EIP-AGRI Focus Group
Forest Practices & Climate Change

MINIPAPER 9: Innovative Wood-based Value Chains - "shift to smart wood"
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1 INTRODUCTION

This mini paper is produced by the EIP-AGRI Focus Group 24 on New forest practices and tools for adaptation and mitigation of climate change. Need of innovative wood-based chains, in terms of increasing use of technologically enhanced wood and woody biomass by economy and society – on one side, and sustainable forest management and practices - on the other side, was identified as a topic at the first meeting of the Focus Group held in Ljubljana, Slovenia, 20-21 June 2017.

Enhancing and *designing improved wood techniques, technologies and products for both traditional uses* and *novel applications* will result in environmentally friendly materials and lower economy-wide GHG emissions. Meanwhile, higher wood demand would also increase the impact on forest ecosystems while bring favourable benefits to forestry sector (e.g. increased harvesting rates, advanced processing of wood), to rural areas and to society, in general (e.g. more and diversified environmentally-friendly products, downstream forest related jobs and less workforce migration, lower GHG emissions).

Under global anthropogenic pressure on natural resources, the need to move towards low emission economies and the challenge to facilitate adaptation to climate change, the *intensified use of wood materials,* following the resource efficiency principle[1], *represents a major opportunity* by: a) enhancing wood products characteristics and use in traditional applications (e.g. buildings, wood fuel) b) substitution of non-renewable, or energy-, or water-, or carbon-intensive materials (e.g. in construction, textile) with new products whose processing and recycling is human-health and environmentally safe (i.e. pollution free over recycled products), c) development of new products from tree parts traditionally not used (e.g. for food, pharmaceuticals), as well as by d) supplementing non-woody biomass supply to economy (e.g. agricultural, marine).

Thus, the paper highlights the stakeholders need to early understand the likely future challenges and opportunities for the forestry sector, e.g. for forest management, for wood processing industry and for competition for wood, and how to contribute to future challenges of the society.

2 DISSERTATION

2.1 Key issues and context in using wood and woody biomass

Wood is traditionally used as a construction material and as an energy source, having applications in all life aspects: individual, commercial and industrial constructions, raw source for other products (celluloses, fibres, etc) and fuel (e.g. firewood, pellets). In the EU-28, around 25% of total biomass supply of terrestrial origin is wood (i.e. ca. 269 million tonnes of dry matter per year). Although recognized as highly uncertain, in the EU, some 100 mil/m3 or 28% of annual roundwood production is used for different energy purposes (http://ec.europa.eu/eurostat). Overall, fuelwood consumption remains rather constant in time, although there is an increase of the share of densified wood based fuels such as pellets and briquettes.

Sustainably harvested wood is a renewable, but limited, resource. Forestry relies on sustainable forest management approach which gives due consideration to all societal and environmental concerns. The overarching principle underlying the sustainability of forest resources is the indefinite continuity of wood supply. This principle is implemented through technical norms and guidelines materialized most often in planning of forest interventions on short run (thus providing for the expected amounts and quality of wood available). Moreover, using wood has a global sustainability dimension as wood market and commerce exercise a rather strong pressure on global forests harvesting.

Wood harvesting follows national circumstances and traditional forestry rules and practices. First, national circumstances are very relevant in defining harvest amount (i.e. age-structure, natural disturbance pattern,

[1] The EU Forest Strategy (2013/659) defines the resource efficiency, optimising the contribution of forests and the forest sector to rural development, growth and job creation as one of the guiding principles

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management approaches). In Europe, over the last half century there has been an overall under-utilization of the available wood at national scale. The harvesting rate in forests – the main source of wood, i.e. fellings as percent of net annual increment, ranges from less than 50% in Mediterranean countries to more than 80% in Nordic countries (SOEF 2015). Among most notable under-utilized resource is the so called "small wood", i.e. from stems and branches, both because forest operations costs of early thinning are simply not cost-efficient and market prices are too low for these such assortments. Another notable under-utilized resource are hardwoods because of lack of demand especially for mature broadleaved forests. Secondly, actual use of wood may not be always optimal according to the size and the potential use in long life products or low emissions paths, e.g. roundwood is used as firewood. Third, significant woody biomass remains currently not harvested (e.g. branches, roots, stumps, etc). Forth, non-forestland wood resources are generally not considered by countries in terms of their actual contribution with industrial wood and biomass, although such amounts seem to be significant (i.e. 87mil m3 in 2010 according to Mantau et al., 2010) with some 50% used as fuel. Sixth, forests are subject to unpredictable events, natural disturbances may have significant impact on management, e.g. age structure, and wood processing, e.g. suddenly make available locally unplanned large quantities of wood, in many cases of lower quality due to damages.

