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Deliverable D2.3: Technical factsheets of forest and agricultural biomass, SRC and pruning supply chains, 1st version

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Case Study

Innovative technology for the energywood supply chain – a focus on unmanaged thinning stands typical in Finnish forestry conditions

Creators: Robert Prinz

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CASE STUDY Innovative technology for the energywood supply chain – a focus on young or unmanaged thinning stands typical in Finnish forestry conditions	
Creators	Robert Prinz
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1 Introduction

BRANCHES project aims to promote the implementation of new cost-effective technologies; mobilize more biomass and create innovative business opportunities in rural areas by improving and strengthening the links between bioeconomy practice and science. The project will ensure communication through the two-way flow of information for the transfer of ideas and technologies between scientists and professionals from agriculture and forestry in rural areas. The valuable knowledge produced by research and development should always be shared far beyond the scientific community. BRANCHES will integrate selected knowledge on forest and agricultural biomass supply chains with available innovative technologies and best practice cases for bioeconomy solutions with bio-energy conversion systems in a wider bioeconomy context. In all EU countries, existing strategies and best available technologies will be presented in easily understandable formats through the national thematic networks launched by BRANCHES.

BRANCHES project will produce and share Practice Abstracts (PAs) from regional best practices useful for the bioeconomy. The selected best practices are summarized in Practice Abstracts (PAs) are shared through the project media and collected on the project webpage (https://www.branchesproject.eu/materials/practice-abstracts-and-factsheets). From these best practices, the most promising bioeconomy solutions are presented in Case Studies to further detail the value chain or technology characteristics.

2 Case description

The goal of the case study is to demonstrate the capacity of innovative energywood supply technology that was considered especially suitable for mobilizing forest biomass from young or unmanaged thinning stands under the conditions that are typical of Finnish forestry. The aim is to demonstrate the entire energywood supply chain from harvesting to forwarding, chipping and transport of forest chips.

The case study includes the demonstration of an innovative harvesting solution with the RISUPETO harvesting device. A BRANCHES showcase of that particular machine and the entire related energywood supply chain was organized as a stand-alone event on Thursday 13.4.2023 from 11 to 14 in the village of Mansikkavirta, Sonkajärvi, North-Savo, Finland (Figure 1). The RISUPETO device is a novel felling head for efficient harvesting of small diameter wood biomass both in forests and edge zones of infrastructure. A video is available from the event through the following link: https://youtu.be/hMHQNyisaD4

Figure 1. RISUPETO harvesting device presented at the BRANCHES showcase-day in Finland.

The case study includes the entire energywood supply chain with the following elements and machines:

- harvesting with the RISUPETO harvesting device mounted on an excavator
- forwarding of energywood with a forwarder equipped with a specific cutting grapple
- chipping of energywood with a drum chipper at the roadside storage
- transportation of chips with a chip-truck

BIOMASS HARVESTING

RISUPETO is a new generation energy wood harvester device. The way the device works, in short, is that it harvests (i.e. cuts, accumulates, fells and bunches) whole-trees within one working cycle. The harvesting of trees from 1 to 30 cm is done without additional work cycles. The machine has been used at sites with dense young stands where the undergrowth has not been harvested, the biomass removal is high and the removal potential of merchantable stem wood is low. When mechanized harvesting has been carried out in the past, operations have typically required the manual removal/clearing of the undergrowth in order to be able to operate with a harvesting machine. With this device, there is no need for that at all, the undergrowth removal harvesting of all-sized wood up to 30 cm is done simultaneously when thinning the forest to the extent that it becomes a growing forest following the current forest management practices/recommendations. In a way, at best, it may save even up to a 1000 euros per hectare while no need to make pre-clearing work, and, managing the forest by RISUPETO, all the harvested wood can be sold as energy wood. The energy-wood removal will become high party due to the need to open thinning tracks in 20 m space. The width of the track itself follows typical width of a conventional CTL-thinning resulting in 4-5 m. The remaining forestry professionals of manual pre-clearing can be used to those exact places where it is not worth of using this method.

Figure 1. RISUPETO harvesting device suitable for mobilizing forest biomass from young or unmanaged thinning stands.

The RISUPETO felling head cuts standing trees with two parallel disk sawblades and accumulates trees in an upright position to the collecting chamber using rotating collecting arms (Figure 2). The collecting arms are attached to the two vertical cylinders, which rotate at the same speed as the disk sawblades. When the collecting chamber of the felling head is full, the accumulated tree bunch is moved to the pile and dropped out. The unloading of the tree bunch is done by tilting the felling head downward and rotating the disk saws

and collecting arms in the opposite direction from that during cutting. The width of the hydraulically powered accumulating felling head is 1.0 m, and the maximum cutting diameter with one cut is 30 cm. There is a recognition device that uses pressure sensors, motors in the upper end, the direct drive that rotates and the slowly rotating guillotine-type blade collecting material in the hold. When a bigger tree comes up against it, it changes from series connection to parallel connection, so the speed is reduced by half and the power is doubled, and it can cut even a big tree.

The accumulating felling head is attached to the boom tip of the medium-sized crawler excavator. The advantages of excavators produced in high volumes include a purchase price lower than that of conventional forest machines such as harvesters and forwarders and, outside the harvesting season, the option of removing the harvesting equipment and using the base machine in the work for which it was originally designed.

Researchers from the Natural Resources Institute Finland (Luke) have studied the first version of RISUPETO in the clearing of field edges and roadside bushes (Laitila & Väätäinen 2021). That is where the device showed its abilities and development potential. The next version was then studied in a completely overgrown young forest restoration site (Laitila & Väätäinen 2023). The harvest result was excellent, and the productivity was at the highest level that has been achieved in similar conditions in the Nordic countries. This makes it possible to rehabilitate problematic sites, particularly overgrown and overdense sites, into a productive state.

A Practice Abstract of this device was presented during a BRANCHES WP2 workshop. The majority of the workshop participants selected this machine as a solution with high potential. Consequently, based on the workshop feedback, this device was chosen for the Finnish WP2 showcase day and case study. More information on the device can be found from the BRANCHES Practice Abstract PA4: http://files.spazioweb.it/3e/57/3e57236d-e15e-4b7b-851c-a3698496dd3f.pdf

BIOMASS COLLECTION

Forwarding of energywood is carried out using a forwarder (Figure 3). In the demonstrated case, the forwarder was equipped with a specific grapple that cannot only load the material, but also cut the material to the length that is most desired (Figure 4). Moreover, cutting to the desired length while forwarding is more time and cost efficient, than cutting trees to the length with the RISUPETO. The grapple saw Mecanil SG280 RC-M G2, a combination of a grapple with a chainsaw is a product from the company Mecanil Oy Ab.

