D3.3 uP_running demonstration case studies analysis

uP_running

Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal

Prepared by: CIRCE

Date: 27/07/2018

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 691748.

DELIVERABLE FACTSHEET

Document Name:	D3.3 uP_running demonstration case studies analysis
Responsible Partner:	CIRCE
WP:	WP3
Task:	Tasks 3.2, 3.3 and 3.4
Deliverable nº:	D3.3
Version:	1
Version Date:	17/04/2019

Dissemination level	
X	PU = Public
	PP = Restricted to other programme participants (including the EC)
	RE = Restricted to a group specified by the consortium (including the EC)
	CO = Confidential, only for members of the consortium (including the EC)

Approvals

	Company
Author/s	CIRCE
	CERTH
	UFG
	SECB
Reviewer	CERTH
Task Leader	CIRCE
WP Leader	CIRCE

DISCLAIMER OF WARRANTIES

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 691748"
"This document reflects only the author´s view and INEA is not responsible for any use that may be made of the information it contains".

This document has been prepared by uP_running project partners as an account of work carried out within the framework of the EC-GA contract no 691748.

Neither Project Coordinator, nor any signatory party of uP_running Project Consortium Agreement, nor any person acting on behalf of any of them:

(a) makes any warranty or representation whatsoever, express or implied,
  (i). with respect to the use of any information, apparatus, method, process, or similar item disclosed in this document, including merchantability and fitness for a particular purpose, or
  (ii). that such use does not infringe on or interfere with privately owned rights, including any party's intellectual property, or
  (iii). that this document is suitable to any particular user's circumstance; or

(b) assumes responsibility for any damages or other liability whatsoever (including any consequential damages, even if Project Coordinator or any representative of a signatory party of the uP_running Project Consortium Agreement, has been advised of the possibility of such damages) resulting from your selection or use of this document or any information, apparatus, method, process, or similar item disclosed in this document.

ABBREVIATIONS

APPR	Agrarian Pruning and Plantation Removal
GHG	Greenhouse Gases
LHV	Low Heating Value
PrMov	Prime Mover
SOM	Soil Organic Matter
VC	Value Chain
VCA	Value Chain Actor

DEFINITIONS

APPR	Agricultural Pruning and Plantation Removal refers to agricultural woody residues produced as a result of agronomic operations applied to vineyards, olive groves, and fruit plantations.
APPR biomass value chain	The set of activities and stakeholders involved in the preparation and use of biomass products obtained out of APPR wood.
Chips	Chipped woody biomass in the form of pieces with a defined particle size produced by mechanical treatment with sharp tools such as knives.
DC Team	Demo Country team, referring to the tandem of an Agrarian Partner (AP) and a Technical Partner (TP) of a Demo Country.
Demo Country	There are four Demo Countries in uP_running project: Spain, Italy, Greece and Ukraine. Demo countries are referred as those countries where demonstrations activities took place.
Hog fuel	Wood that has pieces of varying size and shape, usually more inhomogeneous than wood chips. The main difference from wood chips is that hog fuel is produced by crushing with blunt tools such as rollers, hammers, or flails.
Prime Mover	A stakeholder who has a strong interest and willingness to start a new APPR biomass value chain. It is the main actor in the value chain, the actor who engages the others and who makes the things happen. It is generally the more active actor and usually, the stakeholder taking most of the risk when investing in the new value chain.

EXECUTIVE SUMMARY

In the so-called "Demo Countries" (Greece, Italy, Spain and Ukraine), uP_running partners have been accompanying 20 pioneering stakeholders in evaluating the feasibility of their APPR initiative and carrying out short demonstrations intended to reproduce the future value chains. The main purpose of these activities was to support the pioneers or "Prime Movers" (PrMov) in their decision-making prior starting a new APPR value chain.

The accompaniment mainly aimed at helping each PrMov to gain knowledge, to develop a deeper understanding of the business they are facing, to test at pilot scale the value chain they would like to start, and to obtain a series of items for the final decision-making. The 20 PrMov present a great variety of profiles, they involve diverse models to mobilize the APPR biomass and they need different types of supporting activities. Consequently, the accompaniment was tailored to each one of them. Notwithstanding, the uP_running partners followed a common methodology to carry out the activities and perform the demonstrations. This methodology is summarized in the present report.

According to the business model of each PrMov, successful demonstrations were carried out and involved the real actors that would take part of the future value chains. Out of the 20 planned demonstrations, only one could not be carried out, since the PrMov involved stopped abruptly the business initiative (despite the fact that a capital investment was done already) due to the lack of recognition of a feed-in-tariff by the National Electrical Authority. By analysing the demonstrations performed, some general remarks can be made for APPR value chains, which are summarized as follows:

- Most of the supported initiatives aim at using APPR biomass locally, i.e. mean geographical radius below 30 km.
- Most of the initiatives correspond to small- to medium-scale use for heating purposes, i.e. less than 2,000 tons per year.
- For single farmers or cooperatives with small and dispersed parcels, the investment capacity is limited, and the payback time for chippers/shredders that are utilised only a few days per year is high. In these cases, aggregation/collaboration is needed among the farmers to purchase and share the machine or, alternatively, sub-contracting to agrarian services companies can be done, depending on the availability of such companies in the area.
- From the perspective of the farmers, the business models proposed result in low to moderate cost savings in comparison to the actual pruning management.
- Economic estimations indicate that the logistic operations represent a large part of the APPR biomass cost. Unnecessary operations should be avoided, and the logistics should be optimized as the value chain evolves and grows.
- Shredding, resulting in hog fuel, in the most common method used to treat the APPR wood, in comparison to chipping or baling.
- During the operation of shredding or chipping, feeding the APPR wood is a slow and difficult step due to the shape, size and density of the branches. As consequence, the machines

obtain a much lower capacity and higher fuel consumption, in comparison to the operation with stem-based forestry wood.

- For harvesters with an integrated-shredder, it is crucial to agree the conditions of the pruning branches before harvesting, e.g. an appropriate period for ensuring the natural drying and an appropriate alignment within the rows. Also, arranging the branches in alternative rows may increase noticeably the collection performance and hence, reduce the logistics costs.
- Particle size distribution may vary considerably, and it is a key issue for ensuring that an APPR biomass can be handled by the end-users. A recommendation is to identify the consumers before selecting the logistics scheme and the harvesting machinery.
- APPR biomass can cover a wide range of application cases. Potential end-users have expressed interest in using APPR wood for production of agro-pellets and briquettes, for heating purposes (in farms, agro-industries, municipal buildings, etc.) and for electricity production (either CHP or power only).
- Compared to fossil fuels, APPR biomass is competitive and may offer several economic and environmental advantages. In areas where other solid biofuels are available at higher quality and lower prices, APPR biomass may not be directly competitive and would need supportive measures to take-off.
- Emphasis should be made on the intangible, non-economic benefits of APPR biomass utilization, e.g. decarbonisation, use of local energy sources, avoidance of pollution from open field burning, green image, etc., in any relevant initiative, to support the purely economic arguments.

TABLE OF CONTENTS

1 INTRODUCTION: UP_RUNNING DEMONSTRATIONS CASES

One of the most important activities implemented by uP_running for unlocking the strong potential of APPR biomass is the support offered to pioneering stakeholders in their decision-making prior starting a new APPR initiative. In spring 2017, a total of 20 beneficiaries were selected, 5 per demo country (DC: Greece, Italy, Spain and Ukraine). The selection was done by the project partners in each demo country following an open, public call for applications and according to a transparent process that considered a series of objective and subjective criteria, as well as some prerequisites (e.g., soil sustainability compatibility, beneficiary commitment).

The 20 beneficiaries present very diverse profiles: farmers, cooperatives, agro-industries, residues managers, service companies, city councils, etc. In addition, the size of their initiatives ranges from small self-consumption purposes (e.g., 60 t/y of APPR mobilized) to the establishment of complex supply chains where numerous actors are involved (>10,000 t/y of APPR mobilized).

Since several different stakeholders may participate in the 20 potential value chains, the name of "prime mover" (PrMov) is utilised to refer to the principal actor in the value chain (i.e., the beneficiary of uP_running support): either persons, companies or organisations that take the initiative and the corresponding risks and, therefore, the ones that need a specific support.

For that purpose, a tandem formed by one technical partner and one agrarian partner of the uP_running project worked actively in each demo country, from June 2017 to October 2018. The geographical scope of the demo activities and the name of demo partners are depicted in Figure 1.

Figure 1 Demo countries and their respective DC teams: ASAJA and CIRCE in Spain, DARe Puglia and UFG in Italy, INASO-PASEGES and CERTH in Greece and UCAB and SECB in Ukraine.

Thanks to their experience and knowledge, DC teams accompanied the PrMovs so they had, at the end of the accompaniment, a much clearer scope about the innovative business they want to start. From a general point of view, the accompaniment mainly aimed at helping them to gain knowledge, to make them understand better the business they are facing, to test at pilot scale the value chain they would like to start, and to obtain a series of items for the final decision making: "should I stay or should I go?" In other words, the output of the accompaniment corresponds to 20 PrMovs empowered to make a right decision: either proceeding with the initiative or stopping.

In the present report, the readers will find a summary of the methodology followed by DC teams to accompany the PrMovs (including the organization of demos), as well as a description of the 20 pioneering initiatives and the main results of the accompaniment. Finally, the template used to report both items (the initiatives and the demo results) is presented in section 4, i.e., the "demo factsheets". These factsheets allow a clear and concise description of the 20 demonstration cases, which can be found in Annexes.

2 METHODOLOGY FOLLOWED TO ACCOMPANY NEW APPR INITIATIVES

2.1 Business model prospection and selection

The main objective of this activity was to describe the fundamentals from which the PrMov's organization would create, develop and capture value, based on the APPR management and use for energy. To do so, the following activities were performed by the DC Team:

- A consistency check[1], in order to review a series of item that could be decisive for the feasibility of the business idea.
- An analysis of the Strengths, Weaknesses Opportunities, Threats (SWOT), so as to potentially detect external threats or opportunities, which were crucial for orientating the business model of the PrMov.
- A definition of the value chain operations and contacts with the potential actors of the proposed value chain. Numerous questions had to be solved, concerning the type of machinery, the most appropriate brand and model, the needs for O&M, the storage, etc. At the end, a simple diagram was depicted for the 20 supported initiatives (see Figure 2), in order to summarize the main operations foreseen, as well as their distribution among the different actors.
- A business model Canvas, to outline the business idea, as well as to clearly define the processes that PrMov has to carry out, the machinery and staff needed, the structure of costs, the incomes, etc.

[1] The consistency check used may be found in Annex V of the Consultancy Handbook: http://www.up-running.eu/wp-content/uploads/2018/07/uP_running_D4.2_Handbook_for_consultancy.pdf

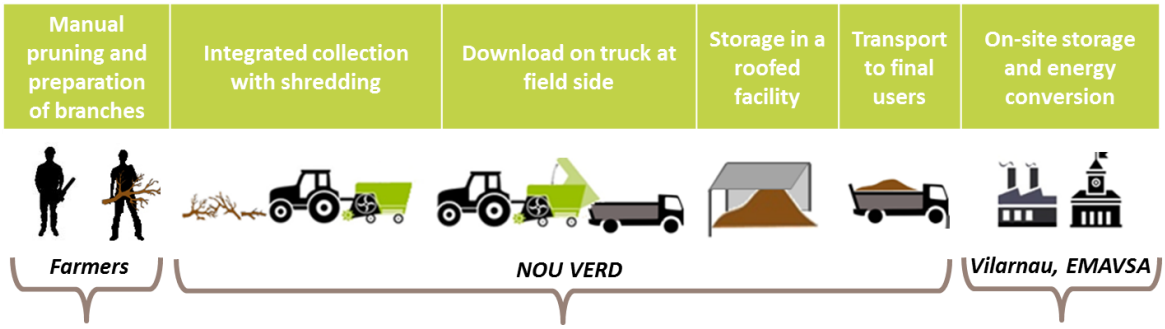


Figure 2 Example of value chain operations diagram (based on "Villafranca del Penedés" flagship case (1))

2.2 Field tests and validation of the APPR biomass produced

A practical manner to "test" the business idea that each PrMov had in mind was to perform a demonstration that reproduces at pilot scale the future APPR biomass value chain and involves the real actors that would take part. This was one of the core activities carried out by uP_running partners in the four demo countries, from November 2017 to October 2018.

The main objective was to obtain useful information for the PrMov decision-making. In some cases, these field tests were organized as "open demo" in order to additionally help the PrMov who were interested in promoting their initiative and attracting local stakeholders (e.g. to announce the pruning service they aim to launch).

Among others, below is a list of the typical items and data monitored during the field tests:

- Productivity of the APPR biomass: quantity of wood produced by hectare in vineyards, olive and fruit plantations, in tons per hectare. Measurements were performed according to the Observatory manual (2), see Figure 3.
- Machineries used to harvest and treat the APPR wood: performance (in tons per hour, or hectares per hour), losses, number of operators, fuel consumption, investment costs, etc.
- Transport: volume and weight of the trailer/truck, fuel consumption, easiness to load and unload the charge, etc.
- Processing: fuel/electricity consumption, consumables (bags, additives, etc.), investment costs, etc.
- Biomass produced: quantity of biomass harvested, format of the biomass produced, etc.
- Value chain actors: satisfaction of demo participants, capacity to adopt the new machinery or techniques, opinions for value chain improvement, etc.

