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EUROPEAN UNION

Greece - Republic of North Macedonia

aGROWchain

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Practical Guide for local authorities demonstrating how to set up a sustainable supply chain fo heating fuel

JUNE 2020

aGROWchain,Interreg IPA-CBC "Greece-Republic of North Macedonia"

Co-funded by the European Union and National Funds of Greece and Repubic of North Macedonia, via the Interreg IPA CBC Programme "Greece – Repubic of North Macedonia 2014 – 2020"

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1. Purpose of this Guide

Main Issue to be addressed

Agricultural residues such as straw, bank canes and tree prunings constitute a significant load of green waste in rural areas. In the case of the Greece-North Macedonia cross-border area, covered by the aGROWchain project, those wastes are poorly managed causing severe environmental impacts.

At the same time, local authorities use expensive fossil fuel for space heating of public buildings, and, due to the current economic recession, very often the amount of heat generated cannot satisfy the real needs of the building users.

While most European countries classify the energy use of biomass as a major source of electricity and thermal energy, Greece disposes it in the environment uncontrollably or in landfills, while farmers usually proceed with the burning of residual biomass in their fields.

Both solutions have a great risk of ecological disaster. Another reason may be the ignorance of the actual available biomass potential and its energy content as well as reactions to renewable energy projects using biomass.

The sustainable management of the green waste can offer a real solution in both of the above problems. There is available technology that can utilize agrowastes as fuel for space heating under the only condition that a reliable supply chain is established.

The goal of the aGROWchain project is to establish a supply chain for green wastes, combined with the relevant business model, which will secure its sustainability. This guide aims to support local authorities in achieving this.

Who is this guide for?

This guide is intended for local authorities, including regional authorities, municipalities, as well as other public and private organizations and stakeholders who wish to play a part in setting up a sustainable supply chain for heating fuel using biomass, and tree prunings in particular.

What is the scope of this guide?

Written under the aGROWchain project, this guide provides a general overview of biomass and its uses, and then gives detailed instructions on how to use two common locally available sources of biomass: tree prunings and reeds. The

information included can guide local authorities and other interested parties on how to set up a sustainable supply chain for heating fuel, using municipal tree prunings, prunings from vineyards and fruit tree plantations, or reeds as a source.

How to use this guide

It is recommended that the reader begins with chapter 2 in order to get an overall understanding of what is biomass (if not already an expert on the topic) and receive answers to a number of frequently-asked-questions. Then, according to whether the reader's focus is on municipal tree prunings, prunings from vineyards and fruit tree plantations, or reedbeds, chapters 3, 4 and 5 describe how to set up a sustainable supply chain for heating fuel in sequential steps. This is why some general information in chapter 3 is – unless noted- also repeated in chapter 4 and (to a lesser extend) chapter 5. For additional efficiency, the knowledge provided by this guide should be supplemented by additional sources on the topic of green biomass creation. Such sources are listed under chapter 6.

Additional sources for guidance

The use of tree prunings and reeds for the production of biomass has been increasingly covered by the literature, and explored in research during the last few years. Chapter 6 includes a listing of additional sources for guidance on biomass from tree prunings, reeds, or the creation of sustainable supply chains using biomass. Sources include scientific articles, guidelines from projects and international associations, etc.

2. Overview of Biomass

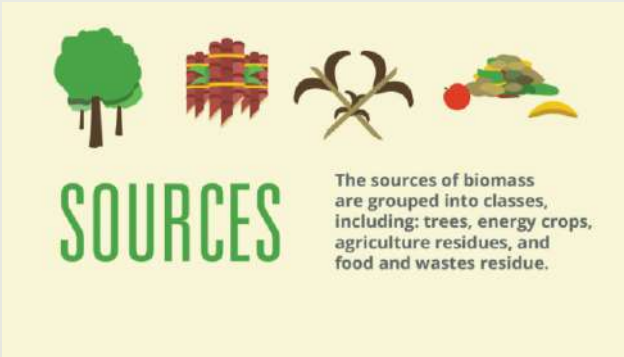
What is biomass?

