EIP-AGRI Focus Group

Enhancing production and use of renewable energy on the farm

MINIPAPER:

"Forest management and use of woody side streams"

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Introduction (drivers, challenges, opportunities, and solutions)

Forest management is normally driven by other factors than aiming to produce by-products like biomass for energy. In Northern Europe forest management is needed during the life cycle of forest in order to produce proper quality wood for the forest industry. In Southern Europe management actions also aim at offering protection of forests against pests and forest fires, which have been more frequent during recent years Furthermore, the function of protection against erosion by reforestation or integrating trees in agriculture becomes more important the looser and dryer the soil is.

Using woody by-products from forest management and biomass from agroforestry, fuels, heat and electricity is potential income for a farmer. Either it can compensate or replace the energy needed from market or it can supply energy to the market.

This paper aims to describe volumes, origin, type and potential of woody biomass available in Northern and Southern Europe. Typical ways of using biomass are described as well as some more pioneering ways to fulfil energy needs on farm or to get some incomes or trade-offs. Furthermore, it is discussed how these benchmarked practices could be adapted more widely or formulated in more profitable way.

Sources of woody by-products and materials

Drivers for forest management in Northern and Southern Europe and typical use of by-products

Driver	By-products	Use of by-products	Farm scale use of by-products
End-product: logwood, pulp, paper, fire-and pest management	Thinning and harvest residues, firewood, industrial side streams, sawdust	Heat and electricity by burning or gasifying, chemicals (pine oil), pellets and briquettes, 2nd generation biodiesel	Heating, CHP (wood combustion, gasification), pelleting, mixture in composting, litter

Summary of main stages in forest management in Northern Europe

	years from start	by-products
Planting	0	none
nursing of plants	+5-15	none
1. thinning	+15-25	energy wood
2. thinning	+25-50	(energy wood*). pulp wood
logging	+40-100	harvest residues (thick branches)

*) if previous cutting is neglected

Figure 1. Thinning of birch forest. By-product is used for heating. Photo: Ville Kari

Figure 2. Making wood chips. Photo: Urakkauutiset

Figure 3. Techniques for harvesting thinning wood integrated with packaging in Catalonia. Photo: Fixteri Group Oy

Techno-economic driver for by-products, Northern Europe

Forest management is typically quite laborious. Especially in the first and second thinning the work is done by hired work. If the first thinning is postponed and two treatments are replaced by one, there is less pulp quality to be harvested. Economy in thinning is poor, especially in the first one, but the second thinning can yield incomes, if the first thinning is done. Typically, the benefit is allocated for next generation and the benefit from marketable log is inherited from previous generation.

The driver on farms scale to use by-products for energy typically are inherited from objectives in forest management. Farmers, more often than other land owners, do the first thinning by themselves and wood is made into chips by contractor.

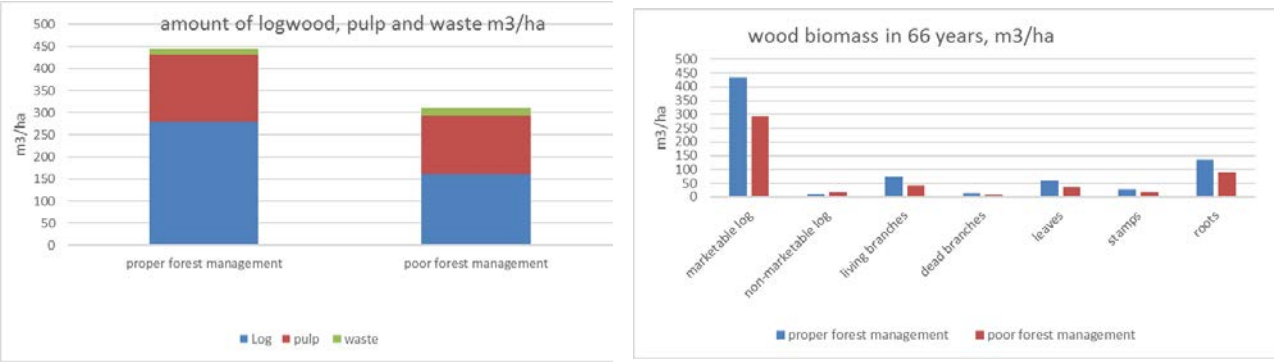

Figure 4a and 4b. Simulated yields of log, pulp and waste wood in proper and poor forest management, for 66 years, starting from planted material, 1800 pc/ha. Yeld in euros is 9808 eur/ha and 6214 eur/ha. Simulation is counted with Motti- simulation-software. As seen in figures, not only total biomass is bigger when forest management is done properly, but also biomass in remaining residues like leaves, stamps and roots is bigger.