Figure 3 Measurements during Demo 12 ("Casa Miquelas"): biomass productivity (left) and fuel consumption (right)

The last step of the demonstrations consisted in determining the quality of the biomass produced by each field test, as well as assessing the market value it may reach from the point of view of potential end-users. The first step was made by obtaining a representative sample of the material produced and analysing its thermo-chemical parameters according to international standards (see Figure 4). Technical partners carried out such analyses in their own laboratories (CERTH, UFG and SECB), or send a representative sample to an external laboratory (in the case of CIRCE).

	Parameter	EN	ISO	
"Basic" analysis	**Water content**	EN 14774	ISO 18134	"Complete" analysis
	Ash content	EN 14775	ISO 18122	
	Bulk density	EN 15103	ISO 17828	
	Size distribution	EN 15149	ISO 17827	
	C, H, N	EN 15104	ISO 16948	
	S, Cl	EN 15289	ISO 16994	
	Heating value	EN 14918	ISO 18125	

Figure 4 Standards for biomass characterization and recommended set of analyses for uP_running demos

Regarding the market value assessment, the objective of this activity was to identify who could consume the APPR biomass and what is actually its value, i.e., what would be the price that final consumers would pay for it. Typical information that was gathered from this activity are: Is the APPR biomass produced "appealing" for end-users? Is it necessary to improve some of its quality characteristics (size distribution, ash content, etc.)? Is the economic value expected by end-users aligned with the objectives of the APPR supplier? Moreover, in several cases, a combustion test was performed at the potential end-users' facilities, which allowed the partners to retrieve some crucial information concerning the operation with the new APPR biomass, e.g.: Were there any problems during the feeding and the combustion? Was the biomass quality adapted to combustion system needs?

2.3 Assessment of the initiative's sustainability

The final step of the PrMov accompaniment consisted in evaluating technically, economically and environmentally their proposed value chain, and in presenting them the results in a final report, in order to provide them all the necessary information for their decision-making. For that aim, three main items were analysed by technical partners:

- Soil conditions: in case the PrMov were APPR producers, partners followed a common methodology to check if the soil conditions allow removing the wood residues from pruning and uprooting operations or not. Particularly, it was of relevance to assess if the systematic withdrawal of residues from the orchard is susceptible to establish a declining trend in soil fertility, considering the content in soil organic matter. During the PrMov selection process, this soil condition was a pre-requisite, and all PrMovs selected were screened for this item and have at least "acceptable" conditions for pruning removal.
  The methodology was developed by UFG and it is detailed in the second uP_running monograph (3). Basically, the assessment of soil condition is performed according to four specific soil and environment criteria: the current soil organic matter, its texture, its slope, and the climatic conditions (according to the De Martonne Annual Aridity Index). A series of thresholds is established for each parameter and the average value of all marks (final score) set if the utilization of APPR wood for energy compatible with the soil fertility.
- GHG savings: in order to check the compliance with sustainability requirements set by the European Commission COM (2010)11 (4), GHG emissions emitted via each APPR value chain demonstrated were calculated, based on a tool developed by CERTH[2]. In particular, the tool allows calculating the equivalent CO_2 emissions for each step of the value chain, the CO_2 emissions per ton of APPR produced, and the corresponding savings of CO_2 compared to fossil fuel heating, cooling or electricity production (considering the typical values of "Fossil Fuel Comparators" set in the RED II Directive (5)).
- Economic feasibility: in order to evaluate the economic performance of each APPR value chain, the partners followed a common methodology, developed by CERTH and available on the project website[3]. The methodology allows calculating some indicators such as Net Present Value (NPV), Internal Rate of Return (IRR) and payback period for new investments. These calculations were performed from the point of view of each PrMov, but the methodology developed also allows evaluating the economic feasibility for the other actors that participate in the value chain.

[2] The guidelines and templates for sustainability assessment are available on the project website: http://www.up-running.eu/other-materials/
[3] The guidelines and templates for economic feasibility are available on the project website: http://www.up-running.eu/other-materials/

3 MAIN RESULTS FROM THE VALUE CHAINS DEMONSTRATED

Table 1 depict the typologies of PrMov accompanied and the main business models proposed. It may be seen that most of them are or are directly affiliated with APPR producers (in 12 cases) that either self-consume their APPR biomass or sell part of it to local end-users. This is specially the case for Greece, where the 5 PrMovs are agriculture cooperatives which are searching for alternative uses of their APPR wood. In the other Demo Countries, several PrMovs consist in consumers that create a demand, which activates the implementation of the value chain. Most of them not only consumes the biomass but also participate in the logistics operations. These final users may produce either heat, cold and/or electricity from the incoming APPR biomass. Finally, two additional PrMovs are neither the producer nor the consumer of the APPR biomass: they are external companies that offer services for APPR collection, treatment, storage or transport.

Table 1. Summary of the 20 PrMov accompanied and the type of value chain proposed

PrMov role	PrMov profile	Value chain model	Greece	Italy	Spain	Ukraine
SELF-CONSUMPTION	**Farmer**	Collects pruning from own or neighbour fields for self-consumption			**Demo12**	
	Agro-cooperative	Collaborative gathering of biomass and self-consumption in relevant facility	**Demo1** **Demo4**	**Demo8**	**Demo15**	
PrMov is an APPR PRODUCER that sells part of the wood	**Farmer**	Harvest own pruning residues and process to market as woodchips				**Demo18**
	Agro-cooperative / Fruit producer	Gathering of pruning in own fields for market (households, schools, greenhouses, etc.)	**Demo2** **Demo3**		**Demo14**	**Demo17** **Demo20**
	Agro-cooperative	Alliance with a pellet producer to produce agri-pellets	**Demo5**			
PrMov OFFERS SERVICES to harvest, treat & market biomass	**Agro-service company**	Provide service of pruning harvest, store and transform biomass to sell to final consumers		**Demo6**		
	Residues manager	Provides service for plantation removals. Establishes a biomass logistic centre in its facilities			**Demo11** (any crop)	
PrMov is a FINAL CONSUMER	**Agrarian consumer**	Buys the APPR to produce heat for drying agriculture products. Also produces electricity and sells to the grid.		**Demo7**		

	Industrial consumer	Creates an important demand, organizes the supply chain and contracts with the intermediaries		**Demo9** **Demo10**		
	Public authority (consumer)	Creates initial demand and promotes local dialogue to establish an initial APPR use in public buildings			**Demo13**	**Demo16** **Demo19**

The facts described above are illustrated in a different way through **¡Error! No se encuentra el origen de la referencia.**, which underlies the main type of PrMov organizations and intended end-use of the APPR wood.

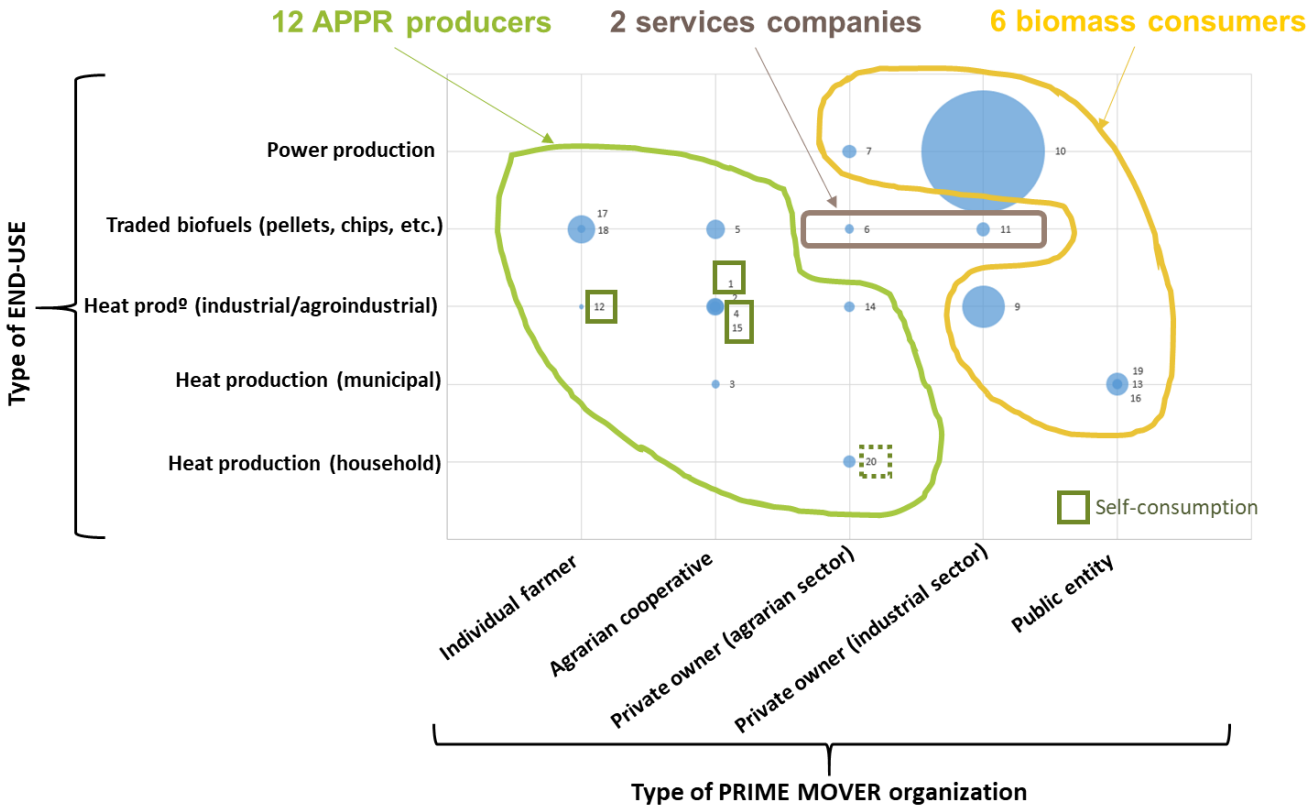


Figure 5 Classification of uP_running demonstrations according to the type of PrMov organization (x-axis), the type of end-use (y-axis) and the size of the initiative in tons per year (bubble size)

Finally, Table 2 gives additional details about the technical aspects of the future value chains, which may be useful for the readers to better understand the demonstrations carried out and the results depicted in the respective "factsheets". As can be seen, the uP_running demonstrations involved a great diversity of actors, exploitation sizes, value chain organisations, and business models.

Table 2. Summary of the 20 APPR value chains demonstrated

Demo Nº	Greece					Italy					Spain					Ukraine				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Intended end-users																				
Heat production (household scale)																				X
Heat production (municipal)			X										X			X			X	
Heat production (agro-industrial)	X	X		X					X			X		X	X					
Traded biomass (pellets, chips, etc.)					X	X					X						X	X		
Power production							X	X		X										
Type of crops involved																				
Olive groves	X		X	X	X	X	X		X	X			X							
Vineyards		X	X		X		X	X	X						X				X	
Fruit orchards				X							X	X		X		X	X	X		X
Origin of the wood																				
Pruning (annual, maintenance, etc.)	X	X	X	X	X	X	X	X	X	X			X	X	X	X		X	X	X
Graft pruning												X								
Plantation removal											X		X				X			
Format of the biomass produced																				
Chips	X	X										X				X				X
Hog fuel			X	X	X[4]		X	X	X	X	X		X	X	X			X		
Pellet						X											X			
Briquette																			X	
Type of machine(s) used in the demos																				
Manually-fed chipper/shredder	X	X	X									X				X	X	X		X
Integrated shredder with big bags						X			X											
Integrated shredder with container				X	X			X		X			X	X						
Large mulcher/shredder							X				X				X					
Pellet/briquette plant																	X		X	
Intended size of the initiative																				
< 500 t/y		X	X			X						X	X		X			X	X	
500 - 2,000 t/y	X			X	X		X				X			X		X				X
> 2,000 t/y									X	X							X			

[4] The intend of the future value chain is to produce an agro-pellet, but it was not possible to have it during the uP_running demonstrations.

In total, 19 demonstrations were performed, involving more than 50 stakeholders and producing more than 130 tons of APPR biomass. One demo could not be carried out in Italy with the PrMov 8 "Cantina Apulia" due to a drastic change in the feed-in-tariff for power generation, which made the business plan no longer valid.

In most of the cases (11 of 19 demos), the **final APPR product was in form of a hog fuel** obtained either by a manually fed shredder, a harvester with integrated-shredder or a large static shredder. For the other cases, more regular chips were obtained by manually fed chippers in 5 demos, two different types of "agro-pellets" were produced in Ukraine and in Italy, and one briquette in Ukraine. Concerning the machinery performance, it may be underlined that it not only depends on the equipment technology but, very frequently, on the shape and size of the branches, which affect strongly the feeding capacity.

As regards the selection of the harvesting technology, it seems that **integrated shredders are an interesting option**, offering different variations (at rear or at front, with big bags or containers, etc.) and avoiding hauling branches (with the corresponding soil incorporation). Notwithstanding, although several models are developed for olive groves, they need to be adapted for the narrower planting patterns of fruit orchards and vineyards. Moreover, the well-preparedness of pruning arrangement on the field through manual or mechanical windrowing had a critical influence on the harvesting capacity and the losses.