Biomass is renewable organic material that comes from plants and animals. Biomass (in the form of wood fuel) is the first energy sourced harnessed by humanity and remained the largest source of energy consumption until well into the 19th century. Biomass continues to be an important fuel in many countries, especially for cooking and heating in developing countries. The use of biomass fuels for transportation and for electricity generation is increasing in many developed countries as a means of avoiding carbon dioxide emissions from fossil fuel use. Biomass can be burned directly for heat or converted to renewable liquid and gaseous fuels through various processes.

Where does biomass come from?

Biomass sources can be divided into four main categories:

1. Trees and forestry-related residues, such as wood grown for fuel, harvest residues, sawmill residues, and *tree prunings.*
2. Crops specifically grown for energy production, such as miscanthus, corn or sugar cane.
3. Agricultural residues, such as straw, animal bedding, food waste and grain husks.
4. Food and wastes residue, such as spent grains, food wastes, or paper, cotton and wool products.



Is biomass sustainable?

The short answer is both yes and no. Burning plant-derived biomass releases CO_2, but it has still been classified as a renewable energy source in the EU and UN legal frameworks because photosynthesis cycles the CO_2 back into new crops. In some cases, this recycling of CO_2 from plants to atmosphere and back into plants can even be CO_2 negative, as a relatively large portion of the CO_2 is moved to the soil during each cycle.

However, the fact that even a fast-growing softwood species mightproduce a sustainable harvest of 10 oven-dried

tons of wood per hectare per annum, with an approximate energy content of 50,000kWh, demonstrates that humanity cannot fuel its future on biomass in a global scale. Biomass may only be sustainable in certain geographical locations.

The "true sustainability potential" of biomass, however, is when it is produced from residues or waste occurring from other processes, which would otherwise be left unused. In this form, biomass can complement other types of renewable energy. Tree prunings fall under this category.

Is biomass expensive?

Biomass itself is not expensive but the technology for converting it to energy can be. Even when it is grown or harvested specifically for energy generation-purposes, biomass fuel is usually relatively inexpensive, especially when compared to "conventional" power sources. Biomass produced from residues and wastes is completely free.

The main cost of biomass, however, concerns the technology which is used for its thermochemical conversion to energy. This cost can vary according to the exact technology used, as well as per country, and it tends to drop as technology evolves and researchers improve existing methods and develop new ways to convert biomass for energy. This is why techno-economic analysis will continue to play a major role in the research of these technologies. In general, it can be said that biomass equipment is usually several times the cost of conventional power plants.

Biomass source and type

The type and source of the biomass fuel is important for many reasons, not least the way in which the fuel is legally defined. Across Europe, the provisions of the Industrial Emissions Directive 2013 have subsumed numerous preceding directives and regulations and now stipulate how waste will be classified and how it must be burned. In many cases waste wood and other wastes are a very important local source of fuel – but it is not legal to simply burn waste wood in a biomass boiler unless those wastes comply with very specific legal provisions.

Equally, the mineral content of the biomass will be dictated by the source and the handling. The mineral content (non-combustible content) and metal salt content, for example sodium and potassium salts, will vary with biomass

species and can adversely affect the combustion qualities of the fuel. In a few cases this can be problematic.

Why should I use biomass?

There can be several potential reasons to use biomass. A very important one concerns its environmental benefits. The local sustainable use of biomass arguably reduces long-term carbon emissions and thus reduces the greenhouse gas concentration in the atmosphere. Although carbon dioxide is released, there is very little, if any, sulphur content and thus sulphur contributions to acid rain are reduced.

There are significant economic benefits as well. If the main cost of the equipment which converts biomass to energy is covered then the energy source itself can be relatively inexpensive or even completely free. Over time, the original investment in technical equipment will pay for itself.

Social benefits can be equally significant. Setting up a biomass supply chain can generate new jobs and provide a boost for the local community.

