces of wood. It's better for CO_2 sequestration by forests because lumbers will come from reforestation with smaller trees which grow faster in few decades! Carbon sink is increasing!

But there are some drawbacks:

– combustibility. It's more challenging for multi-story buildings. In comparison to steel, glass or concrete, wood needs a special protection or treatment to improve its fire resistance.

– high moisture level supports the biological degradation and humidity changes induce dimensional variations. Moisture protection is necessary.

Another drawback coming from the success of wood construction is the procurement and prices which are actually increasing too fast.

3 – Substituting for non-renewable raw materials and "chemicals".

Wood based materials replacing concrete, PVC, aluminum, etc. will reduce carbon emissions (Fig. 2).

Chemicals, polymers …coming from Wood Bio-Refinery show reduced emissions of CO_2 in manufacturing to compare with oil based products!

4 – Substituting for non-renewable energy.

Assuming carbon neutrality Fuel wood from sustainable sources replaces non-renewable energy sources, to reduce carbon emissions!

Fuel wood is 50 % of the renewable energy in Europe and comes from clean wood from stems (50 %), residues (50 %) from harvest operations (branches, foliage, roots, etc.) end of life wood coming from the cascaded use of wood (firstly wood-based products, secondly recovered and reused or recycled and finally used for energy), industry residues and black liquor.

Recently most of the countries from the northern Hemisphere are trying to reduce the use of Fuel wood for Health problems. In France it will be decided to recommend to divide the use of Fuel wood by 2! There is also a campaign to ban the use of wood to replace coal in Power plants.

Since the early 80's there is a development of Bio Fuels, mainly through Thermo chemical processes, which could replace Fuel wood.

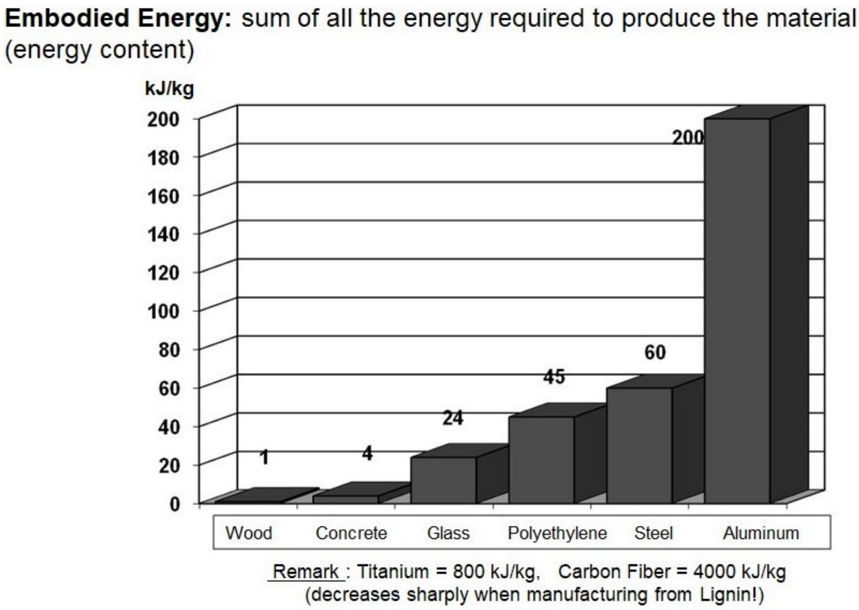

Fig. 2. Embodied (or manufacturing) Energy of Materials [7]

Many possibilities exist to upgrade Fuel wood into bio fuels, gaseous like Hydrogen, liquids or solids (Fig. 3) [8]. At the same time there is a trend to mix wood with MSW (Municipal Solid Wastes).

