Investment in supply chain for vine pruning or similar residues that will be used for biomass boilers

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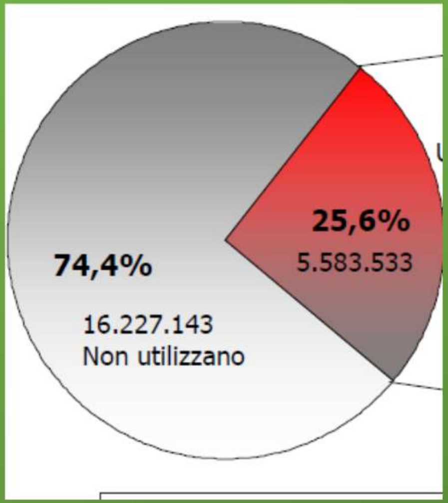
- Promoting renewable energy is a top priority in the policy agenda of the European Union (EU) . The final aim is to reduce the greenhouse gas (GHG) emissions so as to fulfil the targets defined at 26th Conference of the Parties (COP26) in Glasgow, requesting leaders to revisit their nationally determined contributions (NDCs) ahead of next year's COP27.
- It notes the need to reduce emissions by 45 % by 2030, from 2010 levels, to align with the Paris Agreement's 1.5°C ambition.
- According to the European Commission (EC), in 2017 almost 17.5% of the EU’s gross energy consumption came from renewable sources
- Bioenergy is the main contributor in the distribution of renewable gross final energy consumption in EU27: solid biomass, biofuels, biogas and renewable municipal waste are currently more common in the heating and transport sector, whereas their contribution to electricity production is still less substantial

Solid biomass has a strategic role as it is expected to cover about 8% of electricity production and 50% of thermal energy production, becoming the principal source of renewable energy in Italy.

There are two main reasons behind the heavy reliance on wood biomass in the renewable energy targets in Italy.



Firstly, the cost-effectiveness of the raw material that makes it competitive against the other sources, also given the limited potential to increase hydropower, which dominated RES in Italy in the past decades, and geothermal energy (Scarlat et al., 2013).

Secondly, the large availability of wood biomass considering the current low utilization of Italian forests and the consequent opportunity to enhance active forest management, improving job opportunities and incomes in rural areas.

The Renewable Energy Directive (2016/0382(COD)) describes biomass as the **“biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin”**

- **Agricultural biomass** refers to a broad category of biomass originating from agriculture and it includes the following:
- **crops** such as corn, sugarcane and beets etc.
- **oilseeds** such as several plants of brassica family (e.g. rapeseed), sunflower seed and soybeans
- **agricultural residues** such as:**herbaceous crop residues** as cereal straw, corn stover, rice straw
- **permanent crop residues, e.g. orchard prunings and plantation removal wood**
- **agro-industrial by products, such as olive cake, grape marc and sunflower husks**
- **grassy and woody energy crops**
- **leguminous crops**
- animal waste (manure).

agricultural residues and dedicated energy crops as the most relevant ones due to their environmental and economic benefits and for their market growth potential. When it comes to end uses, are particularly interested in heating and power generation

- Agricultural residues can be defined as primary or secondary depending on their origin.
- Primary residues are solid vegetal residues left in the field after harvest or pruning and manure.
- Secondary residues are the portion discarded during the processing phase (olive pits, nutshelling etc).
- Although they consist in a promising feedstock for bioenergy use and, in general, for EU bioeconomy, they are currently underutilised mainly because of logistics constraints and lack of incentives.
- They positively contribute to rural development, representing a possible income for farmers, and if usedas bioenergy feedstock they contribute to climate change mitigation strategies. The following table presents a non-exhaustive list of primary and secondary agrobiomass feedstocks along with technical requirements for harvesting, benefits of mobilisation and seasonality.