Finally, developments on a global or European scale, such as the implementation of the European Green Deal, can dictate a much-needed shift away from fossil-fuels and towards renewable energy sources. In this context, biomass can be an excellent solution for regions to base their transition around.

Can I use tree prunings for biomass?

As should already be evident from the overview provided above, tree prunings can be an excellent source of biomass. Step-by-step instructions for using tree prunings to set up a sustainable supply chain for heating fuel are provided in chapters 3 and 4, below.

Can I use reeds for biomass?

Although they have a lower calorific than wood, reeds can still be a useful source of biomass, which has several advantages. Their collection could also serve other goals, with biomass production being a side-product, as illustrated in the example in chapter 5.

3. How to make use of Municipal Tree Prunings

How can we make use of municipal tree prunings for heating fuel?

As trees in public places usually belong to the local municipality, this provides it with a readily available source of biomass which is their own property anyway. Local authorities can use municipal tree prunings for setting up a sustainable supply chain for heating fuel. The guide presents the recommended process for doing so in five distinct steps below, numbered from 3.1 to 3.5. The municipality of Amynteo, in the Region of Western Macedonia, is used to provide a practical example when outlining the different steps to be followed.

3.1 Map the existing management scheme

The first step towards setting up a new supply chain is to map the management scheme currently used for municipal tree prunings. A simple way to perform the mapping is to obtain the information that addresses the questions of who, what, when and how.

Who: Since the trees belong to the municipality, the question is whether their pruning is carried out by the municipality itself or by subcontractors. In the case of Amynteo both methods are used. As a relatively small municipality (16,973 people), it only has one permanent position for a member of staff who deals with tree pruning. This means that the municipal personnel cannot handle the workload during the time of year when municipal trees are pruned. In addition, the municipality does not have the specialised equipment needed for the pruning of particularly tall trees. Therefore, the municipality hires seasonal contractors to cover these demands.

What: The mapping should include an inventory of what types of municipal trees exist, and what are the estimated annual quantities of prunings produced. In the case of Amynteo, municipal trees include sycamore, poplar, acacia, fir, and pine trees. The estimated annual quantity of prunings produced is around 28-35m^3.

When: It is important to know the recommended time period for municipal tree prunings. In general, the standard

practice is to prune coniferous trees in the end of spring, and the rest in late autumn or early winter.

How: "How" is a crucial practical question which refers to the type of equipment used for pruning and the current management process regarding the collection, processing and disposal of the tree prunings. The standard equipment for pruning and the usage of each tool is presented in the table below.

Equipment / Tool	Usage
Scissor action	For stems up to 1.3 cm - cleaner, closer cut
Anvil cut	For stems up to 1.3 cm - useful for cutting thick branches
Lopping shears or loppers (Scissor action)	They can slice through branches of 5cm or more, depending on species and condition- long handles
	
Pole pruner	For cutting branches that are too high on a tree
	
Hedge shears (manual and power)	They are used mainly for shearing plants into hedges or formal shapes
	
Pruning saws	They are very useful for cutting larger branches that are too large for hand shears.
	

3.2 Ask critical questions

In addition to the questions above, another significant question concerns the current commercial exploitation of the prunings, if one is in place. That is because the new supply chain has to replace any existing chains. If the prunings are not being exploited then the new supply chain will be established from scratch.

The critical questions to be asked are: ***Are tree prunings already being commercially exploited and by whom? If yes, what is the final product? Who are the customers? What is the price?***

In the case of Amynteo, municipal prunings are currently not being exploited in any way, but treated as waste. They are being disposed in a certified landfill site outside the town. However, the fact of fast filling the landfill site pauses a dimension of cost which is not negligible for the Municipality itself, which seeks ways to reduce the quantities landfilled on an annual basis.

3.3 Map potential end-users

Before a new supply chain is set up, it is crucial to identify the potential end-

users of the municipal prunings. This way, it will be possible to estimate the current and potential demand for biomass, calculate costs, establish what technical solutions are needed, and create an overall plan for the supply chain.