Figure 3. Collection of forest biomass from thinning using a forwarder.

Since during the previous step a whole tree felling unit (RISUPETO) is used, the material has the length of the harvested trees at the moment of felling. This whole tree length might be too long for the efficient handling during forwarding and piling at the roadside. The grapple saw is able to cut the pre-piled material to the desired length. The cutting can happen at the same time when grapping the material from the forest ground or when lifting the grapple load to the forwarder´s load space. The material is collected from the pre-piles in the forest site and brought to the roadside for storage.

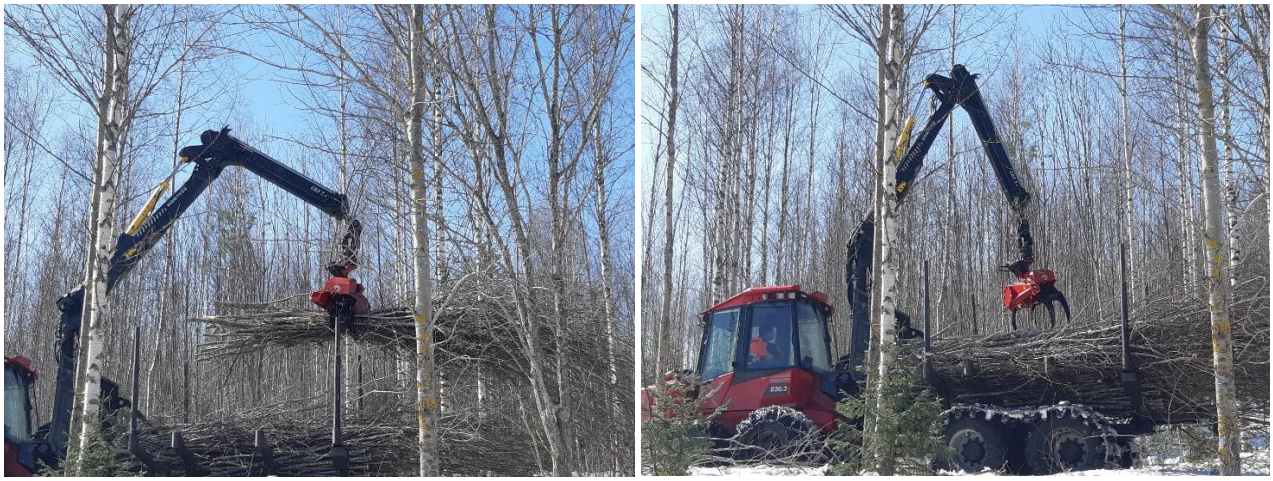

Figure 4. The forwarder is equipped with a Mecanil grapple saw.

BIOMASS CHIPPING & TRANSPORTATION

The biomass chipping and transportation is typically managed by the company purchasing the energywood. The purchaser buys the wood that is harvested form the site, and utilizes their own equipment, in this typical case a wood chipper and a wood chip transport truck.

Figure 5. Chipping of biomass using a truck-mounted drum chipper.

Chipping of energywood: a truck-mounted drum chipper comminutes the whole tree material at the roadside storage into wood chips that are directly blown to the chip truck present at the roadside (Figure 5). The method of roadside chipping is the most common chipping method in Finland. Often, delimbed energy wood is the main energy raw material assortment, but also the provided whole trees work just fine for producing chips for energy use.

Transportation of chips: a chip-truck is loaded with forest chips directly blown by the chipping to the loading space of the truck (Figure 6). The comminuted material is then transported typically directly to the end-using facility, in this case a heating plant. The chips are usually brought directly to the plant without further storage, particular during winter months or heating season.

Figure 6. Chipping at the roadside directly to the chip-truck.

3 Practitioners' feedback & motivation for development

In general, the showcase presenting the entire chain with the harvesting, forwarding, chipping and chip transport was very attractive to the targeted audience. Professionals working with thinning operations, particularly energywood harvesting, seemed to be especially interested in the new technology presented during the BRANCHES showcase day. Attendees of the showcase day were really interested about this particular new device, RISUPETO. The showcase made participants more aware of the potential and benefits of this innovative device. Also, the company presenting the innovative device was very pleased with the arrangements, participation and overall interest of practitioners to the machine.

From an entrepreneur´s point of view, with the RISUPETO harvesting device it is easy and precise to control the movements of the harvester head, which allows the operator to leave the best trees standing. The purchase price of the excavator base machine is significantly lower compared to the price of a conventional logging machine. Furthermore, an excavator allows the use of the base machine also outside the harvesting season, e.g., for work it was originally designed.

The RISUPETO device makes the piling of whole trees ready for forwarding, as well as has the advantage of collecting small wood. Using this device, it is possible to work without interruptions in those areas where it

would not be very reasonable and economical with other machines. A particular benefit of the machine occurs when the undergrowth has not been harvested, forest is overdense and the biomass removal is high. Traditional mechanized harvesting using purpose-build machinery have typically required pre-clearing of the undergrowth. With the RISUPETO device this pre-clearing step is unnecessary, and the harvesting is done simultaneously when thinning. Thus, the harvesting of trees is done without additional work cycles that would affect the efficiency, ideally benefitting even thousand euros per hectare compared to using conventional method.

4 Trade-offs between economic, energy and environmental effects for conventional and improved biomass handling approaches

With the use of an energywood supply chain with the RISUPETO device it is possible to influence on environmental aspects. It is the aim to leave a certain amount of rotten wood in the forest, which is important from a biodiversity and environmental point of view. With this device, it is possible to leave the remaining stump as long as wanted, some want to leave stumps 30-40 cm long, others want them completely cut off close to the roots. If stumps are left longer, the device will shatter the stump, so the amount of rotting wood will multiply by the length of the stump, depending how much is planned to be left per hectare.

In Cut to length (CTL) harvesting, trees are delimbed and cross-cut to log assortments at the site using purpose-build machines. In that case the branches and treetops remain in the forest, meaning also that there will be less available wood material. One positive aspect about using the RISUPETO harvesting device is that the material is more precisely collected from the forest, and all the smaller trees, that would otherwise not be collected with a traditional machine, can also be brought along. Thus, the results will be a cleaner forest this way.

5 Knowledge transfer potential to other regions

The presented innovative technology for the energywood supply chain has definitely a high potential to be transferred to other regions. The conditions of young, overgrown, overdense, and unmanaged thinning stands presented in this case through a typical case under Finnish forestry conditions can also be found in many other regions. There is a strong need to manage such stands in an efficient and sustainable way, ensuring the respective long-term objectives in forestry. Besides, the solution is suitable for mobilizing forest biomass in a profitable means.