PRIMARY AGRICULTURAL RESIDUES

Feedstocks examples	Harvesting requirements	Benefits of mobilisation	Seasonality
Straw, corn stover	Existing agriculture machinery (e.g. Baler)	No additional land required, considerate collection prevents pests, paying attention not to decrease SOC.	During crop harvesting season
Pruning	Agricultural machinery, usually modified for pruning	No additional land required, avoidance of pests / diseases, avoidance of emissions from open-field burning	After the pruning season (usually winter – spring)
Plantation removal wood	Excavators, large shredders, etc.	No additional land required, clear-up of field for new plantations, avoidance of disposal costs	At the end of an orchard's lifetime

SECONDARY AGRICULTURAL RESIDUES[7]

Feedstocks examples	Harvesting requirements	Benefits of mobilisation	Seasonality
Pits and residues from crushing from olive shells/husks from seed/nut shelling, grape marc.	No additional technical equipment; no additional infrastructure	By-Product; no additional land required; concentrated at processing site (no collection costs); avoids disposal costs (e.g. landfilling)	Year round

- Energy valorization of agricultural residual biomass can offer an opportunity for income and diversification productive for agricultural enterprises and producers of biomass, as well as a solution to solve the frequent problem of their disposal.

- Incorrect handling of these by-products can create significant environmental impacts, especially on quality of the air, if burned in the open.

- Pruning can be used as a raw material for the production of wood chips or to be densified in form of pellets, pods and briquettes, intended for modern plants equipped with the technical devices necessary for their combustion, being biofuels with a high content of ashes.

- The types of machines used for harvesting and processing of agricultural biomasses differ according to the physical characteristics of the product and logistics of construction sites.
- The quantity of biomass technically retractable from crops woody varies according to the type of crop and the yield field, terrain orography and pruning methods.
- The type of machine, the length of the rows and the type of inter-row swaths affect both yield and collection costs.
- Such factors can sometimes compromise feasibility technical or economic of the collection.
- The "double pass" construction sites, which involve packing and subsequent collection offer greater flexibility, but they involve higher costs.
- The latter are preferable when there is a need to store large quantities of material for a long time or to facilitate drying natural in order to guarantee the densification of the product

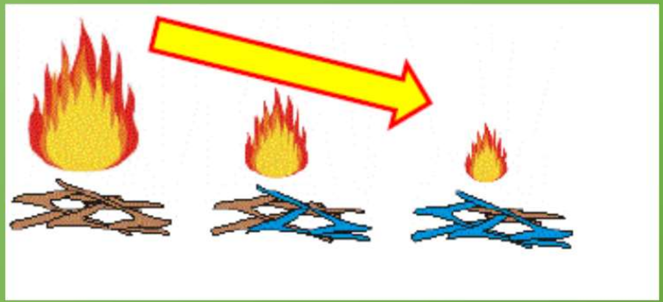
- The combustion of biomass in Europe is currently dominated by the use of wood fuels; due to the growing demand, the quantities of wood available today are increasingly scarce.

- Consequently, alternative biomasses, deriving from agricultural residues (pruning, straw) are enjoying growing interest as a source of energy.

- Italy is the world's leading wine producer with a harvest estimated at 50 million hectoliters.

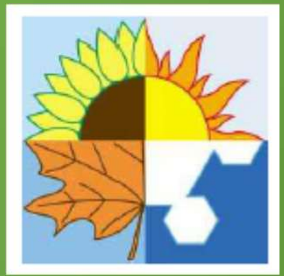
CRITICAL ASPECTS OF VINEYARD PRUNING FOR ENERGY USE

- Low energy density



- Non homogeneous product

- Product availability linked to the season



- Low quality

SUPPLY CHAIN ORGANIZATION
COLLECTION SYSTEM OF VINEYARD PRUNING WITH SHREDDER

VINEYARD

Farm

Harvest and shredding

One chain line

1 Towed shredder

1 tractor

1 trailer

1 operator


Raccolta con rotoimballatrice
e cippatura con cippatrice su vigneto
VIGNETO
CENTRO AZIENDALE
VIABILITÀ ORDINARIA
IMPIANTO pellettificio/ centrale
sarmenti disposti a file alternate
DEPOSITO AZIENDALE
CENTRO DI STOCCAGGIO
RACCOLTA E IMBALLATURA
BREVE DISTANZA
CANTIERE IN LINEA
1 rotoimballatrice
1 trattore
1 operatore
DEPOSITO CIPPATO
FILIERA INDUSTRIALE
LUNGA DISTANZA
DEPOSITO ROTOBALLE
CIPPATURA

- The technical feasibility of harvesting pruning also varies also as a function of the field yield, or rather of the annual quantity of biomass produced per hectare.