Techno-economic driver for by-products, Southern Europe

South Europe has a lower share of forests available for wood supply compared to northern Europe, due to difficulties in wood mobilization, particularly in mountainous areas, but also due to the climate and soil conditions that favour scattered vegetation.
According the EASAC report (2017), priorities in Mediterranean countries differ from those in Northern regions. Fire and pest management with an intensive pest- and disease-monitoring system is an important part of an integrated forest management and adaptation strategy in Central and Southern Europe.
In Portugal, France, Spain and Greece, fire management using prescribed burning to reduce fuel availability together with other fire-suppression practices are applied under specific legal frameworks (Portugal, France and Greece) with specialised teams and a national system for professional accreditation. 'Clean management' and early salvage cuttings after storm damage can also diminish the risk of large-scale bark beetle outbreaks, although such measures run counter to the need to increase deadwood pools in support of biodiversity targets.
In Mediterranean forests, a change in thinning regimes (density management) to earlier and more intensive thinning to improve water use efficiency of trees has the potential to lessen drought stress, fire risk and vulnerability to insects.
In Greece, on the contrary, forests are in continual deterioration due to poor management, competitive agricultural and settlement land uses, intense pasture and summer fires. Forest management is very poor because forests are mainly natural (96%), in mountainous areas with elevation higher to 600m (59% of the forest areas) and at slopes higher than 25% (70% of the forests), which do not allow an easy access and make harvests extremely difficult. The main by-products available are the firewood collected by the forest services and piled at the side of the forest roads.

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Southern Europe exhibits a lower level of economic activity in forestry and the timber industry compared to other areas in Europe, and few systems for the remuneration of social and environmental services that may well be of greater importance than timber production. Nevertheless, forest management (for example for grazing and harvesting of firewood) and its impact on the structure of the forest can still be high.