The focus on an efficient energywood supply chain utilizing a locally available source of biomass can show benefits to the local and regional economy. The utilization of such a renewable source of energy brings economic and environmental benefits particular to rural communities, especially if the alternatives involve fossil-based solutions. Also, social benefits can be mentioned, particular through the employment of people along the entire value chain. The presented solution furthermore allows the flexible and year-round use of machinery, particularly for the investment of the excavator base machine.

6 Summary

In conclusion, the value chain model based on innovative technology for the energywood supply chain is a model of circular economy that consists of the efficient use of biomass from young or unmanaged thinning stands typical in Finnish forestry conditions. The harvested biomass serves as a source of renewable energy, which can cover energy demands of the local or regional consumers. By doing so, the energywood circle is closed, and a green local economy is promoted in line with the EU's energy and climate goals.

References:

Laitila J. & Väätäinen K. (2021) Productivity and cost of harvesting overgrowth brushwood from roadsides and field edges, International Journal of Forest Engineering, 32:2, 140-154, https://doi.org/10.1080/14942119.2021.1903790

Laitila J. & Väätäinen K. (2023) The productivity and cost of harvesting whole trees from early thinnings with a felling head designed for continuous cutting and accumulation, International Journal of Forest Engineering, 34:1, 76-89, https://doi.org/10.1080/14942119.2022.2094192

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Case Study

Power and heating from olive tree management

Case study Lead: ITABIA Italian Biomass Association and CNR IBE

Case study date: 23/08/2023

 This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 10100375

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Content

CASE STUDY Power and heating from olive tree management	
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Introduction

The BRANCHES project aims at increasing the implementation of new cost-efficient technologies, mobilizes more biomass and creates innovative business opportunities in rural areas by improving and strengthening connections among practice and science of bio-based economy. Valuable knowledge produced by research and development should always be shared well beyond the scientific community.

BRANCHES will integrate selected knowledge on forest and agricultural biomass supply chains with available innovative technologies and best-practice cases for bioeconomy solutions with bioenergy conversion systems in a wider bioeconomy context. Across EU countries, existing policies and best available technologies will be presented in easily understandable formats (Practice Abstracts and factsheets) through National Thematic Networks launched by this Project.

Among the various Practices Abstracts created in Italy by the ITABIA and CNR team, the one referring to FIUSIS was highly appreciated by the Italian NTN and for this reason was also the subject of the show-case day (April 2023).

FIUSIS is a 1 MW electric power biomass plant, located in Calimera (Apulia), powered with wood chips obtained from the pruning of local olive trees. FIUSIS has created jobs for around 30 employees, both direct and indirect. It also generates benefits for farmers by avoiding the management costs of residual biomass. Before the activation of the FIUSIS wood-energy chain, the pruning residues (about 10,000 t / year) were burned directly in the fields with all the environmental consequences connected with this practice.

Case description

In the Southern Italian Apulia region olive groves cover about 380,000 hectares and they produce excellent olive oil, which is exported all across the country and abroad. The crop is so prevalent that it alone represent 75% of the total agricultural surface of the area. Olive trees are pruned on regular intervals and

the pruning of Apulian olive groves yields over 800,000 t of wood biomass per year, according to the estimates made by ITABIA within the scope of the H2020 ENABLING project. The disposal problem caused by such a large amount of residue has been turned into a business opportunity by the company FIUSIS, born with the mission of turning olive tree pruning residue into a renewable energy source. The company operates a 1 MWe biomass cogeneration plant, which uses 10,000 tons of olive tree residues per year and produces 8 million kWh of electrical and thermal energy. The plant was commissioned in 2010 and has kept expanding its successful business ever since.