COLTURA	t/ha/anno	Contenuto idrico alla raccolta (M%)
Oliveti	2,5-4,5	35-45%
Vigneti	1,5-3	40-50%
Corileti	1,5-2	35-40%

The quality of the wood chips is mainly influenced by type of wood species and by the machine used for collection.

Prunings have an ash content generally higher than that of the original wood forestry (about 0.5-2% ss of ash is obtained from the trunks in reference to dry matter).

In the case of the vine -often more problematic material to manage - it increases significantly up to 4-5% ss.

In vine pruning the nitrogen and copper levels are usually higher than the average values found in wood Untreated; this is attributable to phytosanitary treatments.

problems of energy use of Agricultural biofuels are linked to the following critical issues:

- unevenness of the size (in the case of wood chips);
- high ash content;
- heavy metal residues, deriving from phytosanitary treatments of the crop.

Harvest costs

- The production costs of pruning wood chips vary widely depending on the type of harvest site and the machines used.
- On average 85% of total costs to be attributed to the tractor and 15% to the harvester or baler machine.
- Harvesting machines vary according to their characteristics logistics of the construction site and raw material.
- Double-pass construction sites (packaging and subsequent collection) offer more flexibility, but involve higher costs, net of chipping.

The double step it is preferred in situations characterized by conditions adverse climatic conditions and when it is necessary to store large ones amount of material for a long time (large yards extension).

The one step chain is preferred in small/medium size orchard

General operational considerations on the collection of pruning residues in vineyards, olive groves and hazelnut groves

- The costs of harvesting pruning in the vineyards (20-65 € / t) are higher than those in orchards (15-45 € / t), above all due to the lower concentration of residue and the higher ones harvest losses (mechanized pruning).
- The cost of collection it also increases with the extraction distance – ie the distance the car has to travel to carry the material from the field to the point of discharge - and decreases with increasing the length of the rows and the concentration of pruning.
- On construction sites in hilly areas it is necessary equip themselves with machines capable of maneuvering in spaces reduced (change of time) and equipped with a compact built-in box for the containment of the shredded or the round bale.
- The cost of collection, packaging and handling may vary substantially with respect to the various parameters considered.
- They range from 20-30 € / t, for very productive plots, up to 45-60 € / t, in low-yielding and small plots size.
- For the transformation of the stored material in the platform the intervention of a large chipper is required.
- The chipper must be able to introduce into the mouth of the load the whole round bales, powers are needed for this above about 300 kW.
- With a machine capable of guaranteeing a productivity of at least 60-70 msr / h, the cost of the operation is 2-3 € / msr, or approx. € 10-15 / t M25.

Physico-chemical quality of vine, olive and stone pruning

- Through laboratory analyzes conducted on pruning samples collected during field surveys on vineyards, olive groves and hazelnut groves, it was possible to assess the compliance of the fuels with the ISO 17225 standard.
- The results identified vine wood chips as the poorest fuel from a qualitative point of view and therefore more complicated to manage.
- The screening of the vine chips, which then leads to the removal of the fine part, below 3 mm, allows to obtain significant improvement effects, not only in terms of reducing the ash content, but also reducing all metals, in particular those that cause problems for the regulatory classification of the product, such as sulfur, zinc and copper.