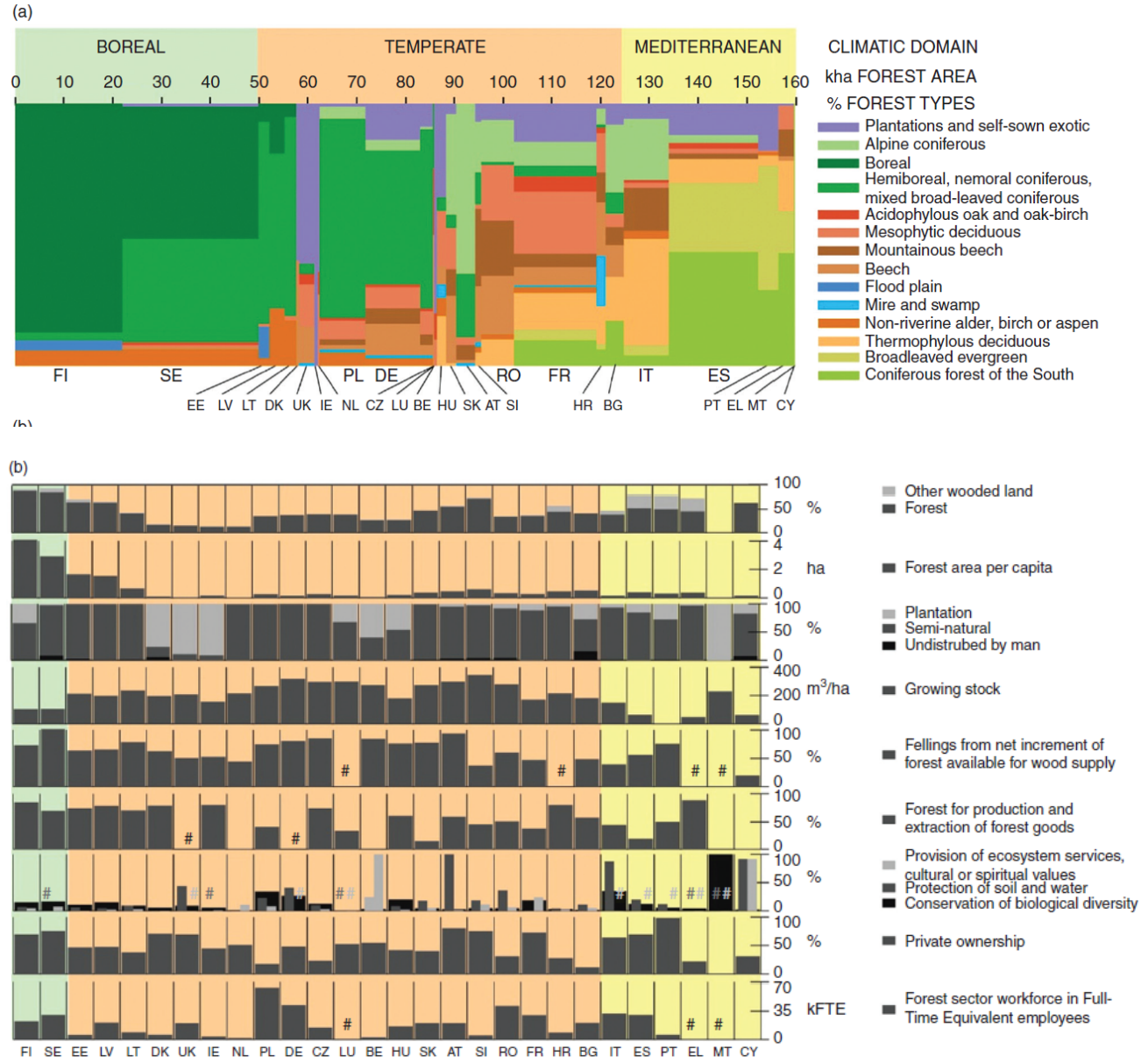

Figure 5a and 5b. Characteristics of the forests the 28 EU Member State. Source: EASAC, 2017.

Agroforestry

One source of woody biomass, but not a by-product, is field grown wood, which typically is willow, aspen, poplar, birch, robinia, eucalypt and others. The most important species for Europe are poplar and willow, for which a number or research activities has been carried out in Europe

These species can produce high biomass yields in short rotation periods that will be used for energy. Woods can also be integrated in farming. The characteristic for these species –so called short rotation forestry - is

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their fast-growing rate on fertile soil, but also their ability to grow in less fertile, marginal lands. By definition, these species require less tillage and cultivation efforts because they are perennial and harvested at short periods (3-7 years), as well as low inputs (fertilisation, pesticides, etc) in their agronomic practices, mostly because they have low economic value compared to agricultural crops as they are used only for energy; as such, the wood quality is also not important.
Material has to be planted and managed similar to forests, however attention should be paid so as to protect new plantlets from competition from other species. Choosing to grow woody material on field, instead of food or feed, is motivated by different reasons and benefits, which are summarized in following table.

Reasons to be Used	Benefits other than biomass	Use of biomass
Integration to waste water treatment	fees for water treatment, nutrient recycling	For energy For extracting pharmaceutical substances and then for energy For making biochar, which can be used as carbon storage, biofilter, energy
Poor drainage and moist circumstances	plantation benefits from abundant water, drainage investment can be postponed	
Physical protection from pests, animals and diseases between neighbouring farms	avoidance of/less migrating animals, pests and diseases and thereby healthier crop and livestock	
Missing generation in farming with no desire to sell the farm/fields >need for low activity farming	Low input maintenance of fields over one generation, adding carbon into soil, easy to change into field	
Huge amounts of biomass needed in restricted area	Lower logistic costs, predictable yield	
Supplementary biomass is needed in addition to forest by-products	Lower logistic costs, predictable yield	
Need for protection from erosion, nitrate leaching or sunshine	Avoidance of erosion, protection of waters system, wellness of pasturing animals	
Withdrawal of productive land for middle term aims (12 years)	a. Preservation of mechanical & other characteristics of soil b. Subsidies in the framework of CAP priorities (provisions for afforestation of agro-land)	

Potentials of woody biomass grown on field or buffer zones (Sustainable Short Rotation Coppice. A handbook).

Species	First harvest	Harvesting interval	dm yield/year *	fm yield/year and moisture
Willow (Salix sp)	1st -4th year	1-4 years	9,6	30-60 t, 45-62% moisture
Poplar (Populus sp)	1st – 6th year	1-6 years	4,9	20-45 t 50-55 %
Black locust (Robinia)	nd	2-4 years	3,9	15-40 t, 40-45%

*derived from average of ft/ha and moisture -% shared with average harvesting interval

Use of by-products on farm

Traditional use of wood as bioenergy is burning pieces of wood, sometimes split (known as cordwood), in low-temperature equipment such as wood stoves. This model is often used for heating living and working spaces with wood produced on or near the farm. Its main disadvantages are the inefficiency of handling and

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transporting such pieces of wood; and the absence of an efficient way to mechanically feed it into combustion equipment, thereby requiring periodic stoking by hand.