Trend in resource efficiency and recycling. Wood from harvesting residues and old wood products are more and more recycled instead of deposited in landfills or left in forests. More than one third from recycled amount is used for burning, while less than one third goes into the second generation of wood products, with the rest remained unrecovered (Vis et. all, 2016).

Demand by industrial and non-industrial consumers also drives the quantity and quality of wood harvest. There is regionally uneven spread of technologies and tradition in use and processed wood, e.g. related to particularities of forest stands (species) and historical investments in wood industry. Structure of the use of harvested wood may also have strong regional and historical pattern, e.g. major feature being that softwood are favoured to hardwoods by processing industry.

Finally, *economic stimulus on using more wood or enhancing cost-efficiency of low income forest interventions* generally lack across EU countries. However, soft measures and drivers exist, like public support for targeted research and technology development, or to enhance *entrepreneurship* (i.e. SMEs establishment, training programs for investors, public-private partnerships for innovative industry investments), as well as voluntary increasing of *final consumers' standards and demands* (e.g. certification of products). *Wood producers* (e.g. farmers, forest administrators) experience no simulants, in practice.

2.2 State-of-the-art of research and practice

Increasing the availability of wood from sustainable managed forest is the main concern of forestry from all the times. Under last half a century lower demand than availability, measures to actual increase of productivity of existing forests might just have had localized impact (e.g. improved and active silviculture, through genetic improvement or fertilization, or active post-disturbances interventions).

Increasing the availability of roundwood and woody biomass by expansion of forest, woody biomass plantations and non-forest lands by improving presence of woody species plantations and forest stands within landscape. Well known cost-effective solutions are the introduction of non-local highly-productive species or cultivars and achieve intensive management programs (irrigation, fertilization, short rotations).

Innovative wood materials are present already in commercial forms. High-strength engineered wood product becomes a key construction material for permanent structural applications, e.g. cross-laminated timber and various boards are increasingly used to pre-fabricate building elements. Small wood, wood residues and recycled wood products receive interest in non-traditional applications, e.g. ultra-lights particleboards, wood pulp-based fibres as substitutes of synthetic textiles and plastics, metallurgical charcoal (biocoke) or packaging. Novel uses are emerging though, e.g. chemicals contained in various parts of trees, like stumps and roots of resinous species, have pharmaceuticals, dietary and cosmetics applications, or, new insulation materials like cellulose compressed into boards or blown-in loose-fill insulation cellulose wool instead of stonewool.

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Woody biomass for energy applications. Using wood is a price-competitive energy source, especially for rural areas. Nevertheless, using biomass emits more carbon per unit of energy than most fossil fuels. Moreover, there is an accounting framework related to EU rules on emission, where emissions related to the conversion of biomass into energy are not accounted under the Emission Trading Scheme (ETS), so called "Zero rating". This provides a strong incentive to convert, for example, coal-power plants into burning wood pellets. Those emissions require, however, an accounting system capable of giving an accurate picture of the level of net emissions and removals from using biomass. The approach chosen is to robustly account for these emissions under the Land Use, Land Use Change and Forestry (LULUCF) sector. The EU renewable energy and climate change policies associated targets have enhanced the use of fuelwood, e.g. for district heating and combined heat and power. Thus, a bio-economy and climate consistent scenario would be to increase the material use of roundwood, while also increasing efficiency in energy use of biomass to maintain or increase the energy supply from lowest quality wood. Increase of biomass applications in bio-economy-based-society would create additional demand for wood and may create competition among wood uses. In this context, one of most likely challenge regards the availability of fuelwood facing strong competition from high-income novel uses (e.g. food industry, medicine).

Technology innovation and industry standards provide feedback on diversifying management/practices and type of wood or woody biomass needed. Effort focuses on enhancing resource availability, minimization of environmental impacts, development of machineries and technology base, as well as instruments for economic analysis to ensure highest investment returns of using any of, or both, wood (i.e. for innovative wood products) and woody biomass (as raw bark, branches, stumps and roots, etc). Innovation in forest operations is limited especially by the operation costs and labour demand. In Europe wood related innovation seems stronger in Nordic compared to Eastern or Southern countries.