For example, in a typical small-scale municipality, potential end-users can include the following:

- Municipal or public buildings (schools, gyms, the town hall, tax office etc.) which can use the prunings for heating
- Existing solid fuel district heating plants, to be directly supplied with the prunings
- A large commercial boiler, if one exists in the area, which can buy the biomass produced
- Greenhouses, or other agricultural applications of the prunings
- Directly supplying a pelletizing or briquetting plant

3.4 Examine available technical solutions

The final key step needed is to examine the available technical solutions that could serve the new supply chain, from the moment the municipal trees are pruned to when the prunings will be converted into energy.

For example, produced tree prunings can be chipped on site by using a towable wood chipper, and then transported to a collection site for further processing or storage. Or the prunings can be transported to a facility where they will be chipped in a stationary wood chipper. Either way, further processing of the produced woodchips will depend on the end-user requirements (this is why it was so important to map end-users).

To continue with the example of the municipality of Amynteo, the following different cases of potential end-users result in different technical requirements:

- The woodchips can be taken to large grate fired boilers, such as those of the Amynteo Municipal District Heating Company (DETEPA). In this case, no further processing is required. The woodchips can be fed to the boiler as is, since such boilers can tolerate high moisture fuels (even up to 50%).

- The woodchips can be taken to a pelletizing or briquetting plant. Again, no further processing is required in this case, because the

chips will be dried, conditioned and further treated in the plant.

- The woodchips can be taken to medium-sized boilers in agricultural businesses. Most such boilers tend to require fuel with moisture content of below 30%, so in this case, further conditioning and drying of the chips will be required.
- The woodchips can be taken to municipal or public buildings, schools, private homes etc. Due to the type of boilers available in such places, again, further conditioning and drying of the chips will be required.

In case further drying and conditioning is required, the new management scheme will have to include provisions for the site and the required equipment to achieve the needed chip quality.

3.5 Set up the new management scheme

Once all the above steps have been properly addressed, it will be possible to move towards setting up the new management scheme for the prunings, resulting in the new supply chain.

For example, the municipality may run the supply chain itself, producing low-cost biomass for heating its facilities/ buildings/DH plants etc. Alternatively, the local authority may subcontract the whole service (biomass collection, processing, storage and final delivery) to a private operator. In this case, the operator will be paid by selling the final product to the municipality at a pre-agreed price.

4. How to make use of Prunings from Vineyards and Fruit Tree Plantations

How can we make use of prunings from vineyard and fruit tree plantations for heating fuel?

Making use of three prunings from vineyards and fruit tree plantation presents several differences from municipal tree prunings, as in this case, the prunings do not belong to the municipality but to local farmers. However, these prunings can also be of great interest to local authorities. The municipality may be interested in using the prunings to heat public buildings, as municipal prunings may not be enough. Or, local authorities might encourage farmers to make use of their prunings in order to help them achieve a better quality of life through increasing their income, having a cheaper and renewable source for their own heating needs, avoiding plant diseases etc.

Either way, Local authorities can make use of farmers' prunings for setting up a sustainable supply chain for heating fuel. As in the chapter above, the guide presents the recommended process for doing so in five distinct steps below, numbered from 4.1 to 4.5. Once again, the municipality of Amynteo, in the Region of Western Macedonia, is used to provide a practical example when outlining the different steps to be followed.

4.1 Map the existing management scheme

The first step towards setting up a new supply chain is to map the management schemes currently used for tree prunings from vineyards and fruit tree plantations. A simple way to perform the mapping is to obtain the information that addresses the questions of who, what, when and how.

Who: In the case of prunings from vineyards and fruit tree plantations, it is

clear that the farmers own both the prunings as well as the equipment used to obtain them.