The second model involves the conversion of wood into pellets, chips, or briquettes, at centralized facilities or with large on-farm equipment. This processed biomass can be transported easily and sold in bulk and fed into burners by machine. This model is widely used for combustion of wood at off-farm locations and for large on-farm equipment where automated, mechanical stoking is used. Pellets, chips, or briquettes, along with straw bales can also be used for greenhouse heating during the winter months, when high temperatures are essential for obtaining good product yield and quality. Pelletized wood can also be made from a wide variety of feedstocks, such as forestry wastes and wastes from forest industries, other tree prunes, old pallets, and fallen limbs.

Figure 6 a,b,c. Centralized facilities with large on farm equipment in a pig farm (Spain) a) feeding equipment of biomass into incineration b) Biomass boiler; c) Heat recovery.

Other options include cultivating wood or cultivating herbaceous plants. Many farms that are located near urban areas may also be able to source cordwood and wood chips from tree service companies and power line right-of-way maintenance companies.

On farm scale, energy wood is typically used as wood chips or pellets for heating of household and buildings for animal husbandry. Woodchips are typically burned either in fixed burner or burner with moving base in constant feeding of fuel and heat is transferred as hot water. Other, decreasing technology is to burn solid wood in solid burner and heat big amount of water which is stored and heated in boiler and transferred as hot water. In drying cereal, so called air-blown incinerators are more typical, since it is easier to achieve high temperatures and power.

Heating hot water for washing is also quite typical way of using wood on farms. In summertime, the boilers and kettles are adjusted to heat mainly water. Heat losses are quite big though, because heat is lost in canals and efficiency in burning is not always optimal with reduced burning process. In addition, with lower burning capacity, emissions tend to be bigger if fuel is not of optimal quality.

Gasifying wood is still rare, but there is existing technology to use wood on farm and to run a generator simultaneously to produce electricity. The typical size of gasifying wood is about 40 kW of electricity and 100 kW of heat. The produced gas can be burned as well for heating purposes. Then the requirements for gas quality are lower compared to gas fed to generator.

By-products can also be processed into fuels like pellets for the heat market and they can be combined with other biomasses like straw, sawdust etc. The price for pellets on the market is quite low though and the market is quite satisfied. There are requirements for pellets as well, depending where they are going to be used, e.g domestic or industrial sector, so that fixed contracts with farmers are required, with specifications on the quality standards of the wood and the wood pellet.

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Novel but existing approaches in utilization of woody biomass from forests and fields as energy source on farms

Approach	challenges	opportunities
Gasifying wood into heat or heat and power	Needs good quality wood chips, pellets or briquettes, costs of technology	Can be adjusted to seasonal need for both heat and power
Gasifying wood and transforming it into biomethane	so far at lab-scale	technology to store energy in more compressed form that wood gas
Farm scale use for heating from residues/by-products from forest management in order to secure from fires (Spain)	Need investment on farm	cheap fuel for seasonal use
Preparing pellets for the market	costs of technology, good quality feedstock	Can be used for different materials, also straw and other dry side streams, and even organic fertilizer
Small scale bio char production	technology is developing, needs some interest in testing and new ideas	Products are useable also in improving soil fertility, process is almost energy self sufficient

Suggestions for wider potential of producing biomass or refining it

Second generation fuels or other ways of bio-refinery of wood other than burning for heat and power are very hard to make profitable. Farmers can cooperate around district heating on local level where the farmers support the burner with waste wood from forest or buffer zones and keep the burner running continuously in a cooperative way. The size can be 0,5- 4 MW. A lot of research is done for pyrolysis of waste wood, but it must be on larger scale than farm size in order to have a chance to be profitable.
Today, most of the farmers use their own wood for heating. Another option is to make charcoal and sell on a local level. Most of the charcoal used for barbecuing is imported now so this could be a new business for farmers.
Pellets or briquettes is another form of wood and a way of refining harvest residues for heat and even power in very different sizes of energy plants. They are affordable, very dense, storable and can be burned with very high combustion efficiency. New business models for producing energy from farms must be developed. Gasification in general is too expensive on farm level but could be done if it was scaled up or when production and consumption is very large. Combination of solar power and CHP-unit(s) could become more profitable, when energy- and transfer cost become more dependent on market and variation of seasonal power level.
From the biomass production point of view, the sustainable forest management, along with short rotation forestry wood cultivated at farm scale, could provide the necessary raw material quantities that are needed to cover electricity and heating needs in the farm and farming activities (space heat, greenhouse heat) or process heat needs in food industries (food drying)