Densification of agricultural pruning

- The densification of pruning, in the form of pellets or briquettes, is an alternative to the use of shredded / wood chips as it is, which allows to overcome the critical issues in the combustion phase of these "problematic" biofuels.
- Compared to wood chips, densified products are in fact characterized by a higher qualitative standardization: homogeneous size, water content <10%, low percentage of fine parts, high energy density.
- This allows to obtain a more stable combustion process and therefore, usually, better emission factors, in particular CO and total dust.
- Densification also offers logistical advantages: reduction of storage space and easy handling.
- The boilers must be designed for two-stage combustion, with automatic adjustment of excess air, have a mobile or self-cleaning hearth and automatic cleaning devices of the exchanger.
- Pruning briquettes can be used in manual loading appliances and boilers.

the characteristics of the wood chips from pruning from vineyards do not allow its use in normal domestic wood stoves.

- Its use is suitable for feeding wood chip boilers.
- in fact, wood chips boilers are an excellent alternative to classic fossil fuel boilers (gas, methane, LPG, diesel oil etc.) both for energy efficiency (with the same performance in fact they can guarantee savings of up to 80%) and for ease of use.

- There are two types of wood chip boilers on the market; fixed grate boilers capable of delivering a power ranging from 25 to 400, and mobile grate boilers capable of delivering over 500 kW (and mainly used in industrial contexts).

- The inverse flame technology consists in burning the fuel downwards, optimizing the total combustion of the wood product, reducing the waste of unburnt products. They are equipped with a wet flue gas exchanger with vertical pipes, which guarantees high performances for the production of hot water for heating and an easy-to-use electronic and modulating control unit.

- They can have a natural smoke draft or, often, a recycling of fumes and forced combustion air with the help of fans

Need of innovation

- the harvesting and transport costs and the low quality of the material represent difficult obstacles to overcome. The machines commonly used to collect pruning derive from conventional mulchers or shredders; these machines work fast, as they were conceived to clean up the fields rapidly and to limit fuel consumption; subsequently, the harvested products obtained have low quality characteristics in terms of storability, chip particle size, and inert contaminations.
- These are crucial characteristics in the post-harvest stages of the energy production chain
- To solve this problem innovative machines and practical handholds for farmers, aimed at optimizing the quality of the product and the costs for production. The harvest was performed using a vineyard pruning harvester designed to preserve the quality of the fuel.
- The machine used for the test is a patented pruning harvester, manufactured by Costruzioni Nazzareno, MAREV Alba 150 model, towed by a tractor Goldoni, model 70 Star with 50 kW power.

- Frontally, the harvester has a pick up system formed by two overlapping rotors. The lower rotor has a length of 1500 mm, corresponding to the real working width of the machine. The rotor includes two converging augers, equipped with metal teeth, designed in a way to ensure the catchment, the conveying, and the lift of soil-free pruning from the ground.
- The presence of shredded fine particles in the stored wood chip piles tends to occlude the air spaces among chips, limiting air circulation and slowing down the dying process of the biomass.
- The persistence of moisture in wood chip worsens remarkably the storage performance of the biomass and promotes microbial degradation.
- The harvest machine was particularly efficient, generating chips with a particle size distribution 2/3 of which included chips between 50 mm and 120 mm, even suitable for feeding boilers without pelleting. **The regular cut and the good particle size allowed high moisture losses to be reached in a short time during storage, rapidly reaching a value of moisture content which was lower than 20%, allowing** direct pelleting and limiting dry matter losses due to microbial degradation.


MAREV
Luce 150

- The worst result was strongly affected by the high unloading time, because the machine filled up the small size bin very quickly. This aspect could be improved by elongating the bin or changing the logistics, for example by working with two trailers at opposite sides of the field. On the contrary, a lower fuel consumption than other commercial harvesters was achieved.
- On the contrary, a lower fuel consumption than other commercial harvesters was achieved thanks to the possibility of using a low power tractor (50 kW).

- References:

- Prof. Giuseppe Toscano Dipartimento D3A – University of Ancona

- Dr. Luigi Pari - CREA Council for Agricultural Research and Economics


roblemi di ingolfamento