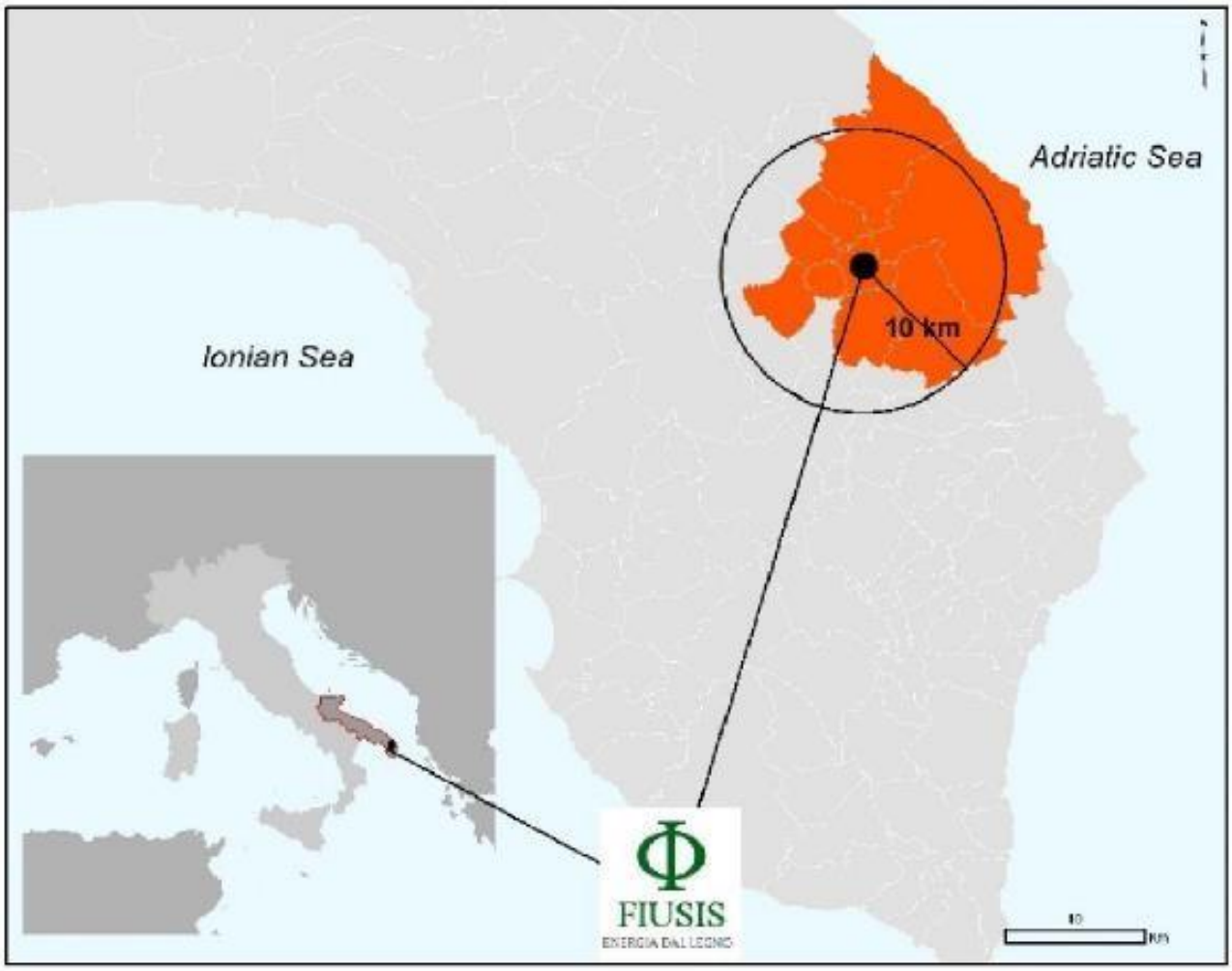

Figure 1: The supply basin of FIUSIS plant

Supply chains

Olive grove management generates a large amount of wood material, in the form of pruning residues, dead old trees and rootstocks. Disposal is obtained by open-air burning, mulching or landfilling. None of those options is environmentally safe, and all incur significant cost. The industrialization of regional olive tree crops has only exacerbated the problem, by increasing the volume and the frequency of operations. FIUSIS has turned this problem into a resource, by capturing the residue stream and channeling into a biomass plant capable of turning waste into a resource. That way, FIUSIS offers farmers a valuable service by providing cost-free waste disposal, while obtaining free fuel for their plant. For farmers, that is by far the best option and that explains why over 2000 farms have joined FIUSIS' scheme. Acceptance is unanimous, and wider participation is mainly limited by the plant's capacity, which points at a high potential for replication of the FIUSIS model.

Since less than a year, the massive olive dieback caused by *Xylella fastidiosa* – a bacterial infection - has caused a realignment of the supply chain, which has been modified to capture the large amount of opportunity fuel generated by the replanting of damaged orchards. Therefore, the showcase day demonstrated not one, but three integrated value chains: pruning residues, stems from orchard termination, roots and branches from orchard termination. Those chains use different methods and technologies, and generate different products – all capable of supporting the bioeconomy. And after a thorough clean-up of the damaged orchards, new plantations are immediately established using diseaseresistant olive tree varieties.

Residue collection is organized through a subsidiary company – Ligna – which coordinates and supports a number of competent local contractors, who are equipped with the most modern machinery. In particular, three main working methods have been adopted, corresponding to the three main residue types: pruning, dead and infestead trees, stumps and roots

Pruning residue is collected through dedicated harvesters that pick up the windrowed branches from the ground and feed them to a shredder, which discharges the comminuted material into a built-in container.

Figure 2 - Harvesting of pruning residues with a four towed shredder (Facma mod. Comby TR200) for olive groves with less than 400 trees

The container is designed for high dumping, so that it can easily transfer its load to a larger agricultural trailer or a truck bin for transportation to the plant (Figure 2). Pruning residue harvesters come in several models and sizes, and they can be designed for fitting to a farm tractor or a dedicated prime mover. Harvesting productivity ranges from 30 to over 50 t per day, at a moisture content from 20% to 40% depending on the season. A different system is applied to heavy pruning operations that generate overly large branches. Those are too big for the dedicated pruning harvesters, and therefore are moved to the field's edge with a tractor carrying a front loader and later shredded with a mobile grinder, discharging directly into truck bins. Grinding productivity ranges from 50 to 100 t per day.

Figure 3 - Comminution of pruning residues with a mobile shredder (Caravaggi mod. BIO900) for bigger olive groves

Olive trees can get very old, but they eventually die. Furthermore, industrial plantations are renewed when production declines, so indefinite aging is not an option. Regardless, old trees are especially vulnerable to disease, and they must be removed in order to contain the infection. Those trees are managed like forest trees: they are cut with chainsaws, moved to a landing and eventually chipped with industrial chippers. The latter come in several models, but the most popular among industrial users are truck-mounted or trailermounted drum chippers, equipped with their own independent engine in the 300-400 kW power range (Figure 3). Chipping productivity easily exceeds 100 t per day.

Once the diseased tree is cut, the game is not over yet. Part of the tree is left underground, and that must also be removed in order to contain the infection and to make space for a new disease-resistant tree. The stump and root are solidly anchored to the ground and special equipment is required for their removal. In most cases, uprooting and size reduction are performed by tracked excavators in the 16 to 20 t weight range. Those machines are equipped with dedicated uprooting attachments, consisting of a robust talon and shear. The former is driven under the stump and used to lift it up, the latter to cut the bulky rootstock into smaller pieces, in order to drop as much soil as possible and to make transportation easier. Rootstock harvesting proceeds at a rate of 20 stumps per hour.

Given the variety of work site conditions, operational models and residue types, precision management is required. Special software is used to geolocate all the farms participating in the initiative, plan and monitor operations, and eventually trace the origin of residue loads delivered to the plant.

Figure 4 - Olive tree residue collection and processing area

Power generation

FIUSIS bioenergy plant started operation in 2010 by commissioning a 1 MWe cogeneration plant aimed to transform 10,000 t of pruning residues per year into 8 million kWh of electricity and heat. It is a good example of clean energy production from a renewable source available locally, due to the close connection with farmers and agricultural contractors for the recovery of olive tree pruning residues.

The industrial site includes a storage area, where the wood chips obtained from olive tree pruning are accumulated and moved to aerate them, in order to reduce the humidity of the biomass, increase its calorific value, and also limiting its degradation by fungi and molds . The images (Figure 5) show an overview of the storage site and the machinery that performs these operations.

Figure 5 - Storage area at the plant

The actual biomass energy conversion plant is based on widely used and tested technologies. An automatic feeding system with rakes and conveyor belt brings the wood chips into a recovery boiler with a moving grate burner from the Italian company UNICONFORT (figure 6).

Figure 6 - The 4.4 MWth moving grate boiler

The boiler burns, in constantly controlled conditions, 24-28 tons of wood chips per day. The heat generated by the combustion of the biomass is recovered by a system of diathermic oil exchangers and used for the cogeneration of electricity and heat in an Organic Rankine Cycle (ORC) unit of the TURBODEN company. This unit has an electric power capacity of 1 MW, based on a turbogenerator, to transform thermal energy into mechanical energy and finally into electric energy (Figure 7). Instead of generating steam from water, as a conventional steam turbine, the ORC system vaporizes an organic fluid in a closed cycle system, which allows to operate at lower pressures and without erosion of the metal parts and blades.