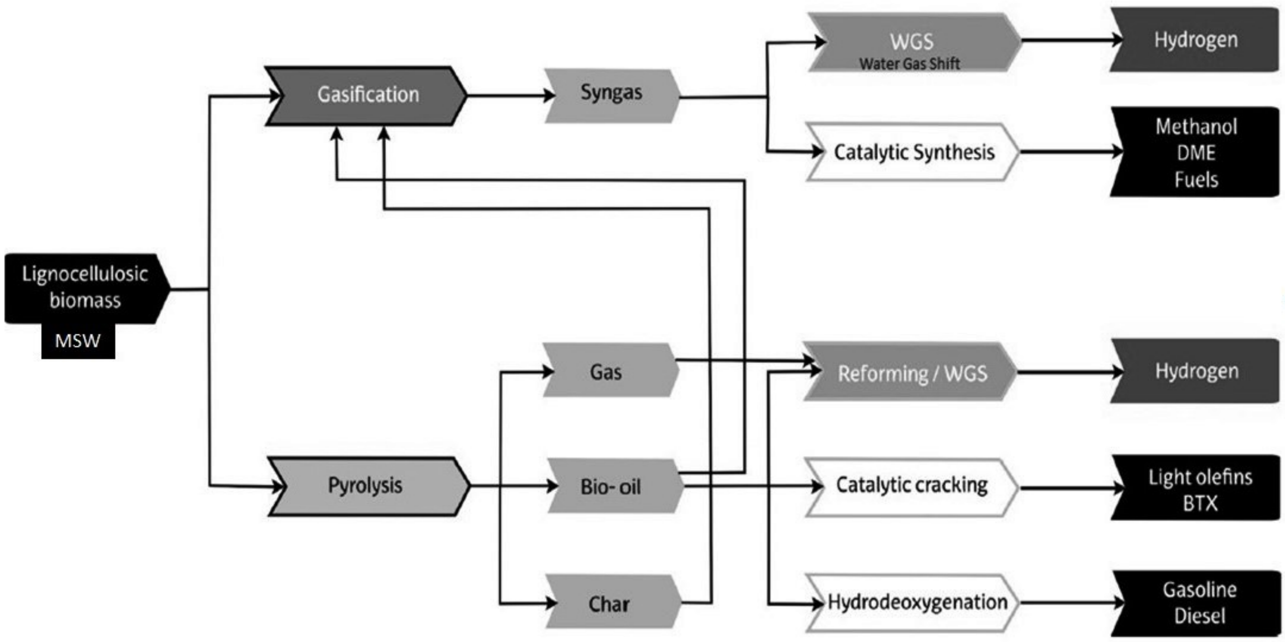

Fig. 3. Schematic representation of the main processes involved in a lignocellulosic thermochemical bio-refinery [8]

There is indeed a big problem with MSW which are either incinerated or land filled with environmental drawbacks. It's better to try to upgrade them in renewable Energy. It will be interesting, namely for Russia [9].

Conclusions

Numerous solutions are existing to fight the global warming, among them, forests and wood are probably the best, taking in account that forests are the most efficient carbon sink when they are properly managed in a sustainable way. Forest Products accounting for only 10 % of Carbon sequestration but they are necessary to help in managing forests! Without them it won't be possible to make forests a real Carbon Sink!

Acknowledgement

The presentation was prepared in the frame of the MOU between Bauman Moscow State Technical University (BMSTU) and University of Lorraine (UL).