From the viewpoint of economic feasibility of the demonstrated value chains, it has been seen that the **cost of APPR biomass at gate varies greatly depending on the logistic scheme and machineries used, the APPR productivity and many other factors** (transports, operator's costs, investment degree, etc.). In general, economic margins are tight and, in most regions, APPR biomass directly competes with other biomass of good quality and relatively low price (30-70 €/t), e.g. sawdust, almond shells, forestry wood chips. The fuel analysis and the assessment of their market value showed that a common issue for APPR product is related to the **particle size distribution**, which strongly limit the use of this fuel in existing biomass installations. Most of the demos stressed out the **absolute necessity of starting a value chain with end-users in mind** and examining in detail their capacity to handle APPR biomass. In that sense, efforts are still needed to increase the awareness of potential consumers, to adapt the combustion technologies and to train the operators and technicians in charge of APPR biomass handling and use. On the other hand, the most usual forms of APPR biomass (hog fuel and chips) are not standardized and cannot be sent to the market as a commodity. Moisture and ash content of the APPR product can also be an issue; the former can be controlled via longer on-field drying; however, this practice has to be approved by the farmers. Higher ash content is an intrinsic feature for annual prunings; it cannot be reduced below a certain point; however, good practices should be employed to avoid intrusion of soil and other contaminations in the APPR biomass.

As regards the business models involved in the demos, the **vast majority is based on a local use of the APPR biomass**, with a geographical radius lower than 30 km, and on relatively small- to medium-scale use for heating purposes, i.e. less than 2,000 tons per year. Some exceptions are found for Italian's Demo 9 and Demo 10, as well as for Ukrainian Demo 17. This fact is in line with the existing cases registered in the Observatory (6).

From the 20 PrMov accompanied, two main typologies of APPR producers have been identified. The first category are single farmers or companies that own a large surface of permanent crops, i.e., more than 300 ha. They usually have the tractors, shredders and trucks needed for most of the logistics operations. This is the case of Ukrainian Demos 17, 18 and 20, as well as Spanish Demo 14. Nonetheless, most of the APPR producers use to be single farmers or cooperatives with small and dispersed parcels that are difficult to access with trailers and heavy machines. In this case, APPR wood is in hand of multiple owners, which makes the logistics more difficult and the capacity of investment more limited. For these reasons, the presence of agro-services companies in these areas and their capacity for managing APPR biomass use to be crucial in order to set-up the value chain. Alternatively, the aggregation/collaboration among several primary producers to purchase the machinery can be also a solution.

Concerning the GHG emissions in comparison to fossil fuels, the savings are high, i.e., between 81 and 97 %, which means that **thousands of tons of CO_2 equivalent emissions may be saved yearly thanks to APPR mobilization**. If expressed per unit of heat produced, the value chains based on pruning and plantation removal biomass produce between 2 and 7 g CO_2/MJ. This is more than ten times lower compared to GHG emissions generated by fossil fuels (set to 80 g CO_2/MJ by the RED II proposal).

Finally, it is important to stress out the **crucial role that public authorities** may have on the development of such initiatives. Firstly, being consumers of the local APPR biomass they create a new demand and activate a new value chains; this is the case of Demo 13, 16 and 19 which are respectively promoted by the city councils of Calanda (Spain), Vinnytsia and Bolgrad (Ukraine). These models may be especially interesting in rural areas with high density of permanent crops, since they allow creating jobs, avoiding emissions from open burning, greening the municipal buildings and, more generally, developing the circular BIOeconomy of the region. On the other hand, interesting synergies with municipal authorities can also materialize regarding joint management of green urban wastes and agricultural prunings (e.g. shared machinery and open storage locations).

4 STRUCTURE OF THE DEMO FACTSHEET

Each supported initiative is described in detail in the annexes of this report, i.e., the “demo factsheets”. Figure 6 shows the template used to illustrate the main results of the 20 value chains demonstrated. It includes six main parts:

1. Title of the initiative and logo of the PrMov organization.
2. General information of the PrMov and its initiative: name, location, type of APPR wood, target amount to mobilize (in tons per year), business model of the initiative, the sourcing radius and, finally, the potential GHG savings (in tons of CO_2 equivalent per year).
3. Business idea, including a brief description of the goal of the initiative, the previous experience of the PrMov, and the main activities included in the new value chain.
4. A diagram of the value chain operations and the actors involved in each step.
5. Results of the demonstrations performed:

- Productivity of the APPR (t/ha)
- Model and brand of the machinery used during the demo
- Performance of such machine (t/h)
- Analysis of the APPR biomass produced in terms of LHV, moisture and ash contents, particle size and bulk density.

6. Main outcomes and lessons learnt, which can be useful for replication of new APPR initiatives.

Figure 6 Template used for the "demo factsheets"

5 CONCLUSIONS

The present document has reported the pioneering initiatives supported by Demo Partners in Greece, Italy, Spain and Ukraine to develop new value chains based on agro-biomass from pruning and plantation removal. New business models were prospected, field tests and biomass product validation were carried out and the sustainability of the initiatives were assessed from the techno-economic and environmental points of view. At the end, a large quantity of information was transferred to the Prime Movers of these future value chains, in order to support their decision-making and orientate their business.

From the 20 PrMov accompanied, one per Demo Country was selected to receive further support from the project towards implementing the value chain proposed. This is the case for the Union of Agrinio agricultural cooperative in Greece (Demo 4), the Agritoppi company in Italy (Demo 6), the city council of Calanda in Spain (Demo 13) and the Triada MK company in Ukraine (Demo 17). It is worth noting that, at the time writing this document, the value chains in Italy and Ukraine are already implemented in a commercial basis, having sign supply contracts with local end-users. In next future, a detailed description of their activities will be given in the public deliverable D3.4 "Handbook of the new uP_running success cases".

From a global overview, the uP_runing demonstration cases have allowed to testify that APPR wood to energy is techno-economically and environmentally feasible. Despite the barriers that still slow down the APPR sector development (see more details in (7)), and the huge efforts needed to implement new value chains, the initiatives reported in this document stress out that APPR use to energy may bring numerous benefits to stakeholders from both the agriculture and the energy sectors (new business lines, new incomes, time savings, wider biomass sourcing, etc.), for the environment (avoid open burning, shift from fossil fuels, etc.) and for the society in general, as they are in line with several European strategies (circular economy, bioeconomy, renewable energies and rural development).

Thanks to the uP_running demonstrations, partners have also created an important knowledge basis, which is aimed to be transferred to future consultants on APPR biomass. Training materials have been elaborated, as well as a Consultancy Handbook, being both available on the web page of the project.

Finally, it is interesting to stress out that a video was recorded in each Demo Country and is available on the YouTube Channel of the project (8). Each video is available in eight languages: Croatian, English, French, Greek, Italian, Portuguese, Spanish and Ukrainian.

6 REFERENCES

1. **uP_running project.** *D6.3 Flagship success cases update v1.* 2017. http://www.up-running.eu/wp-content/uploads/2017/10/uP_running_D6.3-Flagship-cases-report-v1_.pdf.
2. —. *Manual for field measurements on APPR biomass productivity.* 2016. http://www.up-running-observatory.eu/file_uploads/8_en_uP_running_guidelines_for_field_sampling_EN.pdf.

3. —. *Management of pruning residues in a tree crop plantation: gaining a positive trade-off between soil fertility and bioenergy conversion.* s.l. : Second Monograph, 2019.
4. **Report from the commission to the council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling.** *COM/2010/11.*
5. **European Parliament legislative resolution of 13 November 2018 on the proposal for a directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast).** *COM(2016)0767 – C8-0500/2016 – 2016/0382(COD).* 2017.
6. **uP_running project.** *Observatory map of biomass from agrarian pruning and plantation removal.* 2019. http://www.up-running-observatory.eu/en/.
7. —. *Sector analysis and Strategic Plan at national and EU levels.* 2017. http://www.up-running.eu/wp-content/uploads/2016/10/D2.2_Sector-Analysis-and-Strategic-Plan-at-national-and-EU-levels_compressed.pdf.
8. **uP_running YouTube channel.** *https://www.youtube.com/channel/UCJzK-hvD14V7d1OgU1qSIpw.*
9. **EuroPruning FP7 project.** *Development and implementation of a new, and non existent, logistics chain for biomass from pruning.* https://cordis.europa.eu/project/rcn/105073/factsheet/en.

7 ACKNOWLEDGEMENTS

The uP_running partners would like to warmly acknowledge the 20 prime movers who have strongly collaborated during these project activities. Special thanks are extended to all the other actors involved during the field tests and biomass validation: famers, cooperatives, operators, machinery manufacturers, ESCOs, local authorities, etc.

ANNEXES

Next are included the 20 factsheets of the accompanied initiatives. A table is also included below in order to summarize the PrMov name, title of the factsheet, as well as the business model on which the initiative is based on.

Nº	Name of the PrMov	Factsheet Title	Business model
1	EAS Lakonias	SELF-CONSUMPTION OF OLIVE TREE PRUNING AT THE COOPERATIVE POMACE MILL	Self-consumption at an agrarian cooperative facility
2	VAENI Naousa	COOPERATIVE HARVESTING OF VINEYARD PRUNING CHIPS FOR HEATING LOCAL GREENHOUSES	Heating in agro-industries with pruning from an agrarian cooperative
3	AOS Koropiou	COOPERATION BETWEEN AN AGRARIAN COOPERATIVE AND THE MUNICIPALITY FOR A NEW PRUNING MANAGEMENT	Heating in municipal buildings with pruning from an agrarian cooperative
4	Agrinio Union	SELF-CONSUMPTION OF PRUNINGS AT THE COOPERATIVE FORAGE DRYING FACILITY	Self-consumption at an agrarian cooperative facility
5	Aichmeas Cooperative	PELLET PRODUCTION FROM OLIVE TREE PRUNING HARVESTED THROUGH A COOPERATIVE SCHEME	Agro-pellet production for heating in local agro-industries

6	Agritoppi srl	PRODUCTION OF AGRO-PELLETS FROM OLIVE TREE PRUNING	Agro-pellet production for heating in local agro-industries
7	Schiraldi	SMALL-SCALE CHP AT AN AGRO-INDUSTRY FACILITY	Combined heat and power production in agriculture sector
8	Cantina Apulia	SMALL-SCALE CHP AT A SOCIAL WINERY	Combined heat and power production in agriculture sector
9	Tersan	ENERGY, BUT NOT ONLY, FROM OLIVE AND VINEYARD PRUNING	Use of pruning for energy, biofilter and structural matter in a composting plant
10	AgriTRE	A POWER PLANT SUPPLIED BY CEREAL STRAWS FINDS A COMPLEMENTARY BIOMASS FEEDSTOCK	Power production partly based on olive pruning biomass
11	GRUYSER/Ecoadeso	FROM PLANTATION REMOVAL OF FRUIT TREES TO INDUSTRIAL BIOMASS	Plantation removal services to farmers and logistic centre to produce industrial hog fuel
12	Casa Miquelás	SELF-CONSUMPTION OF GRAFT PRUNING IN A QUAILS FARM	Self-consumption at agrarian facility (quail's farm heating)
13	Ayuntamiento de Calanda	PRUNING-TO-HEATING IN MUNICIPAL BUILDINGS	Heating in municipal buildings with pruning from local farmers
14	Frutas Aqua/Dallar Energía	ALLIANCE BETWEEN A FRUIT PRODUCER AND AN ESCO FOR HEATING IN LOCAL FACILITIES	Heating in local facilities with pruning from a fruit producer
15	Cooperativa SJB	SELF-CONSUMPTION OF PRUNING AT THE WINERY	Self-consumption at an agrarian cooperative facility
16	Vinnytsia regional administration	A LOCAL AUTHORITY PROMOTES PRUNING BIOMASS TO SUBSTITUTE FOSSIL FUELS	Heating in municipal buildings with pruning from local farmers
17	Triada-MK	FRUIT TREES PELLET PRODUCTION FOR LOCAL HEAT USERS	Agro-pellet production for heating in local industries and buildings
18	Novooleksandrivske	HOG FUEL FROM APPLE PRUNING USED AT LOCAL HEATING FACILITIES	Heating in local facilities with pruning from an individual farmer
19	Bolgrad city council	SOCIAL FACILITIES HEATED BY VINEYARD BRIQUETTES	Heating in municipal buildings with vineyard briquettes
20	Black Sea fruit company	A FRUIT PRODUCER CONSUMES PART OF ITS PRUNING AND SELLS THE REST TO LOCAL USERS	Self-consumption at fruit company offices and selling to local heating facilities

SELF-CONSUMPTION OF OLIVE TREE PRUNING AT THE COOPERATIVE POMACE

Demo 1

Name: EAS Lakonias

Location: Sparti (Greece)

APPR type: chips from olive tree pruning (biennial)

Target amount to mobilize: 1,000 t/y

Business model: self-consumption at an agrarian cooperative facility

Sourcing radius: below 15 km

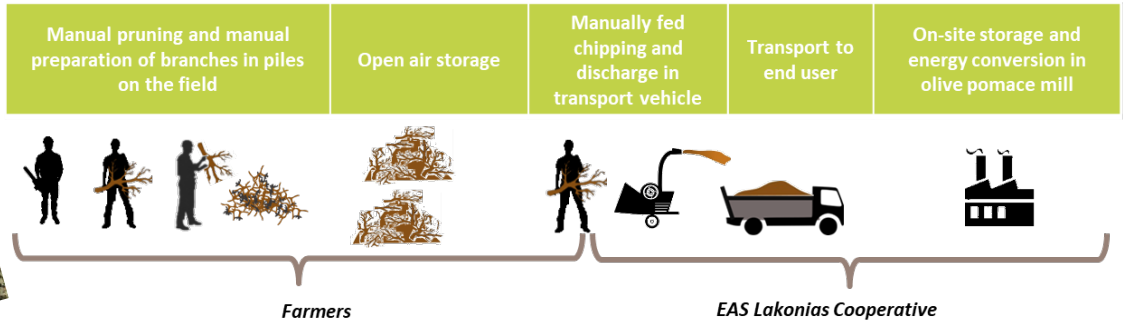
Potential GHG savings: 840 $t_{CO2,eq}$/y

Business idea

EAS Lakonias was founded in 1940 as a second-level co-operative organization, representing the primary agricultural cooperatives in Lakonia, a major center of olive oil production in Greece, with over 95,000 ha of olive groves. Apart from working directly or indirectly with more than 16,000 farmers for the olive oil value chain, EAS Lakonias is the owner and operator of a local olive pomace mill facility, from which it produces biomass (exhausted olive cake) as a fuel for the market. The pomace mill is also self-consuming this olive cake for the drying of the incoming wet olive cake.