What: The mapping should include an inventory of the different plantations and vineyards in the region, the land area that they cover, what types of trees exist in plantations, and, arising from the above, what are the approximate annual quantities of prunings produced. In the example of Amynteo, the land area of the municipality, around the town itself, includes many vineyards and fruit tree plantations. The vineyards of Amynteo are quite famous in Greece and they cover 1,850 acres[1]. Fruit tree plantations cover roughly 4,900 acres[2], which is 21% of the total agricultural land in the region. They include various trees, mainly apple trees, apricot trees, peach trees, almond trees, cherry trees, pear trees, chestnut trees and walnut trees.

When: It is important to know the recommended time period(s) for tree pruning as this will allow the planning and scheduling of the supply chain. In general, pruning takes place in autumn and winter. The main reason is that, at this time of the year, plants are dormant and their functions are minimized. However, there are also some types of plants that should not be pruned then because their flowering season is in winter months. Usually, deciduous trees are pruned in winter, while evergreens can be pruned the rest of the year under certain conditions such as the prevailing weather conditions, their flowering phase, and so on. Grapevines should be pruned during their dormancy, around February or March, before their budding and flowering begins.

How: "How" is a crucial practical question which refers to the type of equipment used for pruning and the current management process regarding the collection, processing and disposal of the tree prunings. The equipment used depends on what the farmers have

[1] 7,500 stremmata
[2] 20,000 stremmata

at their disposal, but this is usually the standard equipment depicted in the table in Chapter 3. As for the management process, it can depend. In Amynteo, the usual way in which farmers manage the prunings is to mulch them on site and left them to decompose in the fields, since open fires are prohibited by law.. However, in recent years, there has been interest from waste management companies for their use as biofuels in burners.

4.2 Ask critical questions

In addition to the questions above, another significant question concerns the current commercial exploitation of the prunings, if one is in place. That is because the new supply chain has to replace any existing chains, and this might entail providing incentives to farmers.

The critical questions to be asked are: ***Are tree prunings already being commercially exploited and by whom? If yes, what is the final product? Who are the customers? What is the price?***

In the case of Amynteo, most farmers mulch prunings on site and left them to decompose in the fields. Their use as firewood is less common and is found mainly in more rural areas. It should be noted that the commercial use of prunings is not yet widespread.

Since, unlike in Chapter 3 where the prunings are municipal, in this case they are the property of farmers, it is important to ask some additional questions which are crucial for ensuring the farmers' participation in such schemes:

Are the farmers willing to change the existing management scheme?

In the case of Amynteo, local farmers seem to be very willing to change the existing management scheme, since plant diseases are recycled in the plantations as mulched prunings decompose in the fields. Therefore, farmers seem to be very willing to give their prunings to the municipality, as this is a way to dispose of them without cost and effort.

If yes, then who will develop the new management scheme (the farmers, a farmers' association, a private contractor or the municipality)?

In Amynteo, an initial investigation of the potential for a new supply scheme shows that most parties, including the farmers, would prefer the new scheme to be jointly developed by a partnership between everyone involved.

4.3 Map potential end-users

Before a new supply chain is set up, it is crucial to identify the potential end-users of the prunings. This way, it will be possible to estimate the current and potential demand for biomass, calculate costs, establish what technical solutions are needed, and create an overall plan for the supply chain.

Since the prunings from vineyards and fruit tree plantations will be in the same region as municipal prunings, the potential end-users will not differ greatly from those identified for that category of prunings, although, in this case, the farmers themselves are expected to be more heavily involved. Potential end-users can include the following:

- House owners, and specifically the farmers producing the prunings, who might be willing to use a part of the volume to heat their own houses and facilities
- Municipal or public buildings (schools, gyms, the town hall, tax office etc.) which can use the prunings for heating
- Existing solid fuel district heating plants, to be directly supplied with the prunings
- A large commercial boiler, if one exists in the area, which can buy the biomass produced
- Greenhouses, or other agricultural applications of the prunings
- Directly supplying a pelletizing or briquetting plant

4.4 Examine available technical solutions

The final key step needed is to examine the available technical solutions that could serve the new supply chain, from the moment the trees are pruned to when the prunings will be converted into energy.