Figure 7 - The 1MW ORC turbine

The electricity produced is fed into the national distribution network with priority for a line that directly feeds the city of Calimera. The city of Calimera can thus boast of being the first city in Salento, and one of the first in southern Italy, for be powered by renewable energy. In addition, heat cogenerated in the ORC unit is recovered and used for pellet drying in a production line built at the same site, further improving the overall efficiency of the biomass energy conversion process.

Particular attention was paid to the reduction of polluting emissions and especially of fine particulate matter. These are drastically reduced through the use of a high efficiency filtration system through which the fumes leaving the boiler are conveyed. Final emissions of particulates are equal to 1 milligram per normal cubic meter, compared to the maximum limit of 30 milligrams per normal cubic meter set for this type of plant. if Before being used at the FIUSIS plant, the olive tree pruning were burned outdoors without any emission control, making these results is even more important.

Moreover, future plans include a facility for turning the wood ash generated by the plant into high-quality fertilizer with a view to full implementation of the principles of the circular economy.

Pellet production

FIUSIS has also commissioned a wood pellet production plant that recovers surplus heat and uses it for drying sawdust (figure 8). The production is one ton of high-quality pellets per day. All the process heat required to produce the pellet is obtained at zero cost, because it is recovered from the power plant.

Twenty-five percent of the electricity consumption that incurs in the pelletizing process is met by the recently installed photovoltaic panels. In the coming years, FIUSIS plans to install additional 250 kW of photovoltaics to cover all the needs of the power plant.

For these reasons, FIUSIS can afford to currently keep pellet prices at € 8 per bag (15 kg), which is well below a national average ranging between €12 and €16 per bag. Today by virtue of these choices the demand for FIUSIS pellets has increased by 2,000 % and production has rapidly increased from 600 t/year marketed in 2020 to 1,500 t in 2021. The plan is to further expand capacity to 6,000 t/year in the short term.

The procedures for obtaining product quality certification are being activated for FIUSIS pellets.

Figure 8 - The FIUSIS pellet plant

Practitioners' feedback & motivation for development

An informal survey was conducted among the public attending the demonstrations made during the FIUSIS Show-case day (April 21 – 2023) and overall 23 interviews were released.

There was a general understanding that the key success factor for FIUSIS was the connection with the region, that is the capacity to engage local farmers and the general population. As a result, local farmers guarantee a steady flow of quality fuel to the power station, while opposition from the general population is prevented. Integration along the whole value chain was recognized as the main success factor, leading to a steady fuel supply and to a remarkable capacity for timely seizing opportunities as they appear.

Further remarks concerned the potential for replication. With the estimated potential of 800 000 t per year in the Apulia region, the consumption of a plant such as FIUSIS amounts to 10 000 t per year, meaning that 80 such plants could be supported by the plantations growing in the Apulia region alone. Olive groves are common in many other areas in the Mediterranean region, and therefore the FIUSIS example could in principle be replicated hundreds of times across Southern Europe.

Additional comments addressed the possibility to further improve the harvesting techniques and technologies demonstrated during the showcase day. For instance, the excavators tasked to orchard termination and removal could be equipped with better equipment than just a modified bucket – such as specialized implements for root extraction and size reduction. Similarly, the efficiency of shredding and screening could be further increased through the adoption of newer dedicated equipment, which would allow decreasing fuel supply cost.

Trade-offs between economic, energy and environmental effects for conventional and improved biomass handling approaches

FIUSIS demonstrate an effective waste-to-value chain, which can adapt to local needs and turn a problem into an opportunity. Furthermore, the example shown in Calimera demonstrated remarkable flexibility, rapidly adapting to unforeseen changes, such as the olive dieback epidemics by Xylella bacteria and the energy crisis originating from the Russo-Ukrainian conflict. As a matter of fact, FIUSIS quickly realigned their supply chains from the dominant pruning residue feed of the past 10 years to a new dominant dead tree stream, suddenly materialized within less than a year. Similarly, they faced the increasing energy costs by setting up a pellet manufacturing plant that could remedy the dramatic shortage of pellet on the local market, while accruing additional revenue that could not be extracted from power sales – since the price of power had been capped by their original feed-in tariff contract (0.28 euros per kWh).

Following the energy crisis, FIUSIS expenditures increased dramatically. Ancillary energy consumption for the operation of the thermoelectric power plant quadrupled: in 2019, the annual bill was about 13,000 € which grew close to 50,000 € in 2022. Spare parts, lubricants and fuels for the machines (tractors, chippers, excavators, etc.) used in biomass handling also increased dramatically: the price of diesel fuel went from 1.45 €/l to 2.20 €/l (average increase of about 0.40 €/l); the price of lubricants went from 0.12 €/kg to 1.2 €/kg (1000 % increase); the price of ammonia for the flue gas filters went from 0.18 €/l to 1.2 €/l (670 % increase); finally, the price of the plastic film (recycled and recyclable) imported from Germany to bag their pellets went from a € 0.12 per bag to € 0.32 per bag (270% increase).

Against this background, power generation suffered a dramatic drop in profitability, fortunately compensated for by the pellet production. The pelletizing plant is very efficient for three main reasons: 1) it sources local raw materials and caters for local markets that accrues strategic savings on transportation and distribution cost; 2) all the process heat required to produce the pellet is obtained at zero cost, because it is recovered from the power plant; 3) twenty-five percent of the electricity consumption that incurs in the pelletizing process is met by the recently installed photovoltaic panels. In the coming years, FIUSIS plans to install additional 250 kW of photovoltaics to cover all the needs of the power plant.

FIUSIS is a concrete initiative that can solve a waste management problem into an opportunity for local development, while returning most of the benefits it accrues to the same territory from which it has extracted them…and that is flexible enough to rapidly adapt and realign in the face of new challenges, which is the very definition of resilience. FIUSIS matches all those specifications.

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For all these reasons, as foreseen by the BRANCHES project, a video was shot during the show-case day (see website www.brannchesproject.eu) which summarizes all the main aspects of the FIUSIS technological system, starting from the field up to the energy production plant.

In addition, the workshop carried out on the second day, which lasted about 3 hours, was also entirely recorded and divided into 6 thematic sessions: 1 – Opening (https://youtu.be/hj1_GStRDdU); 2 - Supply chains (https://youtu.be/t6b_50mpu4A); 3 - Power generation (https://youtu.be/lXfHWaKojFo); 4 - Pellet production (https://youtu.be/18KtRr-dONA); 5 - Ash management (https://youtu.be/scrm4ftwIW0); 6 - Conclusions (https://youtu.be/PFgs5Eim35A). All this material was uploaded to the project website and social channels.