The main aim of the value chain is related to the partial substitution of olive cake as fuel at the pomace mill, leaving more material available for the existing market. Despite the huge pruning potential of the area, the business model is structured at first with the aim to produce 1,000 tons of olive tree prunings per year, since the pruning management operations are new to the cooperative. The proposed management system is primarily based on EAS Lakonias, which is expected to play the key role in most stages of the supply chain. External end-users of the chipped olive tree prunings can also be identified in later stages.

Value chain operations



Main results of the demonstration

Date: April 2018

- APPR productivity: 1.6 t/ha (at 26.5 % moisture)
- Machinery used: manually-fed chipper YAMAchipper VR35-PTO
- Performance: 0.7 t/h, with two operators
- Gasoil consumption: 3.8 L/h

Biomass characteristics (olive tree pruning chips)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18.4	12.9	26.5	5.4	P31S	190

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- Using a manually-fed shredder for harvesting increases the operational costs due to the manual work. On the other hand, such systems are low-cost machines and can be quite versatile, since even if a pruning-to-energy value chain does not materialize, the chipped material can be left on the soil.
- Chipping of fresh prunings is feasible, but this leads to a high content of leaves, which in turn decreases the fuel quality.
- The main bottlenecks for permanent utilization are partly economic and partly technical; exhausted olive cake is already available on site, has a low price and high heating value and homogeneous particle size. Olive tree pruning chips have a higher cost and are more inhomogeneous, thus more difficult to be absorbed by external end-users.
- However, since the pruning chips were successfully combusted at the pomace mill facility, there is a possibility of technically implementing this chain especially in years when olive oil, and hence exhausted olive cake, production is low.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

COOPERATIVE HARVESTING OF VINEYARD PRUNING CHIPS FOR HEATING LOCAL GREENHOUSES

Demo 2

Name: VAENI Naoussa

Location: Naousa (Greece)

APPR type: chips from vineyards pruning

Target amount to mobilize: 400 t/y

Business model: heating in agro-industries with pruning from an agrarian cooperative

Sourcing radius: 25 km

Potential GHG savings: 274 $t_{CO2,eq}$/y

Business idea

The agricultural cooperative "VAENI Naoussa" was founded in 1983 by 330 wine producers. Nowadays, it represents about 50 % of the wine production in the Naousa PDO region, which includes approximately 700 ha of vineyards. In order to find an alternative for the pruning the cooperative is exploring the possibility to treat the branches and sell them as biomass for potential end-users in the area. The management system is primarily based on VAENI cooperative, which is expected to play the key role in most stages of the supply chain.

A potential local market for pruning fuels are greenhouses, since they already combust different types of solid biofuels (wood pellets, sunflower pellets, sawdust, olive cake, etc.) due to the cost savings that can be achieved over fossil fuels. The objective of the VAENI initiative is to implement a simple logistics chain, capable of producing a solid biofuel with such granulometry that it can be exploited directly by final consumers without further pre-processing.

Value chain operations

Main results of the demonstration **Date:** March 2018

- APPR productivity: 2.3 t/ha (at 36.2 % moisture)
- Machinery used: manually-fed chipper (Husmann H 5)
- Performance: 1.15 t/h
- Gasoil consumption: 4 L/h

Biomass characteristics (vineyard pruning chips)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
10.4	17.7	36.2	4.7	P16S	330

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The technical implementation of the proposed value chain is fully feasible.
- The chipper, supplied for the demonstration by the local municipality, has a very satisfactory performance, which greatly reduced the costs and time of the overall value chain.
- The quality of the biomass produced was generally acceptable, although some improvements (e.g. on-field drying) are needed to reduce the moisture content.
- The biomass was successfully combusted at the facilities of an intended local end-user (Andreou Greenhouses), which has two fixed grate biomass boilers (930 kW_{th} and 1.7 MW_{th}).
- The main issue for establishing a business case is economics: the main biomass fuel used by the potential end-users (sawdust) is currently available at a very competitive price (30 €/t) and better fuel properties (lower ash and moisture content).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

COOPERATION BETWEEN AN AGRARIAN COOPERATIVE AND THE MUNICIPALITY FOR A NEW PRUNING MANAGEMENT

Demo 3

Name: AOS Koropiou

Location: Koropi/Attica (Greece)

APPR type: hog fuel from olive and vineyard pruning

Target amount to mobilize: 225 t/y

Business model: heating in municipal buildings with pruning from an agrarian cooperative

Sourcing radius: 20 km

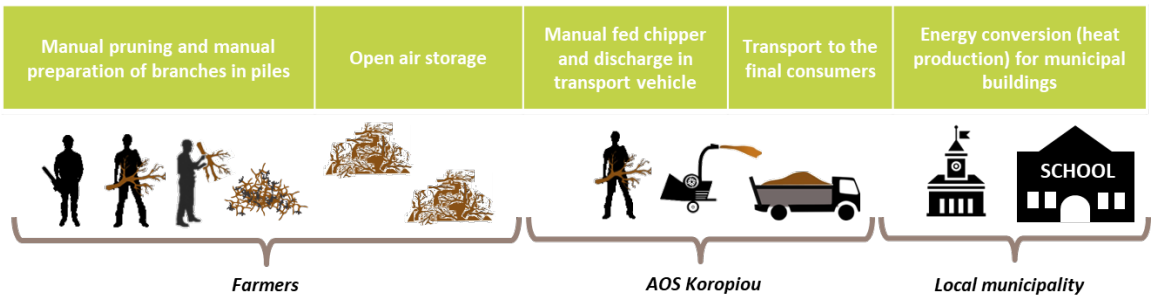
Potential GHG savings: 216 $t_{CO2,eq}$/y

Business idea

AOS Koropiou is an agriculture cooperative in Attica that has access, through its members, to 300 ha of vineyards and 250 ha of olive groves. The cooperative is motivated by the idea that the open-field burning of pruning is a waste and that the biomass should be utilized as an alternative heating source. Unfortunately, local capacities for absorbing APPR biomass are practically non-existent. However, the cooperative is proposing a strategic cooperation with the local municipality, where biomass harvested from prunings could be used as a fuel in municipal buildings, such as schools.

The management system is based primarily on AOS Koropiou, in cooperation with local authorities. After the pruning, farmers can contact the cooperative, which in turn brings to the field chippers for processing the prunings. AOS Koropiou can then supply the shredded fuel to local buildings that have installed suitable biomass heating systems.

Value chain operations



Main results of the demonstration (with olive tree prunings) **Date:** May 2018

- APPR productivity: 1.48 t/ha (at 10.6 % moisture)
- Machinery used: manually-fed chipper (Bugnot BVE8)
- Performance: 0.27 t/h
- Gasoil consumption: 4 L/h

Biomass characteristics (olive tree prunings)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
15.4	17.5	10.6	3.7	P45S	280

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- Due to the manual operations involved, the pruning biomass cost increases. However, as the availability of other biomass sources is limited in the area, APPR biomass could be attractive for end-users as an alternative to fossil fuels.
- Interesting synergies with municipal authorities can materialize regarding joint management of green urban wastes and agricultural prunings (e.g. shared machinery and open storage locations).
- Despite the negative impact on fuel cost, manually fed chippers can be interesting for farmers, since they are low cost systems and quite versatile: even if end-user for energy purposes is not available, shredded material can still be left on the field as organic fertilizer.
- Long field storage of the pruning piles (in this case, almost one year for olive tree prunings) results in an almost complete loss of leaves and reduction of the ash content.
- Appropriate selection of a biomass heating system is necessary in order to be able to feed hog fuel prunings without issues.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

SELF-CONSUMPTION OF PRUNINGS AT THE COOPERATIVE FORAGE DRYING FACILITY

Demo 4

Name: Agrinio Union

Location: Agrinio (Greece)

APPR type: hog fuel from kiwi pruning

Target amount to mobilize: 900 t/y

Business model: self-consumption at an agrarian cooperative facility

Sourcing radius: 35 km

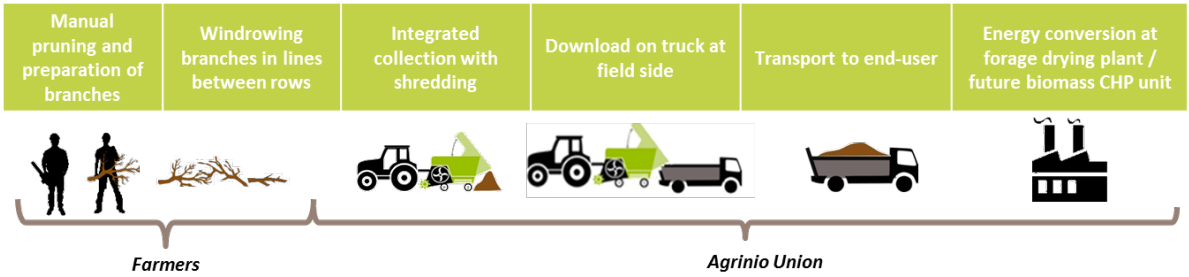
Potential GHG savings: 375 $t_{CO2,eq}$/y

Business idea

Agrinio Union is one of the largest and more robust agricultural cooperatives in Greece with an extended portfolio of operations. Among others, the cooperative operates a forage drying facility; currently, the fuel for the drier is exhausted olive cake. The cooperative is interested in substituting part of this fuel with APPR biomass from annual prunings, while simultaneously providing an alternative to open-field burning. At first, value chain is foreseen to be based on kiwi prunings, since there are a few concentrated and fairly large fields capable of producing meaningful quantities of APPR biomass (around 900 t/y). In the long run, Agrinio Union is also interested in investing in a CHP plant coupled with the forage drying unit, meaning that the value chain would need to be extended to more types of local biomass, including olive tree prunings.

The proposed business model foresees that after farmers prune their trees and prepare their branches, Agrinio Union will undertake all the remaining steps of the value chain: harvesting, transportation, storage and final energy conversion. Integrated harvesting / shredding is foreseen in this value chain considering cost reduction as well as the potential future scale-up of the value chain.

Value chain operations



Main results of the demonstration

Date: March 2018

- APPR productivity: 11.4 t/ha (at 55.1 % moisture)
- Machinery used: integrated shredder FACMA COMBY TR200
- Performance: 5.48 t/h
- Gasoil consumption: 20 L/h

Biomass characteristics (shredded kiwi pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
6.5	17.5	55.1	4.2	P16	200

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The use of an integrated harvesting / shredding system and the high APPR biomass productivity from kiwi plantations resulted in the lowest biomass cost of all Greek cases.
- Notwithstanding, the high moisture content of the kiwi prunings during harvesting resulted in the quick degradation of the material, which had to be discharged in a specific area in order to dry, before combustion could take place.
- Dryer fuel could be expected from harvesting of olive tree prunings, which represent an even higher local biomass potential. However alternative harvesting systems may have to be considered, since the morphology of several local fields could pose difficulties in the use of the demonstrated harvesting system.
- Initial results are very promising for the eventual aim of Agrinio Union to develop a biomass CHP plant fueled by local agrobiomass resources.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

PELLET PRODUCTION FROM OLIVE TREE PRUNING HARVESTED THROUGH A COOPERATIVE SCHEME

Demo 5

Name: Aichmeas cooperative

Location: Livadeia (Greece)

APPR type: pellet from olive tree pruning

Target amount to mobilize: 1,200 t/y

Business model: agro-pellet production for heating in local agro-industries

Sourcing radius: 25 km

Potential GHG savings: 933 $t_{CO2,eq}$/y

Business idea

The proposed value chain concept considered for the Aichmeas Cooperative is based on utilizing the synergies offered by the presence of a local pellet mill. The cooperative develops an APPR biomass harvesting service (based on olive tree prunings) and delivers hog fuel to the pellet plant where it is homogenized and upgraded into pellets. The Cooperative is disconnected from the final utilization and relies upon the pellet plant to identify suitable end-users, typically semi-industrial or industrial combustion facilities and greenhouses.

The sizing of the value chain depends mostly on the ability of the pellet plant to market olive tree pruning pellets; for the evaluation of the value chain, it has been considered that approximately 1,200 tons of olive tree prunings (wet biomass) are delivered to the pellet plant per year; considering that the prunings will also be used as fuel for the pellet plant dryer, the final output of the value chain could be around 700 tons of olive tree pruning pellets (< 10 % moisture content) per year.