Current *research and innovation also focus on enhancing applications of wood products*, e.g. resistance to fire and earthquakes in high-seismic regions, wood engineering technologies (e.g. cross-laminated timber - CLT for bridges and fully/partially wood multistore buildings, LVL - laminated veneer lumber for wooden structures), enhanced wood properties (e.g. modified timber by acetylation), prolongation of durability and waterproofing, and correct classification and sorting of contaminated wood in accordance with the waste wood categories.

Forecasting of wood harvest and biomass availability as mid- and long-term planning at micro and macro-scale. There is continuous improving of modelling tools, i.e. integrating forest management and practices with harvested wood use, and more often national decision makers and authorities routinely use them, e.g. in decision making regarding to the climate change mitigation scenarios. Currently, empiric forest models and trade/wood use are rather independent, although there are ongoing efforts to integrate them, toward generating various wood mobilization scenarios especially at regional/sub-national scale. Improvement of models will also allow better decision making based on the compromise between bio-economy and climate change mitigation, while also support better communication.

Stimulus for enhanced harvesting wood biomass and use. General market behaviour suggest that a resource is not utilized until a market exist for that, while investors may need public support to shift to new technologies. Generally acknowledged is the potential to enhance the use of wood and woody biomass (e.g. bushes) from early thinning and tending operations in young forests from where small dimension wood or biomass could be extracted, for which use the growth of the market seems not enough without adequate program of subsidies.

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2.3 Examples of innovative uses and novel products from wood and woody biomass

Rational use of limited wood resources demands continuous innovation. Best examples, but not limited to, are:

Innovative wood-based materials and set-up of industrial capacity for their production

- *Replacement of fossil derived products by bio-based products* as textile fibres replacing plastic or other fibers with higher carbon footprint by cellulosic industry (e.g. www.paptic.fi, http://www.smy.fi/en/artikkeli/vtt-makes-progress-with-testing-recycled-fibres-novel-wood-based-textiles-are-one-step-closer/ , http://www.lenzing-fibers.com/en/tencel/).
- *Wood based biomaterials in automotive industry (e.g. http://www.crcnetbase.com/doi/pdfplus/10.1201/9781315152967-4)*
- *Wood-based medications and pharmaceuticals, or cosmetics* can be extracted from tree parts which were usually not harvested, e.g. from stumps and roots of coniferous (http://www.smy.fi/en/artikkeli/hundreds-of-euros-per-one-kilo-of-wood-a-wealth-of-products-can-be-extracted-from-stumps/).

Wood frames and architecture in buildings

- *Solving indoor air quality problems in old school buildings by traditional Scandinavian loghouses: school complex constructed completely out of log timber from municipality of Pudasjärvi, Finland* (https://yle.fi/uutiset/osasto/news/worlds_largest_timber_building_draws_international_attention_in_pudasjarvi/8472657 and http://forum-woodnordic.com/wp-content/uploads/2015/09/C3.3-Tomi-Timonen.pdf
- *Wood beams and rafters*: replacing concrete elements (e.g. https://celt.fi/)
- *Wood in high rise building*: (e.g. https://www.detail-online.com/article/18-floors-in-wood-student-residence-in-vancouver-30362/) as well as suitability of pre-fabricates wood components in high rise building (http://www.buildup.eu/en/practices/cases/treet-wooden-high-rise-building-excellent-energy-performance)
- *Modified Wood and Thermally Modified Wood in facades and decking* (e.g. http://thermory.com/ https://www.accoya.com/)
- *Public leisure: large wooden roof* in Therme Bucuresti (https://therme.ro/en/), Romania

Biodegradable products with horticultural use

- *Biodegradable* horticultural plastic soil cover sheets (https://phys.org/news/2014-07-biodegradable-paper-plastics-bio-economy-horticulture.html).

3 CONCLUSIONS

Sustainable wood is a candidate for next generation of climatic neutral source of materials and chemicals, with a significant potential utilized by adequate support of research and innovation. Over coming decades, additional wood demand will create a need for strengthening of the sustainable forest management for which reasons forecasting and coordination may be needed at the EU economy-wide scale. Forest management need stronger tools for planning and forestry practice need support for intensification.