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Platforms or potential groups of actors to deploy new or wider uses of woody biomass

A wood energy plant can be run by farmer, group of farmers or other actors in addition to farmers. There are associations and platforms for planning and financing large energy units, but farm scale energy production is typically secondary activity on farm, agricultural production being the primary one. Often either knowledge of profitable or best technology, interested co-operators, business models, customers (in case of delivered energy) etc. is missing.

Local /regional development projects funded by European and national funds, and supported by associations close to formers and forest owners, try to promote farmers' energy investments. In finding suitable energy producing solution for a farm, municipality or company also counselling services are available and they often co-operate with local development services. Unions of promotion of interests can also be involved. Energy Co operative Body of Karditsa serves as a model platform for deployment of renewable energy on village level. This local initiative has achieved its operation due to its shareholders' persistence and local stakeholders support, and recently has started producing pellets (feedstock: by-products of the surrounding sawmill wood factories).

Austrian energy agency has created and launched a **BioHeat**- calculator for planning an energy unit delivering heat for customers. It is free but needs registering.

To ensure climatic and social acceptance in using woody biomass for energy and profitability in agriculture, some points are essential:

- Diverse forest ecosystems must be conserved, but still it can remain as source of timber, food and other product, and energy from side-streams as well as environment for social wellbeing
- Sustainable forest management contributes to income generation and employment
- Collaborative partnerships, including local administrations and economic actors (e.g. farms) is needed to solve regional and global forest-related issues.
- Competitiveness of alternative sources.

FAO has created of platform of materials worldwide "Sustainable Forest Management (SFM) Toolbox. That website covers Forest management and use of forest products and interesting cases about innovative approaches in forest management.

For large scale of energy production there are several platforms:

IRENA (International Renewable Energy Agency) has launched new technical guidelines on Woody Biomass, as part of its online **Project Navigator platform** to support the successful development of woody biomass projects. These guidelines describe in nine stages what is needed to plan, establish, operate, and decommission a bankable woody biomass project. It is free for users and needs registration.

The **European Technology and Innovation Platform on Renewable Heating & Cooling** **(RHC-ETIP)** brings together stakeholders from the biomass, geothermal, solar thermal and heat pump sectors – including the related industries such as district heating and cooling, thermal energy storage, and hybrid systems – to define a common strategy for increasing the use of renewable energy technologies for heating and cooling.

The **European Biomass Association** **- AEBIOM** is a European trade association open to national biomass associations and bioenergy companies active in Europe. AEBIOM was founded in 1990 and aims to promote biomass production and application throughout Europe. It is the umbrella organisation of the European Pellet Council (EPC), and the International Biomass Torrefaction Council (IBTC).

Recommendations for wider use of woody biomass

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District Heating/heating of industrial sites/other farms

- Energy Communities contribution into more local co-operatives run by farmers or sourced by local waste wood
- Farmers can serve other (bigger) farms with wood or entire heating service
- Mobile heating units (seasonal grain drying, other sites) for better benefit for investment
- Dry biomass and good burning is essential to reduce emissions– attention to quality parameters and burning technology

Charcoal

- On farm or as co-operatives producing charcoal from waste wood and short rotation wood and selling for different purposes (barbeque, soil amendement, biofilter etc...)

Pellets

- Farmers or farmers' cooperatives can produce pellets on the farm or in specific pelletising facilities from waste wood and short rotation wood. Pellets can be used either on farm or delivered to market scale

Wood gas

- Decentralized CHP-production, integrated drying of wood chips, in case of dependable and affordable technology – too expensive so far

Promoting Short rotation wood

- Use as carbon & nutrient sink
- Simultanous protecion of water system
- Protection of carbon release from organic soils
- Avoidance of agricultural land to other uses (urban, networks)

Suggestions for operational groups

- Evaluating economic opportunities for small scale on farm use/transformation/commercialization of woody side streams.
- Implementation of mobile heating units at farm level and other sites. Viability analysis
- Forest management: opportunities for local farms
- finding platforms and business models for short rotation wood in combination of charcoal production/waste water treatment/biofilter
- Short rotation forestry production and use at farm-scale: testing clones, growing techniques, harvesting and refining technologies for energy and other products.

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