Value chain operations

Main results of the demonstration **Date:** March 2018

- APPR productivity: 2 t/ha (at 19.9 % moisture)
- Machinery used: integrated shredder FACMA COMBY TR200
- Performance: 3 t/h
- Gasoil consumption: 60 L/h

Biomass characteristics (agro-pellet from olive tree pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
14.0	18.1	19.9	4.3	P31S	210

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The long distance between the trees allowed the harvesting system to operate fast and effortlessly; however, it had a negative impact on the biomass productivity per hectare.
- Increased storage of the branches on the field is expected to have a positive impact on the fuel properties, e.g. reduction of ash content due to lower amount of leaves.
- Olive tree prunings delivered at the pellet plant would have a higher price and worst fuel characteristics than the main feedstock for wood pellet production (sawdust). Market prices for olive tree pruning pellets are expected to be lower than the standard wood pellet ones, so the profit margin of the pellet plant is tighter. Identification of suitable end-users for these "agropellets" is also difficult.
- In this case, the immediate plans of the cooperative have been stopped due a fire that damaged the local pellet plant. However, further research on olive tree pruning pellets production and market development is carried out by the European H2020 project AGROinLOG (http://agroinlog-h2020.eu).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

PRODUCTION OF AGRO-PELLETS FROM OLIVE TREE PRUNING

Demo 6

Name: Agritoppi-Baselice

Location: Lucera (Italy)

APPR type: pellet from olive tree pruning

Target amount to mobilize: 300 t/y

Business model: agro-pellet production for heating in local agro-industries

Sourcing radius: 30 km

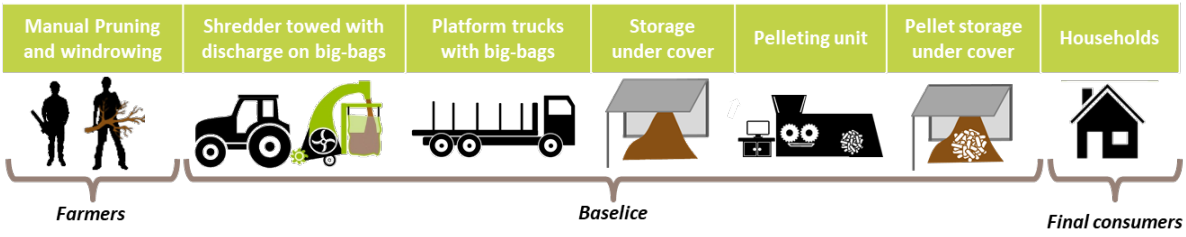
Potential GHG savings: 295.7 $t_{CO2,eq}$/y

Business idea

Baselice is a family leading a farm that offers agro-mechanical services in the Tavoliere Plain (Foggia Province). Through cultivation contracts signed by farmers, Baselice provides a wide range of specialized mechanical operations on both herbaceous and permanent crops. Among these operations, a new kind of service was recently activated: a service of pruning shredding followed by the removal and collection of the same crop residues. In this way, a new branch of the farm was activated, named "Agritoppi".

The Agritoppi company manages the largest part of the value chain, from shredding of pruning and its collection up to its upgrading into agropellet. Generally, each farmer undertakes independently the tree pruning operation and the consequent pruning windrowing activity. If these conditions are satisfied, the Agritoppi work team simply performs pruning shredding and harvesting operations, usually for free (i.e. without payment from the farmer). If the Agritoppi work team also performs tree pruning and pruning windrowing, then a payment by the farmer is agreed, depending on the number of trees per hectare. At the end of the value chain, the users of the agropellet are householders (farmers themselves) or small agro-industrial companies operating with multi-fuel stoves or boilers.

Value chain operations



Main results of the demonstration **Date:** Feb 2018

- APPR productivity: 3.7 t/ha (at 28 % moisture)
- Machinery used: integrated shredder (Shredder Nobili TRP RT 175) + pelletizing equipment (Smartwood VBR 300)
- Performance of the harvester-shredder: 1.5 t/h
- Gasoil consumption of the harvester-shredder: 12 L/h

Biomass characteristics (agro-pellet from olive tree pruning)

LHV MJ/kg		**Moisture** % a.r.	**Ash** % d.b.	**Pellet diameter**	**Bulk density** *kg/m³, a.r.*
d.b.	a.r.				
19.7	18.2	6.9	3.0	D08	580

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The interest from potential end-users is very high due to the enlargement of biomass sourcing, being currently based on olive pits and pomace.
- Agritoppi is offering the pruning collecting service for free, but only if pruning branches are already disposed in windrows, in order to attract farmers availability, or at a fee of approximately 20-30 €/ha, depending on the tree plant density.
- The service activity is feasible and there is no need to force further the pruning harvesting and to increase the agro-pellet productivity.
- The big-bag solution facilitates an easy discharge in the middle of the row. However, it also entails collecting the big-bag from the plantation at a later stage than with the other systems. The cost of each single bag should be considered in this case.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 7

SMALL-SCALE CHP AT AN AGRO-INDUSTRY FACILITY

Name: Schiraldi Energy S.R.L.

Location: Lucera (Italy)

APPR type: hog fuel from olive pruning (also vineyard)

Target amount to mobilize: 600 t/y

Business model: combined heat and power production in agriculture sector

Sourcing radius: 50 km

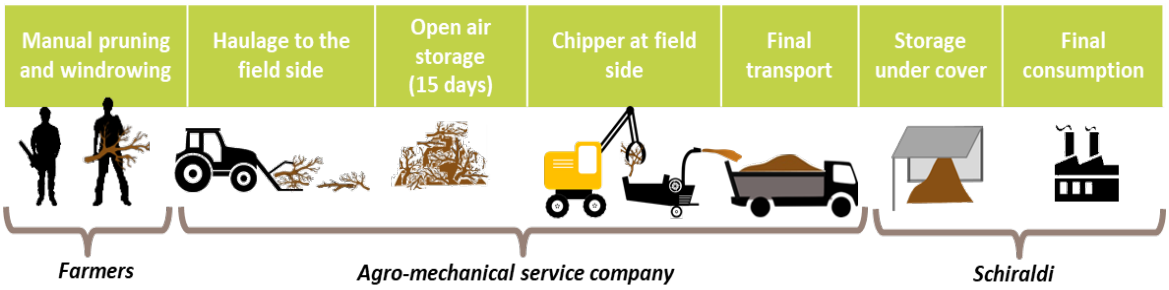
Potential GHG savings: 426.8 $t_{CO2,eq}$/y

Business idea

Schiraldi is a large and solid company of the agricultural sector, which operates as both wholesaling and retailer of agricultural productive factors (mainly crop seeds, fertilizers and pesticides). Currently, the company aims at enlarging and diversifying its activities making new investments in the agro-energy sector. In particular, Schiraldi has bought three modular pyro-gasification facilities (each one producing 20 kW_e). They can work under combined heat & power (CHP) conditions and the idea is to use tree crop pruning as fuel feedstock. Apart self-consumption of heat and considering the produced electricity, the business idea is to offer this energy to the national electrical company and to receive the consequent feed-in tariff.

Concerning the organization of the value chain, the upstream actors are mostly agro-mechanical service companies, which take charge of most logistic operations for harvesting, treating and supplying the biomass to the Schiraldi bioenergy plant. To stimulate the involvement of the contracting companies, Schiraldi purchased two chipping machines and make them available to agro-services companies for supplying the biomass to the plant.

Value chain operations



Main results of the demonstration

Date: Oct 2018

- APPR productivity: 2.2 t/ha (at 25 % moisture)
- Machinery used: static chipper (Caravaggi Bio 1250) fed by a spider loader
- Performance of the static chipper: 9 t/h
- Gasoil consumption: 22 L/h

Biomass characteristics (hog fuel from olive pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
17.3	13.7	18.4	4.1	P100	200

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The model applied by Schiraldi consists in purchasing and then lending the chipping machines to the collecting companies and it allows obtaining a certain fidelity and therefore stability in the pruning supply to the plant.
- The particle size distribution of the hog fuel produced may represent a critical factor due to the risks in the current fuel feeding system at the pyro-gasification plant. Improvements should be done for reducing the size and increasing the homogeneity of this biomass.
- This business model depends strongly on the selling price of the electricity to the national grid, and the potential feed-in tariff available.
- The initiative is currently in stand-by due to the lack of the national regulation framework supporting renewable energies.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 8

SMALL-SCALE CHP AT A SOCIAL WINERY

CANTINA APULIA
Vigne e vini del Mediterraneo

Name: Cantina Apulia cooperative

Location: Stornara (Italy)

APPR type: hog fuel from vineyard pruning

Target amount to mobilize: 1,200 t/y

Business model: combined heat and power production in agriculture sector

Sourcing radius: 40 km

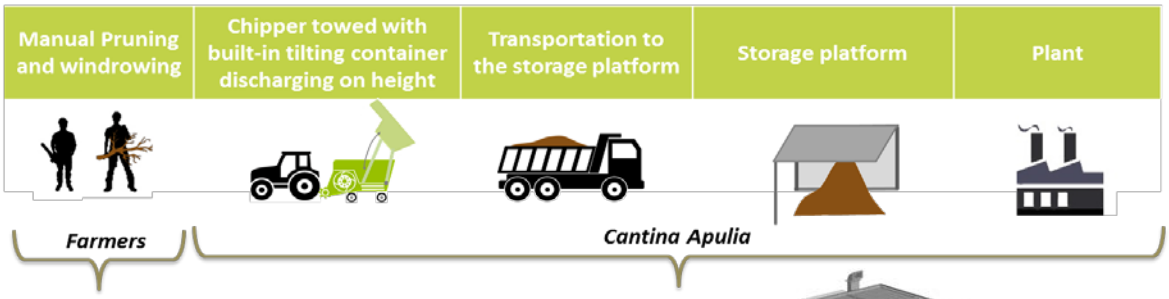
Business idea

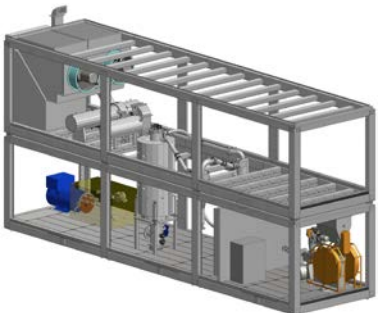
Cantina Apulia is a wine making cooperative made of approximately 220 farmers and more than 600 ha of vineyard. The cooperative is managing a consolidated wine production and is planning to use one of the wine by products (grape marc) for converting it to electricity, through a pyro-gasification plant of 1 MW_e. Afterwards, the company would sell the electricity to the national grid and be paid with a subsidized price. Together with grape marc, an alternative biomass feedstock to be supplied to the energy plant is vineyard pruning. Depending on the dynamics of the market price attributed to marc, it will be possible to increase or reduce their contribution to energy production, thus obtaining the maximum economic advantage. On the other hand, the heat stream obtained by the energy plant can be used in drying the marc or the pruning, if needed.

Considering the large number of farmers that belong to the cooperative, pruning availability is guaranteed, in the same way as the availability of grapes for wine production. The cooperative takes charge of all the logistics operations needed for mobilizing the vineyard pruning from the fields and converting them to energy.

As regards the final consumer, all the produced energy is transferred to the public electrical grid and, therefore, there is just one "client" to be detected, embodied by the Italian Electrical Authority. The feed-in-tariff assures a subsidized price to the electrical energy produced and sold.

Value chain operations





KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The income this business idea is based on depends entirely on the feed-in-tariff recognized by the Italian Electrical Authority. Without this kind of profit all the business plan no longer holds and the whole system collapse.
- Due to a lack of regulation framework supporting renewable energies in Italy, the initiative is currently stopped, although the pyro-gasification plant was already purchased by the cooperative.
- Accordingly, neither demonstration could be performed, nor fuel analyses could be carried out.
- By the way, notwithstanding these critical conditions, the cooperative has got all the authorizations and permissions to build and to manage the bioenergy plant. As soon as the new national regulations on renewable energy will be entered into force, the cooperative will be ready to restart the project that is based on very solid technical end economic pillars.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 9

ENERGY, BUT NOT ONLY, FROM OLIVE AND VINEYARD PRUNING

Name: Tersan Puglia S.P.A.

Location: Modugno (Italy)

APPR type: hog fuel from olive trees pruning (also vineyard)

Target amount to mobilize: 6,000 t/y

Business model: use of pruning for energy, biofilter and structural matter in a composting plant

Sourcing radius: 50 km

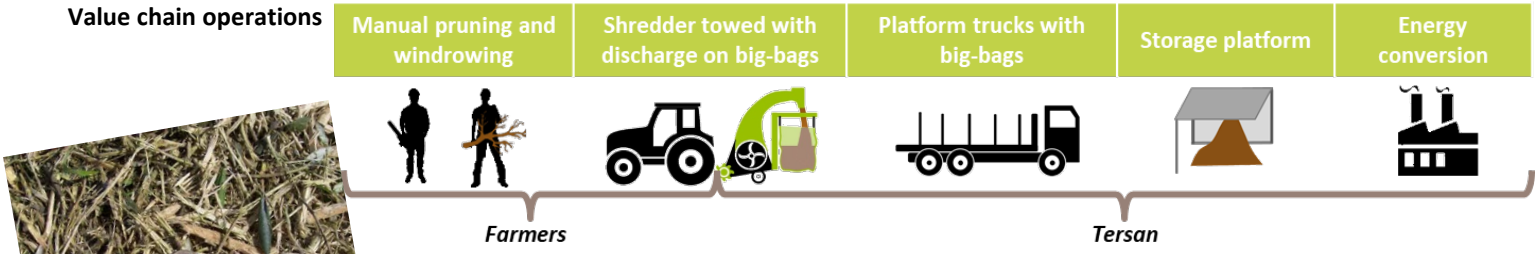
Potential GHG savings: 6,749 $t_{CO2,eq}$/y

Business idea

Tersan is the largest composting plant in the Apulia region; the process starts from the organic municipal waste separately collected from other wastes in several municipalities. The company needs large amount of wood chips for three different reason: a) to supply a biomass boiler used for drying the compost obtained in the final production stage; b) to obtain an activated biofilter useful in reducing the odor impact of the composting process; c) to add bio-structural material into the composting mix and improve its agricultural quality.