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4 RESEARCH NEEDS

Improved use of wood and woody biomass requires more scientific research (first three priorities were identified by this Focus Group during its second meeting in Santiago de Compostela, Spain, 22-23 November 2017), such as:

- Describing the technological properties of wood and defining methods to enhance its biochemical and technological properties for the tree species which become more relevant under climate change at various geographical scales or toward diversification of their use. This includes research on fundamental chemical compounds with application in substitution of classic materials and providing climate friendly solutions for re-use and recycling (e.g. cascading with final step as product for soil fertility improvement);
- Application of small wood from hardwoods knowing current trend in expanding broadleaved tree species in Europe as response to climate change impacts. Continuous search of new or enhanced non-energy uses of wood may drive new type of demands in terms of tree species, tree parts and dimensions, harvesting season, etc. Particularly, there is a demand to find uses for hardwoods – there are many underutilized broadleaf forests and more and more conifer stands (especially spruce) are replaced with broadleaves tree species that are less impacted by climate change;
- Adjusting forest management practices and interventions to maximize wood supply toward long life wood products and bio-economy needs. While sustainability of management of forest resources remains fundamental, the forest interventions and operations may be subject to further understanding and diversification. Although, significant changes in forest management toward increasing productivity and production, e.g. modifying the length of the production cycle, stands composition, etc., need precaution and understanding of long term impact on forests stability and productivity;
- Advanced understanding of the evolving competition between a) energy and material use, b) wood assortments (by-products of high value-added products, raw dimensions or biomass, recycled), c) among wood from various forest interventions and d) wood and other non-woody biomass types. This includes, a continuous research for more efficient burning installations. Further question is if an energy mix with minimum contribution of firewood is realistic, can wood be phased out in the future?
- Development of end-user/practitioner friendly tools for integrated modelling of forest productivity and C dynamics in forest C pools, GHG emissions/CO2 removals and wood products chain, which necessary must incorporate economic module;
- Development of technical guidelines on the use of engineered wood in constructions, e.g. for designs and testing the resistance of wood in residential and industrial sector;
- Research on adequate indicators for rigorous testing and procedures for approval process of novel wood products or technologies or uses, i.e. health and environmentally safe;
- Research effort to accurately estimate the duration of C residence/lifespan of wood products for all significant wood products for each country or region, e.g. life time and decomposition pattern;
- Understand the triggers for more use of non-energy wood by various actors and design funding opportunities and stimulus for supporting enhanced wood use and economically viable solutions.

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5 IDEAS FOR INNOVATIONS

5.1 Ideas for innovative projects

1. Development of eco-friendly wood gluing substances allowing health safe cascading use, assuming last step in cascading is composted organic fertilizer
2. Design public support programs for enhanced harvesting and use of wood and woody biomass.

5.2 Potential EIP Operational Groups

TITLE: COLLABORATIVE ANALYSIS OF THE GHG MITIGATION OPTIONS ALONG SPECIFIC WOOD VALUE CHAINS

- *Why the operational group:* identify economic benefits by coordinated actions of all actors at local scale/regional (e.g. across certain forest activity, wood product, geographical/administrative scale) from higher resources use, increased energy efficiency and economy-wide lower GHG emissions.
- *What is about:* forest resource status and management analysis, life cycle analysis for wood products, economic analysis, forest resources and market analysis and projections, participative activities
- *Actors:* (1) forestland owners (state, private), (2) service contractors (e.g. forest administrators, management planning, wood harvesting, planting), (3) industry (wood/woody biomass processing), (4) scientific support (providing tools and existing knowledge), (5) retailers and (6) consumers.
- *Expected results:* improvements all along wood value chain of current practices, tools, guidelines used by each actor and of their interlinkages. Overall general objectives (e.g. rural development, enhance local economy, GHG mitigation) reached through clearly identified operational objectives at actor level on short run (e.g. adaptive management, enhanced coordination amongst).

Further research needs coming from practice, ideas for EIP AGRI operational groups and other proposals for innovation can be found at the final report of the focus group, available at the FG webpage **https://ec.europa.eu/eip/agriculture/en/content/focus-groups/new-forest-practices-and-tools-adaptation-and**

6 REFERENCES

6.1 Articles, papers, Web links to research projects, etc.

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6.2 Web links

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Point of view: LULUCF – nightmare for sustainable forestry. Available at: http://www.smy.fi/en/artikkeli/point-of-view-lulucf-nightmare-for-sustainable-forestry/

S2BIOM Project. http://www.s2biom.eu/en/about-s2biom.html

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