Finally, the dissemination of the FIUSIS case study also took place through the publication of various articles in specialized magazines including Machinery World (see Annex 1).

Knowledge transfer potential to other regions

Some years ago, in the framework of the AGROinLOG H2020 Project, the Research Centre for Engineering and Agro-Food processing of CREA was in charge to promote the birth of a bioenergy chain based on the use of olive tree prunings in the Greek region of Ftiotide, by sharing knowledge on agricultural mechanization. Despite the huge areas of olive grow plantations, such bioenergy chains have never taken off anywhere in the Country. On the contrary in Italy the are several practical examples of pruning utilization for energy purposes. Among these FIUSIS is the first biomass power plant in the world to use exclusively olive tree residues as a fuel source. This plant, besides representing a good example of integration with the region for the energetic exploitation of olive prunings, operates in an area of the Apulia region where the climatic characteristics and the management methods of the olive groves are very similar to the Greek ones in the interested area. For these reasons, FIUSIS has been identified as a reference model to be followed in the organization of the production chain to set up in Greece.

Sustainability

FIUSIS supports the local community by employing 33 trained employees, and provides a strong environmental benefit by avoiding the net emission of 4,500 tCO_2 per year if compared to an equivalent plant fuelled with natural gas, which represent the second best alternative. A plant fed with fuel oil would emit twice as much carbon. At the same time, material use by the FIUSIS plant avoids the field burning of 10,000 t/year of pruning residues. While now declared illegal, field burning is a traditional practice that is very difficult to stop in the absence of cost-effective alternatives.

The initial investment of 8 M € was made possible through project financing. At present, the company has an annual turnover of around 2 M €, a most important result given the specificity of the local context and the positive effects this initiative generates on the local agricultural sector. In particular, FIUSIS offers a cost-free residue disposal alternative to over 2,000 farmers, increasing the profitability of their own farms.

Finally, FIUSIS is financing studies (Polytechnic of Turin, University of Salento) for the production of fertilizers from biomass combustion ashes. This is therefore a winning model of sustainability, studied and replicated in Italy and abroad.

Summary

The organization of the supply chain and the machinery system can be transferred to many regions of the Mediterranean area where the residues of the olive groves abound. In addition to modern energy conversion and emission control technology, FIUSIS has developed an efficient system for the collection, conversion and storage of olive tree prunings which makes the entire production system of this plant completely sustainable.

Figure 9 - The BRANCHES working group during the show case day and The CEO of FIUSIS Marcello Piccinni with the video operator MIchele Lezza

Annex 1. Article on the FIUSIS Case Study

La green economy in tempo di crisi

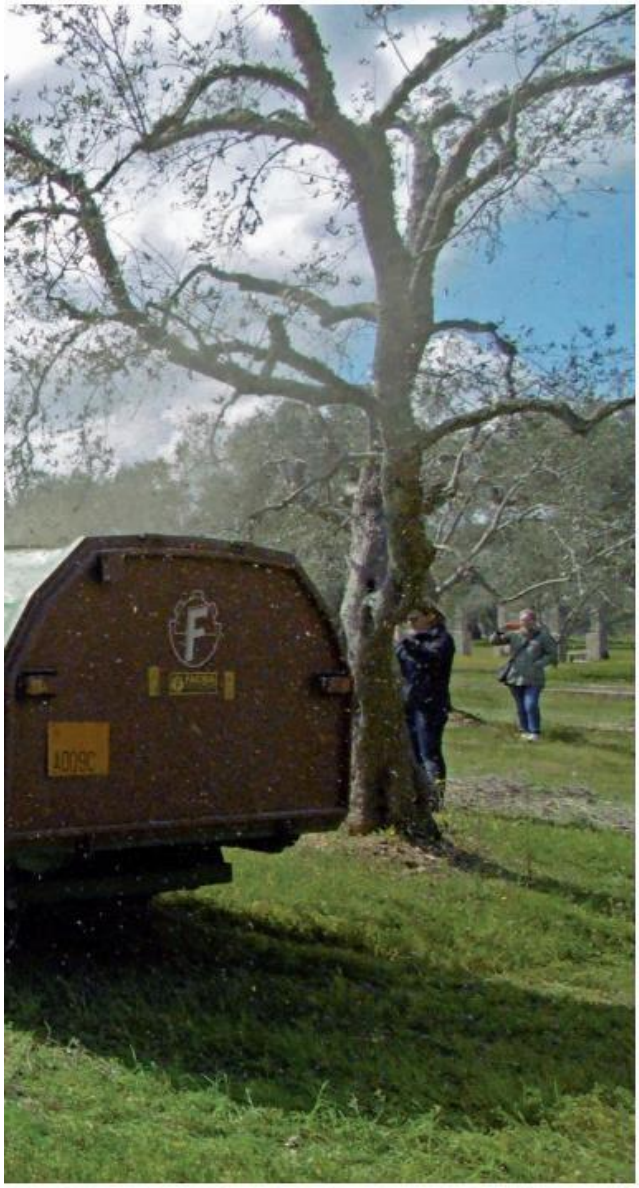
Per fronteggiare i cambiamenti climatici, le emergenze sanitarie e l'instabilità geopolitica l'Europa punta da tempo su strategie volte alla sostenibilità. Il Progetto BRANCHES finanziato con il programma Horizon 2020 ha collezionato un gran numero di esempi virtuosi di bioeconomia circolare in ambito agricolo. Questi modelli ci dimostrano una spiccata capacità di resistere alle avversità dei nostri tempi e fanno ben sperare per il futuro

di Matteo Monni – Italian Biomass Association

Tra le varie iniziative finanziate con fondi EU per contrastare i cambiamenti climatici sta dando grandi soddisfazioni, in termini di risultati tangibili, il Progetto H2020 "BRANCHES" – Boosing RurAl Bioeconomy Networks following multi-actors approaCHES (www.branchesproject.eu) – per cui Itabia è il principale responsabile della comunicazione.
Fino ad oggi, nell'ambito di questo progetto sono state selezionate diverse decine di buone pratiche (Practice Abstracts)

by Matteo Monni – Italian Biomass Association

Among the various EU-funded initiatives to combat climate change, the H2020 project 'BRANCHES' - Boosing RurAl Bioeconomy Networks following multi-actors approaCHES (www.branchesproject.eu) - for which ITABIA is the main communication manager, is giving great satisfaction in terms of tangible results.
To date, several dozen good practices (Practice Abstracts) have been selected within the framework of this project, all