References

1. Deglise X. «Ecological management» of forests and wood products // Lesnoy vestnik / Forestry Bulletin, 2017, Vol. 21, № 4. P. 6–9. DOI: 10.18698/2542-1468-2017-4-6-9.
2. Gorbacheva G. A., Sanaev V. G. Wood Science for the Architecture: From Tradition to the Future // Proceedings of the annual meeting of the IAWS «50 Years International Academy of Wood Science – Wood Science for the Future». Paris. 2016. P. 54.
3. Chadwic A., Williamson P. URL: https://www.geolsoc.org.uk/Geoscientist/Archive/July-2015/Steps-and-cycles (дата обращения: 23.03.2021).
4. Deroubaix G. Forest and wood products assets for climate change Mitigation: prospects for maximizing their effects // 2021 World Wood Day Virtual Symposium & The 3rd IUFRO Forest Products Culture Colloqium. 2021. P. 11–12.
5. Churkina G., Organschi A., Reyer C. P. O. et al. Buildings as a global carbon sink // Nature Sustainability, 2020, Vol. 3. P. 269–276. URL: https://doi.org/10.1038/s41893-019-0462-4.
6. Amiri A., Ottelin J., Sorvari J., Seppo Junnila S. Cities as carbon sinks – classification of wooden buildings // Environmental Research Letters. 2020. 15. 094076. URL: https://iopscience.iop.org/article/10.1088/1748-9326/aba134/pdf (дата обращения: 23.03.2021).
7. DegliseX. Le bois un matériau de construction durable // Conférence Olympiades de la chimie / ENSIC, 12th January 2005.
8. Arregi A., Amutio M., Lopez G., Bilbao J., Olazar M. Evaluation of thermochemical routes for hydrogen production from biomass: A review // Energy Conversion and Management. 2018, Vol. 165. P. 696–719. URL: https://doi.org/10.1016/j.enconman.2018.03.089.
9. Kovalenko K., Kovalenko N. The problem of waste in the Russian Federation // MATEC Web of Conferences 2018, 193, 02030. URL: https://doi.org/10.1051/matecconf/201819302030.

УДК 630.812:582.632.1

С. Г. Елисеев,
к. т. н., доцент кафедры ТКМД, ФГБОУ ВО «Сибирский государственный университет науки и технологий имени академика М. Ф. Решетнева», г. Красноярск, РФ,
eliseevsg@sibsau.ru

В. Н. Ермолин,
д. т. н., зав. кафедрой ТКМД, ФГБОУ ВО «Сибирский государственный университет науки и технологий имени академика М. Ф. Решетнева», г. Красноярск, РФ,
vnermolin@yandex.ru

А. В. Намятов,
ассистент кафедры ТКМД, ФГБОУ ВО «Сибирский государственный университет науки и технологий имени академика М.Ф. Решетнева», г. Красноярск, РФ,
namyatov2010@yandex.ru

Е. В. Митина,
лаборант кафедры ТКМД, ФГБОУ ВО «Сибирский государственный университет науки и технологий имени академика М. Ф. Решетнева», г. Красноярск, РФ,
eugeniya.mitina@yandex.ru

ПРОНИЦАЕМОСТЬ ДРЕВЕСИНЫ BETULA PUBESCENS И ЕЕ ИЗМЕНЕНИЕ

Проницаемость для жидкостей и газов является одной из важных физических характеристик древесины. На проницаемость древесины оказывают влияние анатомические и физиологические особенности древесных пород и наличие либо отсутствие пороков древесины. Одним из распространенных пороков древесины, влияющих на ее проницаемость, является побурение. В представленной работе проведены исследования влияния побурения древесины на проницаемость древесины Betula pubescens. Полученные данные свидетельствуют о резком снижении проницаемости березовой древесины пораженной побурением. Снижение проницаемости отмечено во всех структурных направлениях.
Ключевые слова: *древесина, береза, проницаемость, пороки древесины, раневая реакция, побурение.*

S. G. Eliseev,
Candidate of Technical Sciences, Associate Professor at the Department of TCMD, “Reshetnev Siberian State University of Science and Technology”, Krasnoyarsk, Russia,
eliseevsg@sibsau.ru

V. N. Yermolin,
Doctor of Technical Sciences, Head of the Department of TCMD, “Reshetnev Siberian State University of Science and Technology”, Krasnoyarsk, Russia,
vnermolin@yandex.ru

© Елисеев С. Г., Ермолин В. Н., Намятов А. В., Митина Е. В., 2021