CASE STUDY

Vineyards pruning valorisation for energy purposes as local strategy to promote circular economy

Vilafranca Municipality coordinated a project from 2014 to 2016 called Vineyards for heat co-funded by the European Commission's LIFE Programme (LIFE13 ENV/ES000776), which intended to demonstrate the performance of the biomass circle with pilot tests in two wineries (Codorniu and Vilarnau) and in one area of public facilities in Vilafranca.

The project aimed to apply and implement a vineyards virtuous circle (VVC) as a local strategy to mitigate climate change contributing to meet the goals to reduce greenhouse gases (GHG) according to the sustainable energy action plan (SEAP) derived from the political commitment and engagement to the Covenant of Mayors. The VVC intends to make profit of vineyards pruning to generate heat and cold for institutional guarantor, in this case, the municipality of Vilafranca.

The objective was to settle the bases to transition the region of Penedes into an efficient low carbon economy area and to contribute to the objective of reducing agricultural emissions by 42 % (roadmap 2050).

After the project has ended, the value chain has evolved to incorporate new actors and improve the value chain design to increase its efficiency.

Vilafranca del Penedès Town Council is located in one of the most important winemaking regions in Catalonia (Spain). Winegrowing in the Penedès region produces 30,000 tonnes of vine pruning waste annually (vine shoots) (Figure 1). This material is usually burned in the vineyards, which does not allow for energy harnessing and causes pollution. Vine pruning waste can easily be transformed into a source of biofuel that has high energy potential.

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The new value chain involves all actors of the biomass value chain, which is key to successfully develop it. The project consortium included the town council of Vilafranca as the coordinator of the project, COVIDES cooperative in charge of the biomass supply, NOU VERD in charge of the biomass management, and INNOVI addressing biomass consumer engagement and promotion. After the project has ended, new actors were involved to further develop the value chain. More precisely, the value chain actors currently involve the Celler Cooperativa La Granada and EM-AVSA, although the municipality is still contributing to further promote the innovative practice.

Figure 1. Location of Vilafranca del Penedès.

The main steps of the value chain include:

- Biomass collection and transport to the storage site
- Biomass management: pre-treatment, storage and supply
- Energy production (combustion and ash management)

The technology and equipment currently used along the whole value chain is already commercial (TRL 9).

BIOMASS COLLECTION

The pruning of vine shoots is carried out every year at the end of the grape picking season from the end of November to mid-March by the cooperative La Granada.

During the project, vineyard biomass was collected during the pruning seasons of 2014-2015, 2015-2016 and 2016-2017. A total of 778 hectares were harvested, and a total of 469 tonnes of biomass were obtained. 349 tonnes of biomass were supplied to a boiler at Girada district heating to produce heat. Nowdays, Cooperative La Granada collects the vine shoots from 200 hectares around Vilafranca. The yield varies greatly from 0.7 tonnes per hectare on dry years to 1.2 tonnes per hectare on rainy years, which are significantly more productive.

In terms of the equipment needed to carry out the collection, a key challenge during the project was to find a biomass harvesting system that avoided vine shoots mixing with other materials, thus avoiding additional treatment costs. A pre-pruning machine was designed to vacuum the shoots directly from the plant before they would fall to the ground (Figure 2). The machine was used during several pruning seasons in spur-pruned vineyards and, despite making improvements to the model, the project did not achieve to produce a machine that operated satisfactorily. While the machine was able to carry out the pruning effectively, the mechanism designed to collect the waste was not.

Figure 1. Prototype developed to collect vineyard pruning.

An alternative solution was found by using a different machine that already existed on the market: Peruzzo Cobra Collina, a picking and shredding machine (collector with catcher) that was adapted to collect pruning waste.

Nevertheless, the homogeneity of the material was not optimal and clogging occurrence in the boiler feeding system led to change the collection system. The La Granada cooperative is currently using a regular tractor equipped with an implement which allows the farmer to rake pruning from the rows to the field side (Figure 3 and 4).

Figure 3. Equipment used to rake vineyard pruning.

Figure 4. Vineyard pruning collection.

Once the prunings from a field have been piled, they are placed right next to the road in order to optimize the collection process. A boom truck picks the biomass and transports the biomass to the storage site (Figure 5).

Figure 5. Loading to transport the biomass to the storage site.