Considering the first type of use, Tersan purchased a Uniconfort boiler, providing a useful thermal power of approximately 3 MW_{th}. The goal is to substitute the wood chips from forestry (imported from abroad or North Italy) by hog fuel obtained from the pruning residues of the local fruit-tree plantations. In order to ensure the availability of APPR biomass, the company selected a "hybrid" solution that consists in purchasing three shredding/harvesting machines and making them directly available to farmers for supplying pruning to the bioenergy plant, without any kind of intermediation.

Value chain operations



Main results of the demonstration **Date:** Oct 2018

- APPR productivity: 2.2 t/ha (at 25 % moisture)
- Machinery used: integrated shredder and discharge to big-bag (Shredder Nobili TRP RT 175)
- Performance: 1.5 t/h
- Gasoil consumption: 12 L/h

Biomass characteristics (hog fuel from olive trees pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
19.9	17.0	13.0	4.8	P100	195

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- Considering the combustion technology, the quality and distribution size of the hog fuel are not so critical, and some inhomogeneity can be tolerated.
- The costs incurred by the company for the APPR biomass supply are significantly reduced thanks to the "hybrid" model of machines loaning.
- The choice to have direct relationships with farmers and not mechanical service companies is not simple and the overall management of biomass supply to the plant is quite hard to be performed.
- Tersan has established very good relationships with farmers and farmer cooperatives and productive organizations. This condition greatly facilitates the possibility of securing pruning supplies, also by making commercial agreements: pruning in exchange for compost.
- The present initiative shows a great bioeconomy attitude: energy, but not only energy, can be the final use of pruning, thus contributing in the multifaceted biomass utilization range.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 10

A POWER PLANT SUPPLIED BY CEREAL STRAWS FINDS A COMPLEMENTARY BIOMASS FEEDSTOCK

Name: Agritre

Location: Sant'Agata di Puglia (Italy)

APPR type: hog fuel from olive trees pruning

Target amount to mobilize: 50,000 t/y

Business model: power production partly based on olive pruning biomass

Sourcing radius: 70 km

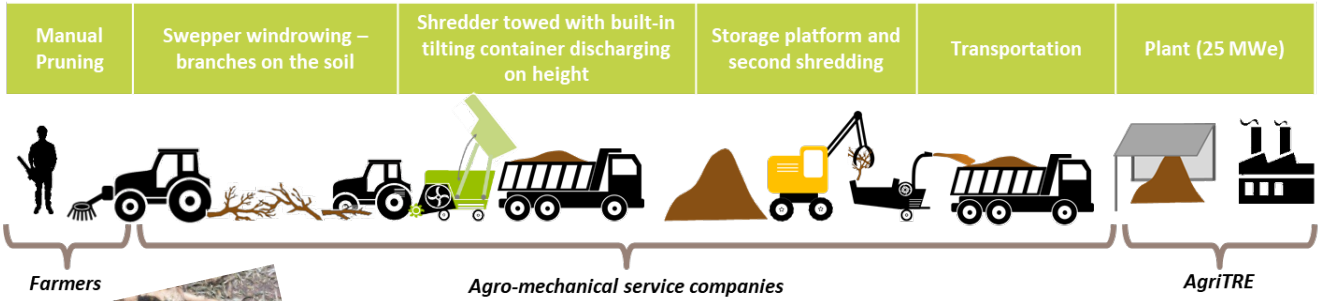
Potential GHG savings: 27,360 $t_{CO2,eq}$/y

Business idea

AgriTRE is an industrial company managing, since 2013, a 25 MW_e power plant (80 MW_{th}) mostly supplied with cereal straws. After the first five year of plant operation, the company has decided to modify the biomass mix supplied to the plant, by significantly increasing the amount of shredded pruning, up to a total maximum amount of 35 % (by energy contribution).

The upstream components of the value chain are composed, by the most, by agro-services companies providing for the logistic operations and allowing for biomass supply to the bioenergy plant. Supply contracts are signed between AgriTRE and the agro-services companies in order to strictly define the quantities and the economic conditions of the trade, as well as the quality (with reference to moisture and exogeneous materials).

Value chain operations



Main results of the demonstration

Date: April 2018

- APPR productivity: 2.3 t/ha (at 25 % moisture)
- Machinery used: integrated shredder (FACMA 140 and 200) + a secondary shredder (CARAVAGGI Bio 1250) fed by a spider loader
- Performance of the integrated-shredder: 2.5 t/h
- Gasoil consumption of the integrater-shredder: 12 L/h

Biomass characteristics (hog fuel from olive trees pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
16.8	12.7	21.1	3.2	P100	150

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- Up to now, more than 15,000 tons of pruning biomass are supplied yearly to the power plant and no difficulties have been reported. The objective is to increase this amount up to 50,000 tons per year.
- AgriTRE chose to externalize all the logistic costs and to buy the pruning biomass at a cost comprised between 50 and 55 €/t, depending on the moisture and ash contents.
- The company is particularly careful in monitoring the content in soil particles and clods.
- This initiative is possible thanks to the large amount of fruit-tree pruning in the area (approx. 150,000 tons per year in the Foggia province).
- In addition, the economic sustainability of the initiative is ensured by the subsidized tariff formerly agreed with the Italian Electric Authority and guaranteed for a 20-years period.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

FROM PLANTATION REMOVAL OF FRUIT TREES TO INDUSTRIAL BIOMASS

Demo 11

Name: Gruyser - Ecoadeso

Location: Fraga (Spain)

APPR type: hog fuel from up-rooting of fruit trees (only the aerial part)

Target amount to mobilize: 625 t/y

Business model: plantation removal services to farmers and logistic center to produce industrial hog fuel

Sourcing radius: 50 km

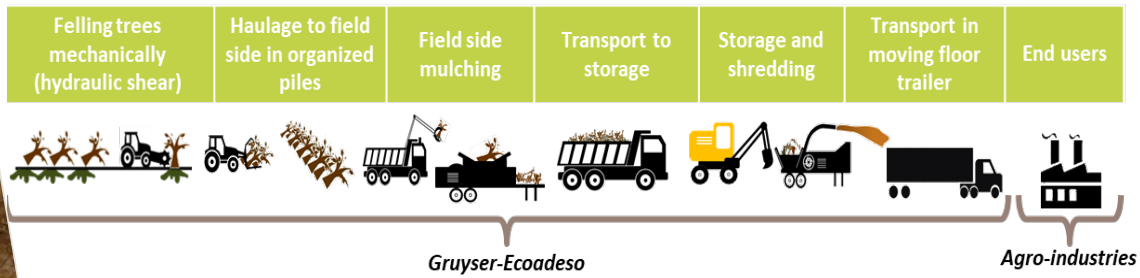
Potential GHG savings: 579 $t_{CO2,eq}$/y

Business idea

This logistic operator (Gruyser) associated with a residues manager (Ecoadeso) has been thinking and preparing during the last 5 years to open a new business line based on the management of the residues obtained after the removal of fruit plantations. They are located in an area of Aragón with high density of fruit production, they have most of the machines (trucks, tree cutting shear, shredders, etc.) and they have collected already some wood from plantation removals.

This business model is based on a separate treatment of the wood from plantation removal: 1) to get a good quality biomass from the aerial part of the fruit trees and 2) to valorize the stumps for compost use. It is a quite complex business model, which needs many machineries (being most of them of high economically value) that should be utilized in other complementary business activity in order to avoid too long payback times. The value chain begins from the farmers, which own the plantations and sub-contract to Gruyser-Ecoadeso for removing the plantation. Gruyser-Ecoadeso then acts as agro-service company and performs all the operations, up to the transport to end-users (agro-industries, mainly).

Value chain operations



Main results of the demonstration

Dates: December 2017

- APPR productivity: 24.5 t/ha (at 36 % moisture), only aerial part
- Machinery used: large shredder Doppstadt AK430
- Performance: 2.4 t/h
- Gasoil consumption: 22 L/h

Biomass characteristics (hog fuel after 5-months storage and a second shredding)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18.1	14.5	16.9	2.0	P31	170

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- The density of fruit plantations is very high in the area and plantation removal is more and more used, producing a large amount of wood that is currently burnt at field side, although a small fraction may be used as firewood in some cases. For all these reasons, offering an alternative to farmers is warmly welcome.
- Nonetheless, the main bottleneck comes from the demand-side, as not so many biomass consumers have installations adapted to burn the hog fuel. Alternatively, they would buy it at very low prices (< 40 €/t) and make additional treatment in their facilities.
- As regards the logistics, the high number of machineries to mobilize on field makes it feasible only if large plantations have to be up-rooted (minimum 20 ha).
- Feeding the shredder at field-side is very slow, due to the shape and size of the fruit trees. The performance and gasoil consumption of the machine are largely affected.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 12

SELF-CONSUMPTION OF GRAFT PRUNING IN A QUAILS FARM

Name: Casa Miquelás

Location: Fraga (Spain)

APPR type: chips from graft pruning of fruit trees

Target amount to mobilize: 75 t/y

Business model: self-consumption at agrarian facility (quail's farm heating)

Sourcing radius: 5 km

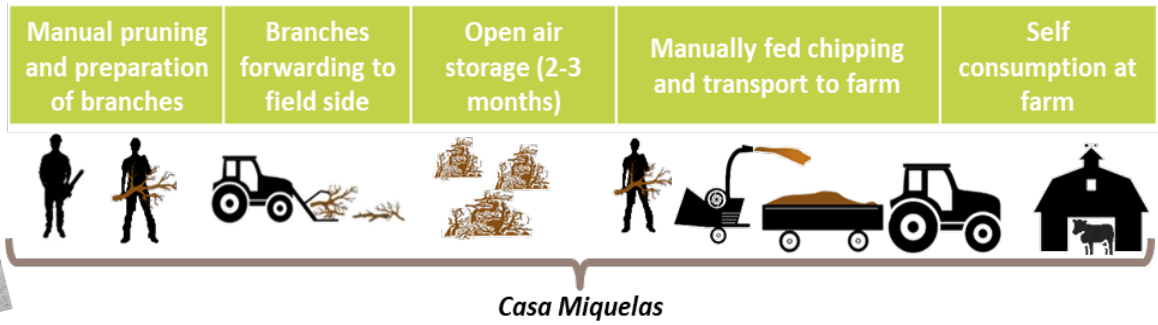
Potential GHG savings: 65 $t_{CO2,eq}$/y

Business idea

Casa Miquelás is a farmer that owns 40 hectares of fruit trees and produces a high amount of pruning wood when he performs grafting operations to change the fruit varieties. He also owns a farm of quails, which is heated by a rudimentary biomass boiler, operated with almond shells (~70 €/t).

The farmer-rancher would like to use his own wood from graft pruning in the farm, instead of burning them on open air. He prefers to avoid any sub-contracting activity and to operate the chipper by himself and his operators (could be rented or bought). The value chain operations consist in the following: a) manual pruning and preparation of the branches; b) haulage with tractor and gather in piles at field side; c) open-air storage (around 2-3 months); d) manually fed chipping; e) transport of the chips produced to a storage place, near the farm (less than 5 km from fields); f) consumption in the rudimentary biomass boiler that it is already installed in the farm.