The green economy in times of crisis

tutte riferibili alla sfera della bioeconomia con una particolare attenzione alla valorizzazione delle biomasse derivanti dal settore primario. Si tratta di interessanti esempi da cui emergono – oltre ad aspetti tecnologici innovativi – anche una spiccata capacità imprenditoriale o sperimentale dei protagonisti in essi descritti. Per rendere maggiormente incisiva la campagna di informazione, su tali casi di studio sono state realizzate delle schede descrittive sintetiche ed esaustive tutte scaricabili dal sito web del progetto sia in inglese, sia nella lingua del Paese di riferimento. A partire da questo lavoro ha preso il via un'originale iniziativa ideata in relazione alla complessa situazione di crisi contingente. Quindi, sono stati contattati gli stakeholder coinvolti nelle diverse pratiche selezionate per sentire in che modo la pandemia da COVID 19 e la guerra in Ucraina avessero influito sulle rispettive attività imprenditoriali. In estrema sintesi le domande sono state poste con l'intento di valutare, da una parte il ruolo delle rinnovabili (in particolare della bioenergia) nel mitigare gli effetti della crisi energetica, dall'altra gli ostacoli e le opportunità che tale crisi ha creato nel comparto della bioeconomia e bioenergia. Di conseguenza, dalle interviste emergono essenzialmente i principali impatti (negativi e positivi) dell'aumento del prezzo dell'energia. Questi sono riconducibili, sia a un generale aumento dei costi di gestione ordinaria delle imprese, sia ad una crescente convenienza per l'impiego della biomassa in termini di risparmio, autonomia (disponibilità locale) e gestione del territorio.

In order to cope with climate change, health emergencies and geopolitical instability, Europe has long relied on strategies aimed at sustainability. The BRANCHES project funded by the Horizon 2020 programme has collected a large number of virtuous examples of circular bio-economy in agriculture. These models show a remarkable capacity to withstand the adversities of our times and bode well for the future

of which refer to the sphere of the bio-economy with a particular focus on the smart usage of biomass derived from the primary sector. These are interesting examples which reveal - in addition to innovative technological aspects - also a marked entrepreneurial or experimental capacity of the protagonists described in them. In order to make the information campaign more effective, concise and comprehensive, some descriptive sheets were produced on these case studies, all of which can be downloaded from the project website both in English and in the language of the country in question. From this work, an original initiative designed around the complex contingent crisis situation got underway. Thus, stakeholders involved in the various selected good practices were contacted to hear how the COVID 19 pandemic and the war in Ukraine had affected their respective business activities. In a nutshell, the questions were asked with the intention of assessing, on the one hand, the role of renewables (especially bioenergy) in mitigating the effects of the energy crisis and, on the other hand, the obstacles and opportunities that this crisis has created in the bioeconomy and bioenergy sector. Consequently, the main negative and positive im-

BIOECONOMIA

L'azienda Fiusis

Nella Puglia meridionale gli uliveti si estendono per circa 400.000 ettari e producono ottimo olio d'oliva, esportato in tutta Italia e all'estero. Si stima che dalla potatura degli oliveti pugliesi si ottengono oltre 800.000 t di biomassa legnosa all'anno. Il problema della gestione di una così grande quantità di residui è stato trasformato in un'opportunità di business da un'azienda virtuosa. Fiusis è un impianto di cogenerazione a biomasse da 1 MWe, che valorizza annualmente circa 10.000 t di potature di ulivo per ottenere circa 8 milioni di kWh di energia elettrica e termica. L'azienda dispone anche di una linea di produzione di pellet di legno che utilizza i cascami termici in eccesso per l'essiccazione della segatura e produce circa 1 tonnellata al giorno di pellet di alta qualità. Fiusis oltre a produrre benefici all'economia locale con 33 dipendenti specializzati offre vantaggi ambientali evitando l'emissione netta di 4.500 t CO_2 all'anno rispetto ad un equivalente impianto alimentato a gas naturale (rappresenta la migliore alternativa). Per tutte queste ragioni, l'impianto è stato selezionato come modello di buona pratica italiana di bioeconomia circolare candidata al Premio europeo del Progetto BRANCHES per la sua sostenibilità e ampia replicabilità in molti altri contesti. Per condividere e diffondere l'esperienza maturata, la società Fiusis – in collaborazione con ITABIA, CNR IBE – aprirà i propri cancelli per raccontare e mostrare la filiera di approvvigionamento e conversione energetica dell'impianto di Calimera (LE).

The Fiusis company

In southern Apulia, olive groves cover about 400,000 hectares and produce excellent olive oil, which is exported throughout Italy and abroad. It is estimated that over 800,000 t of woody biomass are obtained annually from the pruning of Apulian olive groves. The problem of managing such a large amount of waste has been turned into a business opportunity by a virtuous company. Fiusis is a 1 MWe biomass cogeneration plant, which annually uses about 10,000 t of olive prunings to obtain about 8 million kWh of electrical and thermal energy. The company also has a wood pellet production line that uses surplus thermal waste for drying sawdust and produces about 1 tonne per day of high-quality pellets. Fiusis not only benefits the local economy with 33 specialised employees, but also offers environmental advantages by avoiding the net emission of 4,500 t CO_2 per year compared to an equivalent plant fuelled by natural gas (it is the best alternative). For all these reasons, the plant was selected as an Italian good practice model of circular bioeconomy candidate for the European BRANCHES Project Award for its sustainability and wide replicability in many other settings. To share and disseminate the experience gained, the Fiusis company - in collaboration with ITABIA, CNR IBE - will open its gates to describe and show the supply chain and energy conversion of the Calimera (LE) plant.

Il risultato finale di questo lavoro sarà l'elaborazione di un Report di indirizzo strategico che si intitolerà "*Bioenergy in a time of crisis*" con cui mostrare al decisore politico i punti di forza e di debolezza della bioeconomia, settore innovativo e in espansione, di fronte a dinamiche imprevedibili e difficili da controllare. Per dare un'idea del taglio dato alle menzionate interviste si riporta quella rilasciata da Marcello Piccinni, amministratore dell'Azienda Fiusis, una centrale termoelettrica da 1 MW di potenza che si alimenta uni-

pacts of the energy price increase emerge from the interviews. These can be traced back both to a general increase in the day-to-day running costs of companies and to an increasing benefits of using biomass in terms of savings, autonomy (local availability) and land management.
The end result of this effort will be the drafting of a Strategic Orientation Report entitled 'Bioenergy in a time of crisis' with which to show policy-makers the strengths and weaknesses of the bio-economy, an innovative and expanding sec-

camente con le potature di uliveti del Salento in Puglia. Tale realtà è un modello di economia circolare legata al contesto agricolo che – per le sue lodevoli soluzioni tecnologiche e organizzative – sarà oggetto il prossimo aprile di uno dei 5 show-case day previsti in Europa dal Progetto BRANCHES (Vedi Box).