Although there are many benefits on the social and environmental side, economic feasibility is key and was therefore envisaged when designing and implementing the changes to further improve the value chain (from the initial design). The cooperative La Granada offers two possible services to their associates:

First, the collection of the vine shoots takes place in between rows in the field, piling of the prunings, loading, and transport to the storage site with a total price of approximately 60 euros per hectare (payment from the farmer to the cooperative for the respective service). Second, the farmer takes care of the collection and piling of the vineyard pruning while the loading and transport to the storage site is organised by the cooperative with an approximate cost of 40 euros per hectare. Seeking to adjust the economic feasibility of the value chain, the services prices were increased from previously 50 and 25 euros per hectare, respectively.

Another key aspect of the biomass collection process lies in the planning stage. In many cases, wine-growers' plots are spread across an larger area, thus the collection needs to be planned across the borders of winegrowers in order to maximise the efficiency.

BIOMASS MANAGEMENT

A key role to achieve good quality of the biofuels involves the storage and pre-treatment.

The storage site covers an area of 5,000 square metres and is located at a strategic position that facilitates the supply to the district heating in Vilafranca's La Girada assuring cost competitiveness is achieved by reduced transport costs. The storage site is divided into two differentiated areas. In one part the vine shoots are unloaded and stored in uncovered piles to dry. In the second area the material is chipped and stored under cover within a shed (Figure 6 and 7).

Figure 6. Vineyard pruning storage.

Figure 7. Chipped material storage under shed.

The chipping is scheduled periodically once a certain minimum amount has been collected. In order to perform the chipping, a high-power equipment is used, and chipping is conducted at the storage site (Figure 8).

Figure 8. Chipping.

During the project, the chipping took place at the field, but the machinery used did not reach a sufficient quality of the product. The material produced did not reach the required homogeneity and therefore an additional second chipping or a sieving was necessary. The chipper currently used is able to process around 20 to 30 tonnes during a 4-hour period and a better quality material is obtained, particularly regarding the homogeneity (Figure 8 and 9).

Figure 9. Chipped material.

ENERGY PRODUCTION

A centralized heating system run on biomass in La Girada has replaced heating systems and domestic hot water (DHW) that were produced using natural gas and/or electricity. Fossil-based energy sources have not been eliminated, but they are nowadays only used as back-up.

The installation of the boiler (Heizomat RHK-AK 500) was carried out as part of the LIFE Project and supplied thermal energy to four buildings (Dolors Piera primary school, an educational resource centre, parquet pre-school and alt Penedès Regional Archive). Heat supply began in January 2016. Taking into account the results achieved during the project lifetime, a new building (Ricard Fortuny Sociosanitary Centre) was connected to the Girada district heating network (Figure 10).

Figure 10. Boiler and district heating system.

EMAVSA, a service company, is in charge of the boiler operation and its maintenance. Additionally, EMAVSA and alongside the cooperative La Granada are in charge of organising the biomass supply to run the boiler.

Taking into consideration the boiler performance achieved during the project, some improvements were implemented (Figure 11). Seeking to avoid clogging, a cutting system was installed at the boiler entrance to improve the material size homogeneity.

Figure 11. Additional cutting system.

Additionally, the ash removal in this type of boilers running on biomass, which in average presents a high ash content, was initially carry out manually every second day using a metallic bin. Nowadays, a new container with a capacity of 700 litres was installed, which allows to empty the container mechanically after 10 days (Figure 12).

The deployment of the district heating network calculated during the project revealed an energy reduction of around 153,000 kWh of natural gas and 12,653 kWh of electricity per year. Additionally, the overall reduction of greenhouse gases emissions associated was around 241 tCO2eq.

Figure 12. Ash container.

Motivation for development

When installing a biomass boiler that is to be run on agricultural biomass, there are certain technical considerations that need to be taken into account: primarily, the material is not very dense and becomes easily entangled and the ash content is high (Table 1). Therefore, these peculiarities should be taken into consideration during the management and design of the biomass system to avoid operational problems and inefficiencies.

Table 1. Biomass characteristics.

	Average Lower Heating Value	Average bulk density	Average ash content
Vineyard pruning	4,116.21 kWh/t	157 kg/m^3	6.32 %

Agricultural biomass can provide a good thermal performance, although, based on the results achieved, the installation of these boilers in urban areas is recommended when using a centralized (district heating) boiler and when long-term use is envisaged. This will ensure optimum yields and maximum returns on investment.