Value chain operations



Main results of the demonstration **Date:** January 2018

- APPR productivity: 19.8 t/ha (at 28 % moisture)
- Machinery used: manually fed chipper (Junkarri 250), coupled to 85 CV tractor
- Performance: 1.7 t/h, with two operators
- Gasoil consumption: 7.2 L/h

Biomass characteristics (chips from graft pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18.2	13.1	23.1	1.8	P16	280

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- Although the chipper produced a good quality biomass, it should be improved by adding an adequate sieve, in order to reduce the occurrence of large particles.
- Also, the connection to tractor should be optimized so as to decrease the gasoil consumption.
- The existing biomass installation is not able to handle the pruning chips, due to their particle size distribution. In particular, the storage and feeding system need to be modified.
- The economic feasibility of the initiative is low, due to high investment cost for pursuing the chipper and modifying the boiler installation. In order to amortize the chipper in a reasonable time (< 10 years), renting or sharing with other farmers is needed, or, alternatively, a funding solution is required. Finally, synergies with municipal waste managers may also be found to rent the chipper few days a year.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 13

FROM PRUNING OF LOCAL FARMERS TO HEATING IN MUNICIPAL BUILDINGS

Calanda

Name: City council of Calanda

Location: Calanda (Spain)

APPR type: hog fuel from olive trees pruning (also fruit trees plantation removal)

Target amount to mobilize: 300 t/y

Business model: heating in municipal buildings with pruning from local farmers

Sourcing radius: 10 km

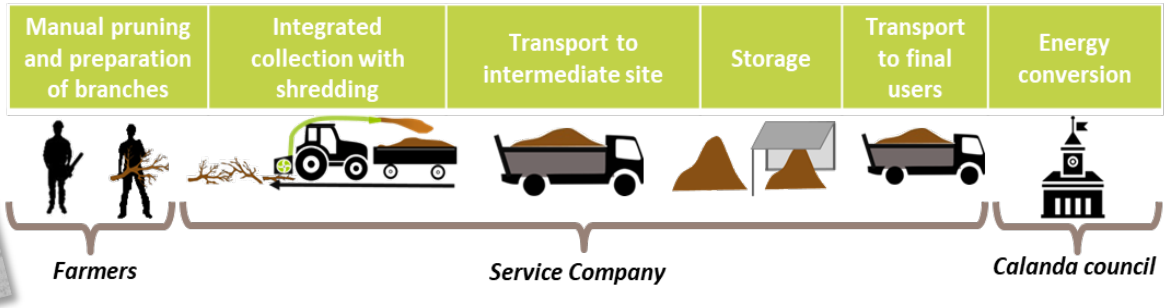
Potential GHG savings: 244 $t_{CO2,eq}$/y

Business idea

Calanda municipality has a total of 3,991 ha of permanent crops, mainly olive and fruit trees. The council has already started years ago a "decarbonisation" of the municipal buildings by applying measures of energy efficiency and by prioritizing of biomass for heating. They want to use local APPR biomass in the multi-fuel biomass boilers they have in the social house (150 kW), in the one they are currently installing in the swimming pool (300 kW). The business model is based on a public-private partnership to valorize the local wood obtained through maintenance pruning of olive groves, mainly. Moreover, there also exists a high potential of wood from fruit trees plantation removal, which could also be mixed with the olive tree pruning, before being delivered to end-users.

As regards the value chain, farmers will be in charge of the pruning operations and the preparation of branches, while a service company will be responsible of the overall logistics (from field to end-user), so as to collect, shred, store and transport the APPR biomass. The end-users would be the Calanda city council, but also some agro-industries operating in the area.

Value chain operations



Main results of the demonstration **Dates:** May 2018

- APPR productivity: 8.9 t/ha (at 29.1 % moisture)
- Machinery used: integrated shredder (Lopez Garrido TBM 2000), coupled to 240 CV tractor
- Performance: 6.6 t/h
- Gasoil consumption: 32 L/h

Biomass characteristics (hog fuel from olive tree pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18.0	12.4	29.1	4.0	P16	315

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- The pruning harvesting was successful, with a quite high performance of the machine and good quality of the hog fuel produced.
- Notwithstanding, the gasoil consumption was high, and should be reduced by improving the tractor connection and operation.
- The main bottleneck for this initiative was to find an agrarian service company with good contacts with farmers and available machinery (tractor, trucks, storage site, etc.). Fortunately, and thanks to the demonstration, a local company has been identified and is already making steps towards mobilization and treatment of olive pruning prunings and fruit trees removal.
- For the municipal swimming pool, the estimated payback period for the new biomass boiler is very interesting (less than 5 years), in comparison to the current fuel oil installation.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 14

ALLIANCE BETWEEN A FRUIT PRODUCER AND AN ESCO FOR HEATING IN LOCAL FACILITIES

Name: Frutas Aqua

Location: Zaragoza - Caspe (Spain)

APPR type: hog fuel from fruit trees pruning

Target amount to mobilize: 400 t/y

Business model: heating in local facilities with pruning from a fruit producing company

Sourcing radius: 50 km

Potential GHG savings: 265 $t_{CO2,eq}$/y

Business idea

The Frutas Aqua company owns around 500 ha of fruit trees and they have good contacts with potential "renewable" heat consumers in their area. They are exploring the possibility to develop a new business activity by valorizing their pruning wood as biomass. For that aim, they are in contact with an energy services company (ESCO), newly formed and called "Dallar Energía". This young enterprise seeks to enter in the market through the distribution of agricultural biomass, and the operation and maintenance of appropriate boilers for this type of fuel.

Currently, Frutas Aqua shred and let the pruning on soil, as organic amendment. In the potential value chain, they would shred, collect and transport the pruning wood to an intermediate storage. Then, the Dallar Energía would transport and supply the biomass produced to the potential end-users (e.g. agro-industries, city councils, etc.).

Value chain operations

Main results of the demonstration

Dates: January 2018

- APPR productivity: 3.4 t/ha (at 33 % moisture)
- Machinery used: integrated shredder (SERRAT Biomass 100), coupled to 85 CV tractor
- Performance: 0.8 t/h
- Gasoil consumption: 10 L/h

Biomass characteristics (hog fuel from peach tree pruning)

LHV MJ/kg		**Moisture** % a.r.	**Ash** % d.b.	**Particle size**	**Bulk density** *kg/m³, a.r.*
d.b.	a.r.				
17.4	10.6	33.3	6.4	P63	140

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- It was difficult to find an integrated shredder adapted to the crop layout. Also, the performance was much lower than expected, due to some blockages in the feeder, as well as in the suction tube that transports the biomass to the deposit.
- The hog fuel produced presents a quite heterogenous particle size distribution, which requires that the biomass installation has specific hopper and feeding systems.
- In addition, there exists an important issues related to economics: the main biomass fuels used by the potential end-users (almond shells or forestry wood chips) are currently available at a competitive price (70-80 €/t) and better fuel properties (lower ash and moisture content).
- Moreover, in Aragón region there exists the possibility to receive funds for letting the shredded pruning on soil, although it depends on the fruit crop and other factors.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

SELF-CONSUMPTION OF PRUNING AT THE WINERY

Demo 15

Name: Cooperativa Bodega San Juan Bautista

Location: Fuendejalón (Spain)

APPR type: hog fuel from vineyard pruning

Target amount to mobilize: 360 t/y

Business model: self-consumption at an agrarian cooperative facility

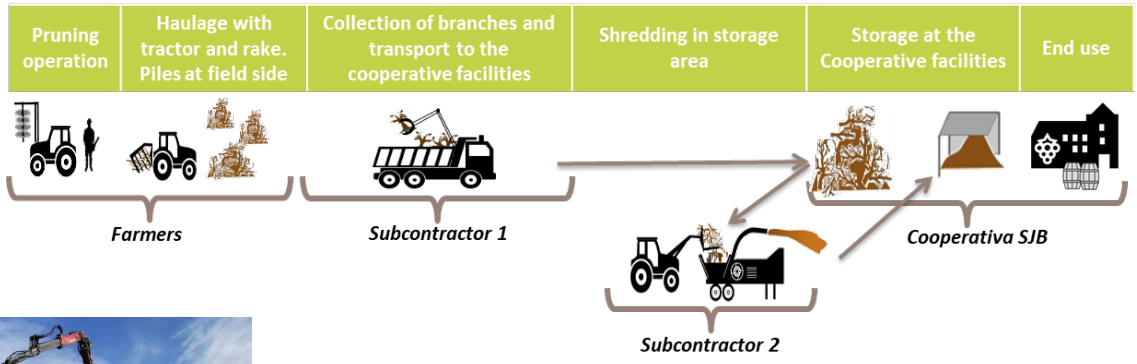
Sourcing radius: 5 km

Potential GHG savings: 332 $t_{CO2,eq}$/y

Business idea

The Cooperative covers 99 % of the wine growers in the area of Fuendejalón town, representing more than 2500 ha and 600 members. The business model consists in a self-consumption scheme to use the vineyard pruning residues (currently burnt on field) of the members for heating and cooling purposes in the winery (approx. 360 tons/year of vineyard chips at 20 % of moisture content). In order to avoid investment for new agrarian machinery, the cooperative decided to sub-contract most of the pruning management operations, as can be seen in the following figure. A first company (agro-service company or a waste management company) will be subcontracted to collect the branches and transport them to the storage facility created by the cooperative. There, the branches will be stored in large piles and let dried during the summer season, until a second company will be sub-contracted to shred the branches and prepare the hog fuel to be used in the new biomass boiler of the cooperative.

Value chain operations



Main results of the demonstration

Dates: Feb. & Apr. 2018

- APPR productivity: 1.1 t/ha (at 35 % moisture)
- Collection of piles with a truck: 4.08 t/h
- Machinery used: large shredder Vermeer HG6000
- Performance: 11 t/h
- Gasoil consumption: 35 L/h

Biomass characteristics (hog fuel from peach tree pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
17.8	14.2	20.9	3.1	P45	150

d.b. dry basis; a.r. as received

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

Main outcomes and lessons learnt

- As the current pruning management is based on open air burning, in order to avoid plagues and diseases in the vineyard, a shift to energy or compost purposes is attractive for the cooperative.
- Notwithstanding, it was difficult to find a service company in the area, with a shredder adapted to the pruning material. Moreover, the performance of the shredder was relatively low (compared to the operation with forestry wood). This was mainly due to the shape and density of the pruning branches, which strongly slowed down the feeding velocity.
- Before shredding, it was necessary to shake the pruning branches, due to the high amount of stones and soil that were incorporated during the haulage.
- The investment for the corresponding boiler and chiller is high and the equivalent hours of operation are quite low (demands is restricted in some specific and narrow periods). Accordingly, payback times make quite difficult the economic feasible of the initiative.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 16

A LOCAL AUTHORITY PROMOTES PRUNING BIOMASS TO SUBSTITUTE FOSSIL FUELS

Name: Vinnitsa Regional State Administration

Location: Tyvriv (Vinnitsa, Ukraine)

APPR type: chips from pruning of apple trees

Target amount to mobilize: 1,680 t/y

Business model: heating in municipal buildings with pruning from local farmers

Sourcing radius: 35 km

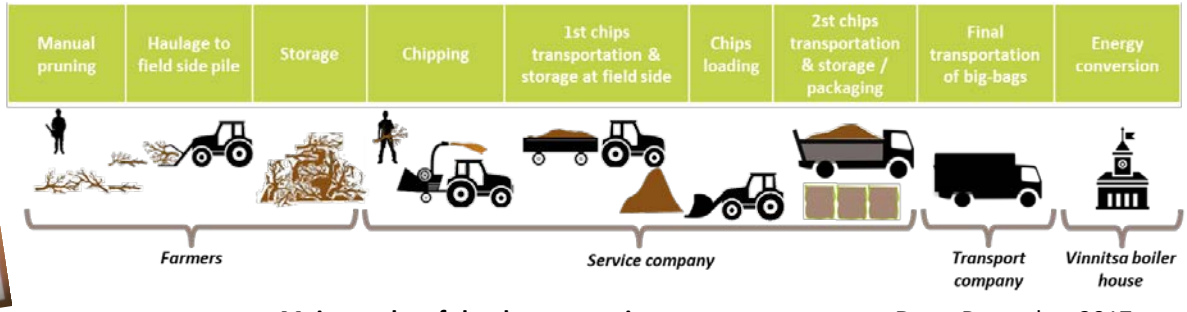
Potential GHG savings: 1,185 $t_{CO2,eq}$/y

Business idea

The municipality of Vinnitsa is exploring the possibility of using APPR biomass in an existing municipal boiler house, operated by the utility company "Vinnytsiaoblteploenergo". For that aim, Vinnitsa Regional State Administration initiated cooperation with the members of the local horticulture association. Overall theoretical potential of APPR residues in Vinnytsia region accounts for 73,000 tons per year. Up to now, farmers did not consider pruning wood as commercial product, and usually burn them on open air or store them at field side.

The value chain operations consist in the following: 1) manual pruning; 2) haulage with tractor and gather in piles at field side; 3) open-air storage (around 2-3 months); 4) manually fed chipping; 5) collection of the chips into the trailer, transportation to the field side; 6) loading of chips to the tip lorry and transportation to the storage facility; 7) packing of chips in bags; 8) transportation of bags to the final consumer; 9) consumption of chips for heat production in the municipal boiler house.