Secondo l'esperienza aziendale maturata da Piccinni, negli ultimi 3 anni, pandemia e guerra hanno determinato un notevole aumento dei prezzi delle materie prime e dell'energia, creando non poche difficoltà economiche a Fiusis. Queste, fortunatamente sono state superate grazie alla capacità di portare innovazione nelle linee produttive dell'azienda (elettricità e pellet).

Per quanto riguarda la produzione di energia elettrica – core business aziendale – va detto che il contratto con il Gestore dei Servizi Energetici (GSE) blocca il prezzo di acquisto dell'energia a 0,28 euro per kWh. Quindi, nonostante l'inflazione e la forte crescita dei costi di tutte le materie prime, il valore del kWh immesso nella rete non può aumentare e quindi i margini di guadagno si sono ridotti notevolmente. Tale contrazione degli utili aziendali si evince in relazione a quanto segue:

- i consumi energetici ausiliari al funzionamento della centrale termoelettrica sono quadruplicati. Nel 2019 la bolletta annuale era di circa 13.000 euro e nel 2022 sfiorava i 50.000 euro;
- in forte aumento anche i costi per l'acquisto dei pezzi di ricambio, i lubrificanti dei carburanti per le macchine (trattori, cippatrici, escavatori, ecc.) utilizzate nella movimentazione delle biomasse. Il gasolio passa da 1,45 €/l a 2,20 €/l (aumento medio di circa 0,40 €); lubrificanti da 0,12 €/kg a 1,2 €/kg (aumento del 1.000%); ammoniaca da 0,18 €/l a 1,2 €/l (aumento del 670 %);
- il film plastico (riciclato e riciclabile) importato dalla Germania per insaccare il pellet è passato da 0,12 € a sacco a 0,32 € a sacco (aumento del 270%).

In questo contesto, la produzione di energia ha subito un drastico calo di redditività, fortunatamente compensato dalla produzione di pellet il cui processo è reso particolarmente efficiente per i seguenti motivi:

- si rifornisce di materie prime locali e si rivolge al mercato locale. Ciò consente di ottenere notevoli risparmi sui costi di trasporto e distribuzione;
- tutto il calore di processo necessario alla produzione del pellet è ottenuto a costo zero, perché recuperato dai cascami termici della centrale a biomasse;
- il 25% del consumo di elettricità sostenuto nel processo di pellettizzazione è soddisfatto dai pannelli fotovoltaici recentemente installati. Nei prossimi anni, Fiusis prevede di installare ulteriori 250 kW di fotovoltaico per coprire tutte le esigenze della centrale.

Per questi motivi Fiusis può permettersi di mantenere il prezzo del pellet a 8 € a sacco (15 kg), ben al di sotto di una media nazionale compresa tra 12 e 16 € a sacco. Oggi in virtù di queste scelte la domanda di pellet Fiusis è aumentata del 2.000% e la produzione è passata rapidamente da 600 t/anno commercializzate nel 2020 a 1.500 t nel 2021. Il piano è di espandere ulteriormente la capacità a 6.000 t/anno nel breve termine.

In conclusione, la politica di Fiusis basata sulle risorse del territorio, l'innovazione tecnologica, la cogenerazione energetica (elettrica e termica) e l'integrazione delle fonti rinnovabili (biomasse e solare) ha assicurato grande resilienza e vitalità in un periodo di forte crisi per tante aziende poco propense a innovare.

Matteo Monni

tor, in the face of unpredictable dynamics that are difficult to control. To give an idea of the slant given to the aforementioned interviews, we report the one given by Marcello Piccinni, director of the Fiusis company, a 1 MW thermoelectric power plant that is fuelled solely by prunings from olive groves in the Salento region of Apulia. This entity is a model of circular economy linked to the agricultural context which - for its praiseworthy technological and organisational solutions - will be the subject next April of one of the 5 showcase days planned in Europe by the BRANCHES Project (See Box).

According to Piccinni's business experience, over the past three years, pandemics and war have led to a significant increase in the prices of raw materials and energy, creating quite a few economic difficulties for Fiusis. These, fortunately, were overcome thanks to the ability to bring innovation to the company's production lines (energy and pellets).

Regarding the production of electricity - the company's core business - it must be said that the Conto Energia contract with the Gestore dei Servizi Energetici (GSE) locks in the purchase price of energy at EUR 0.28 per kWh. Thus, despite inflation and the sharp rise in the costs of all raw materials, the value of the kWh cannot increase and therefore profit margins have shrunk considerably. This contraction of company profits is evident in connection with the following:

- *the energy consumption incidental to the operation of the thermal power plant has quadrupled. In 2019, the annual bill was around EUR 13,000 and in 2022 it was close to EUR 50,000;*
- *the costs for the purchase of spare parts, lubricants and fuels for the machines (tractors, chippers, excavators, etc.) used in biomass handling also rose sharply. Diesel rose from 1.45 €/l to 2.20 €/l (average increase of about 0.40 €); lubricants from 0.12 €/kg to 1.2 €/kg (increase of 1,000 %); ammonia from 0.18 €/l to 1.2 €/l (increase of 670%);*
- *plastic film (recycled and recyclable) imported from Germany to bag pellets rose from €0.12 per sack to €0.32 per sack (270% increase).*

In this scenario, energy production has suffered a drastic drop in profitability, fortunately offset by the production of pellets, whose process is made particularly efficient for the following reasons:

- *they source raw materials locally and target the local market. This results in considerable savings on transport and distribution costs;*
- *all the process heat needed to produce the pellets is obtained at zero cost, because it is recovered from the thermal waste of the biomass power plant;*
- *25% of the electricity consumption incurred in the pelletising process is met by the recently installed solar panels. In the coming years, Fiusis plans to install an additional 250 kW of photovoltaics to cover all the needs of the plant.*

For these reasons, Fiusis can afford to keep the price of pellets at €8 per bag (15 kg), well below a national average of €12 to €16 per bag. Today, as a result of these choices, demand for Fiusis pellets has increased by 2,000% and production has risen rapidly from 600 t/year marketed in 2020 to 1,500 t in 2021. The plan is to further expand capacity to 6,000 t/year in the short term.

In conclusion, Fiusis's policy based on local resources, technological innovation, energy cogeneration (electric and thermal) and the integration of renewable sources (biomass and solar) has ensured great resilience and vitality in a period of severe crisis for many companies with little inclination to innovate.

Matteo Monni