The keys for replicability in this case include:

- Use commercial (tried and tested) machinery for the collection of vine shoots
- Collect and manage biomass near to the end-users. The collection process must be planned to be highly efficient. The drying and storage of vine biomass must be strategically located near to the main consumers in order to keep the selling price competitive and to avoid excessive transport costs
- Large facilities with sustained demand are preferable
- Technical improvements to boilers and selection of the most adequate equipment according to the biofuel specific characteristics: boilers should have a chain conveyor system in the combustion chamber to counter the fuel's lack of fluidity and with continuous cleaning to avoid unnecessary stops and re-starts
- Set up of a municipal services company is a key element as it ensures the stability of the project by contributing to ensure energy supply and customer confidence

Additionally, another relevant aspect concerned the necessity of private and public sector to work together in order to promote and implement the initiative as well as to align all actors involved in the value chain. Based on the municipality experience it is time consuming and sometimes difficult to mobilize agents. Local authorities willing to promote this type of value chain need to clearly define the type of initiative or value chain besides the corresponding business model they intend to develop, taking the region's specific characteristics into consideration. When designing the project, it is essential to set realistic objectives, both in the short and midterm. It is also relevant to involve professionals with the needed expertise to correctly dimension the value chain and assess its suitability and profitability.

Economic-, energy- and environmental perspectives

This value chain allows to strengthen the link between rural environment and circular economy through the utilisation of by-products to obtain a renewable energy locally.

Various benefits arose associated to the collection of the pruning. Firstly, the economic benefits derived from savings in fuel costs (replacing expensive fossil fuels) due to the substitution with wine shoots (biofuel). Secondly, it implies an environmental benefit due to the reduction of emissions derived from the otherwise uncontrolled burning of these vine shoots at the fields. And thirdly, social benefits are created in terms of employment associated to the biomass procurement and logistics.

The achieved benefits also include the reduction of the energy dependency and vulnerability to price changes of imported fossil fuel, increase energy security in the territory, as well as create new jobs based on a green economy. Furthermore, there is an improvement of the air quality in line with the Europe 2050 objectives and the roadmap of the Spanish National Plan of Air Quality and Atmospheric Protection in addition to contributing to an increased awareness regarding circular economy at regional and national level.

Additionally, the carbon cycle is affected since the same amount of CO2 that has been stored during the vine's lifecycle (carbon dioxide is fixed through photosynthesis in the vine) is returned to the atmosphere. During the vine biomass combustion process, this CO2 is released once again into the atmosphere and the cycle begins once again. The remaining ash is used as a fertilizer therefore contributing to the circular economy objectives.

Therefore, this value chain based on vineyard pruning allows to obtain a decentralized and local form of renewable energy, de-centralized and local, that reduces dependence on fossil fuels and contributes to promote competitivity and innovation in the area, enhancing and adding value to the economy of the region. The environmental and social benefits derived from the generation of "zero kilometre" renewable energy have turned a side-, or waste-product into an energy resource. Thanks to its good results, this innovative practice is attracting the involvement of other groups interested in promoting a circular economy.

Knowledge transfer potential to other regions

It would make a lot of sense to replicate this initiative in places where raw materials (biomass) are generated, which can be reused for energy or other purposes. Areas which concentrate a critical mass of stakeholders devoted to an agricultural activity that yield this type of biomass are key. The targeted value chain focuses basically on forestry or agriculture biomass, which is currently not used, for which a strategy should be designed to recover the material and generate an energy value. In case that most of the stakeholders involved agree and actively participate, the project will more likely be successful.

The current situation set an attractive framework to develop this type of initiative. Nowadays, the society is interested in projects of this type targeting the promotion of local/regional circular economy Currently many governments support such initiatives. At the European level, financial resources have been made available, and municipalities need to be aware of this opportunity. Administrations willing to develop a similar project could participate and apply for this financial support. Best cases example have a key role to promote this type of initiatives in other regions or municipalities, although each site specific characteristics (type of biomass available, existent actors, etc.) need to be carefully considered in order to adapt the strategy accordingly.

CASE STUDY

Summary

In conclusion, the value chain model based on vineyard pruning is a model of circular economy that consists of the use of agricultural biomass from the pruning of vines as a source of renewable energy, which can cover energy demands of the local consumers. By doing so, the vine circle is closed, and a green local economy is promoted in line with the EU's energy and climate goals.

ABOUT BRANCHES

BRANCHES is a H2020 "Coordination Support Action" project, that brings together 12 partners from 5 different countries. The overall objective of **BRANCHES** is to foster knowledge transfer and innovation in rural areas (agriculture and forestry), enhancing the viability and competitiveness of biomass supply chains and promoting innovative technologies, rural bioeconomy solutions and sustainable agricultural and forest management.

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THE PARTNERSHIP

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