Value chain operations



Main results of the demonstration

Date: December 2017

- APPR productivity: 3 t/ha (at 35 % moisture)
- Machinery used: manually-fed chipper (Hemmel-Ukraine RM 51) attached to tractor MTZ 82
- Performance: 0.55 t/h, with two operators
- Diesel consumption: 3 L/h

Biomass characteristics (chipped apple trees pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18	10.9	34.3	2.0	P45B	270

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- The wood chips from apple trees pruning satisfied the requirements of the existing biomass boiler facility. Notwithstanding, since the boiler operator controls the quality parameters of the consumed fuel, it is important to provide moisture and fraction control of the produced chips. Biomass characteristics indicated in the agreement for its supply, and the final price related to their compliance.
- Good synergies between municipality and local farmers can be achieved: as the availability of other biomass sources is limited in the area, APPR biomass is attractive for municipal end-users as an alternative both to other biomass and to fossil fuels.
- Municipalities, as operators of existing biomass boiler-houses are ready to buy pruning biomass at market price for other biomass types (forestry chips, etc.).
- Therefore, it is important to optimize the diesel consumption and manual work during the operations at field side in order to control the final cost of the produced biomass.
- For today, such APPR biomass value chain should have a service company as a core actor, since both farmers and end-users don't have equipment, time and willingness for pruning collection and treatment.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

FRUIT TREES PELLET PRODUCTION FOR LOCAL HEAT USERS

Demo 17

«ТРІАДА-МК»

ЩЕДРИЙ ХУТІР

Name: Triada-MK LLC farm

Location: Murovani Kurylovtsi (Vinnitsa, Ukraine)

APPR type: pellet from plantation removal of fruit trees

Target amount to mobilize: 2,550 t/y

Business model: agro-pellet production for heating in local industries and buildings

Sourcing radius: 25 km

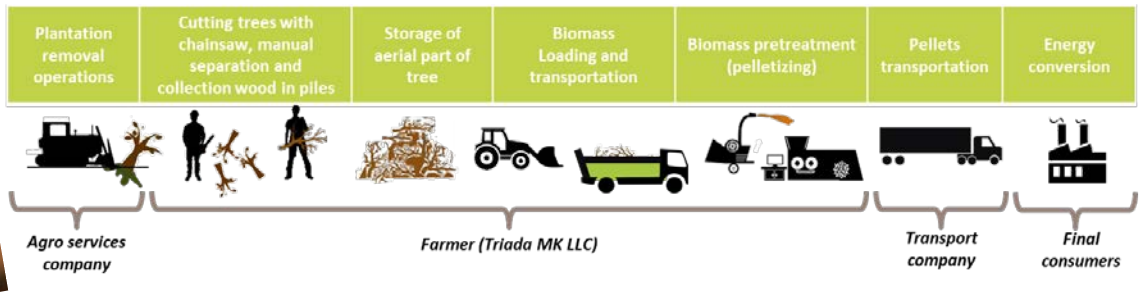
Potential GHG savings: 1,520 $t_{CO2,eq}$/y

Business idea

The farm Triada-MK is interested in including the pruning and plantation removal management as a new business line. It currently includes 430 hectares of fruit trees plantations, from which 100 hectares should be uprooted. The farmer has previous unsatisfied experience in establishing chain with direct selling of APPR chips to biomass boiler house. In order to become more competitive, the farmer wants to produce pellets from his own APPR wood, but also to provide a service of trees uprooting for neighboring farmers.

The value chain begins with the assistance of an agro-service company, which removes the old orchards. Then, the farm workers cut the trees and collect the wood in piles at the field side. The farmer loads the biomass on an agrarian trailer, which transports it to the pelletizing facility. There, the wood is pre-treated (chipped and dried) and pelletized. Finally, an external company transports the pellets to the final consumer. Alternatively, the farmer can use his own transport facilities or sell the pellets to final consumers through distributors.

Value chain operations



Main results of the demonstration **Date:** December 2017

- APPR productivity: 30 t/ha (at 37 % moisture)
- Machinery used: manually fed stationary wood chipper (Hemmel-Ukraine RM 41), hammer mill (Hemmel-Ukraine RM 71) and OGM-1.5 pellet press
- Performance of the pellet press: 1 t/h
- Electricity consumption: wood chipper - 14.5 kWh/t; pellet press - 133 kWh/t

Biomass characteristics (agro-pellet from fruit plantation removal)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18.5	15.3	12.6	4.8	Ø 8 mm	530

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- The ash content of the agro-pellet should be reduced, e.g. by minimizing the contact with soil during harvesting operations.
- In order to adapt the existing pellet plant to the APPR biomass characteristics, the technology has been adjusted by modification of pelletizing matrix and rollers, installation of new control system for production parameters.
- In comparison to the production of APPR chips, the agro-pellets are more competitive in the local market.
- The chipping and drying processes at the production facility should be optimized in order to increase the performance of the pellet press.
- Several end-users are already able to consume the agro-pellets. Especially, municipal boiler house subordinated by the Vinnitsa Regional State Administration (Demo16) has already signed a long-term agreement for agro-pellet supply from Triada-MK farm.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 18

A FARMER PRODUCES HOG FUEL FROM APPLE TREES PRUNING

ПАТ «НОВООЛЕКСАНДРІВСЬКЕ»

Name: PJSC Novooleksandrivske farm

Location: Nova Oleksandrivka (Kyiv, Ukraine)

APPR type: hog fuel from pruning of apple trees

Target amount to mobilize: 204 t/y

Business model: heating in local facilities with pruning from an individual farmer

Sourcing radius: 5 km

Potential GHG savings: 111 $t_{CO2,eq}$/y

Business idea

The farmer cultivates 560 hectares of fruit trees plantations. Extensive apple trees are cut once every three years. Farmer is collecting a small amount of pruning that is sold as firewood. The new business model consists in collecting the smaller pruning branches for hog fuel production in the existing mobile shredder and selling the obtained biomass to local consumers.

After manual pruning, the workers cut large branches with chainsaws, take firewood with a diameter of more than 50 mm and collect the APPR biomass in windrows. From several days up to two weeks, the prunings are stored at field side. Then workers collect wood and feed it manually in the shredder Urban TR70 attached to a tractor. Hog fuel is packed into bags with a weight of 10-15 kg. Workers load full bags into a tractor's trailer that transports the biomass to the storage facility or directly to local consumers. The hog fuel can be consumed at different heating facilities, either municipal buildings or local industries.

Value chain operations

Main results of the demonstration **Date:** April 2018

- APPR productivity: 8.5 t/ha (at 46 % moisture). Collected each 3 years.
- Machinery used: manually-fed shredder (Urban TR70) attached to tractor MTZ 80
- Performance: 0.75 t/h
- Diesel consumption: 7 L/h

Biomass characteristics (shredded apple trees pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18	8.5	46.2	2.3	P125	270

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- The hog fuel has been positively validated in two different heating installations that currently use fuel wood (one school and one industry).
- Notwithstanding, the moisture content of the hog fuel should be reduced. This can be achieved through a longer storage of the pruning branches at the field side, during dry weather period.
- The hog fuel has a relatively large size and it may create problems in the feeding systems of the existing biomass boilers. Modification of the shredder is therefore needed (e.g. by adding a sieve).
- Manual operations during shredding reduce the effectiveness of the whole value chain. Special equipment and modern machines (e.g. for transportation) should be used to increase the productivity of a value chain.
- The production costs for the hog fuel (30 €/t) are not competitive with the existing local market price for the main biomass fuel used by the potential end-users (fuel wood): current price of which is 20-23 €/t, moreover fuel wood has better fuel properties (lower ash and moisture content). Therefore, the logistics operations should be improved or the business model re-adapted.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 19

SOCIAL FACILITIES HEATED BY VINEYARD BRIQUETTES

Name: Bolgrad city council

Location: Bolgrad (Odesa, Ukraine)

APPR type: briquettes from vineyards pruning

Target amount to mobilize: 350 t/y

Business model: heating in municipal buildings with vineyard briquettes

Sourcing radius: 5 km

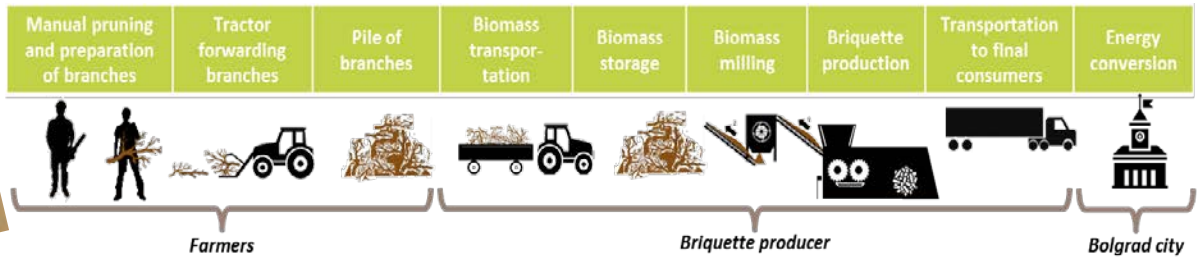
Potential GHG savings: 169 $t_{CO2,eq}$/y

Business idea

The Bolgrad city is in a region with the biggest plantation of the vineyard in the Odessa oblast. The council would like to promote the use of vineyard pruning for heating in municipal buildings. Moreover, two failed projects on fossil fuel substitution for thermal energy production in the kindergarten and the maternity hospital need to be re-scoped to modify the biomass boiler in such a way that they can operate with vineyard pruning. Also, the city council is in a good collaboration with a private enterprise that owns mobile chipper, briquette plant and transportation facilities.

The Bolgrad City Council called for a participation to farmers who are interested in mobilizing their biomass for heat production at the social facilities of the town. Several local farmers responded and one of them owns a large plantation of vineyards in the 5 km radius from Bolgrad. For demo purposes, the farmer organized the transportation of pruning branches to the briquetting plant of the "Izmail Production Company" LLC. Finally, the “agro”-briquettes was packed in bags and transported to the boiler house of the primary medical and sanitary assistance center (80 kW coal grate boiler), in Bolgrad.

Value chain operations



Main results of the demonstration

Date: April 2018

- APPR productivity: 3 t/ha (at 49 % moisture)
- Machinery used: manually fed stationary hammer mill and mechanical press
- Performance of the press: 0.29 t/h
- Electricity consumption: hammer mill - 52 kWh/t; press: 48 kWh/t

Biomass characteristics (briquettes from vineyards pruning)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18	16	11	3,4	Ø 50 mm	763

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- Thanks to an initiative of the municipality, local farmers and entrepreneurs have seen a new direction for their business lines: briquetting of vineyard pruning residues.
- Nevertheless, farmers near Bolgrad do not have modern machines such as harvesters with integrated shredders. The alternative is to forward the branches and pile them at field side, with the respective incorporation of soil and stones. That causes poor fuel characteristics.
- Purchasing of such modern equipment is not feasible for small farmers, individually. A potential alternative may be that the entrepreneur who produces briquettes and wants to diversify the feedstock (current sourcing is based on sunflower husk and straw) buys such equipment.
- The briquette plant faced difficulties to mill the vine shoots, due to the flexibility of a wet pruning wood. Standard knives of the chippers (designed for forestry wood) cannot be used directly.
- Feasibility study confirms the effectiveness of pruning briquettes use for substitution of coal in municipal buildings. Despite the fact that validation showed possibility to use produced briquettes in an existing multi-fuel boiler (worked on coal), new and modern biomass boilers should be installed.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 691748

Demo 20

A FRUIT PRODUCER CONSUMES PART OF ITS PRUNING AND SELLS THE REST TO LOCAL USERS

Name: Black Sea Fruit Company

Location: Kostyantynivka (Zaporizhia, Ukraine)

APPR type: chips from fruit trees pruning

Target amount to mobilize: 510 t/y

Business model: self-consumption at fruit company offices and selling to local heating facilities

Sourcing radius: 10 km

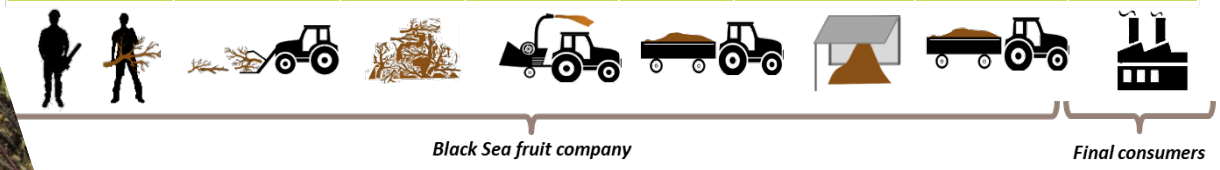
Potential GHG savings: 303 $t_{CO2,eq}$/y

Business idea

The Black Sea Fruit Company is a large producer of fruits (cherries, strawberries, apricots, plums, apples, etc.) with a total area of 240 hectares in the South-Est of Ukraine. Currently, the company has a high interest in organizing a value chain to produce wood chips from pruning for its own-consumption (in the office) and for selling to local biomass consumers. Also, the company has proposed to the municipality to install biomass boilers in schools and kindergartens.

After pruning, the workers put branches in the middle of the row. The tractor with forks pushes out the APPR biomass and collects it in piles. The biomass is dried and chipped by a manually fed chipper attached to the tractor and trailer. The tractor with the trailer transports wood chips to the storage facilities. When the heating season starts the tractor with the trailer transports the wood chips from APPR to the final consumers for the heat production.

Value chain operations



Main results of the demonstration

Date: March 2018

- APPR productivity: 2.9 t/ha (at 46 % moisture)
- Machinery used: manually-fed chipper (Heizohack HM 8-400) attached to tractor Belarus 92.1
- Performance: 0.67 t/h
- Diesel consumption: 6.4 L/h

Biomass characteristics (see Table below)

LHV MJ/kg		Moisture % a.r.	Ash % d.b.	Particle size	Bulk density *kg/m³, a.r.*
d.b.	a.r.				
18	12.9	25	4.3	P100	280

d.b. dry basis; a.r. as received

Main outcomes and lessons learnt

- Storage and natural drying should be improved in order to decrease the moisture content of the APPR chips. The storage facility with the roof should be used for dry wood chips.
- Blunting of chipper knives have an exceptional influence of the wood chips quality. It is necessary to ensure the control for the sharpness of knives by the chipper operator.
- Manual feeding significantly reduces the performance capacity of the chipper: 90 % reduction of the capacity during the demonstration.
- The particle size is large and specific hopper and transport system are needed to feed the APPR biomass to existing biomass boilers.
- Feasibility assessment confirmed the effectiveness of APPR chips production for own consumption in a new modern 50 kW biomass boiler and natural gas substitution. Nevertheless, performance capacity of the chipping equipment should be increased to ensure better economic characteristics.
- In addition, due to the lack of such fuel on the local market (mainly pellets and briquettes are proposed), selling of the chips with a price near 50 €/t will be very attractive both for farmer and for end-users.

KEY LINKS

Project webpage: www.up-running.eu

Map of biomass from APPR: Observatory

Videos: YouTube channel

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691748