For example, produced tree prunings can be dragged to the side of the fields and chipped on site by using a towable wood chipper and then transported to a collection site for further processing or storage. Or, alternatively, the prunings can be processed and gathered from the interrows by a mulcher/shredder or chipper with an integrated bin or big bag or a tractor trolley. Then they can be transported to a collection site for further processing or storage. Either way, further processing of the produced

woodchips will depend on the end-user requirements (this is why it was so important to map end-users).

Again, the end-users and their requirements will be virtually identical with the case of municipal tree prunings. In the example of the municipality of Amynteo, the following different cases of potential end-users result in different technical requirements:

- The woodchips can be taken to large grate fired boilers, such as those of the Amynteo Municipal District Heating Company (DETEPA). In this case, no further processing is required. The woodchips can be fed to the boiler as is, since such boilers can tolerate high moisture fuels (even up to 50%).

- The woodchips can be taken to a pelletizing or briquetting plant. Again,no further processing is required in this case, because the chips will be dried, conditioned and further treated in the plant.
- The woodchips can be taken to medium-sized boilers in agricultural businesses. Most such boilers tend to require fuel with moisture content of below 30%, so in this case, further conditioning and drying of the chips will be required.
- The woodchips can be taken to municipal or public buildings, schools, private homes (including the farmers' homes) etc. Due to the type of boilers available in such places, again, further conditioning and drying of the chips will be required.

In case further drying and conditioning is required, the new management scheme will have to include provisions for the site and the required equipment to achieve the needed chip quality.

4.5 Set up the new management scheme

Once all the above steps have been properly addressed, it will be possible to move towards setting up the new management scheme for the prunings, resulting in the new supply chain.

In the case of tree or vineyard prunings the main role of local authorities (such as the municipality) is to inform the farmers about the possible ways of their exploitation. Furthermore, local

authorities may act as end-users for the produced biomass, heating its facilities or buildings. In this case, the local authority may act as a catalyst towards the development of a local biomass market which will benefit everyone and strengthen the economy of the region.

To this end, there are several options in hand, strongly depending of course to the local and/or national conditions. For example, the existence of the framework for Energy Communities in Greece is a very useful tool in this direction: legal entities can come together with individuals to establish an Energy Community, aiming for instance to exploit the biomass residues and/or to provide heat to the District Heating Network and/or electricity to the grid, etc. This form can very well be applied in similar cases as the one identified in aGROWchain project.

Furthermore, all these activities are usually facilitated by local intermediary organizations, acting in between the various players involved in the biomass supply chain. The role of these intermediary organizations can substantially be covered by local and regional Clusters, who aim exactly at bridging the gap between the multiple helix representatives and bringing them together, in order to develop synergies and interactions among them.

As long as biomass for bioenergy usage is more economically feasible at rather short distances, the regional dimension is crucial at this very point: not only biomass is cheaper, but personal relations are also often developing at closer ranges, when people have more often the chance of meeting each other more often than being located remotely. In this sense, the development of trust and confidence, a long and gradual procedure, is often supported and boosted by events organized by the Clusters.

Within this environment, the various players learn to work together, trust each other and build long lasting relations between them.

Additionally, clusters often tend to mobilize the research community and decision makers around their activities.

In this way, the latter are associated to the biomass supply chain, understand its mechanisms and are more eager to support its development, in view of the common benefit. It is under these official or tacit relations that a fully operational ecosystem is deployed, forming the necessary background for the optimum exploitation of biomass at local and regional level.

5. How to dispose of Reeds by converting them to Biomass

In which cases can reeds be used as heating fuel?

The Common Reed is a large perennial species of grass which favours damp to moderately flooded conditions. In such conditions, it usually grows as the dominant plant species and forms extensive continuous patches known as reedbeds. Reedbeds, depending on their size and location, can play important roles in ameliorating local hydrological conditions. In other cases, however, they can cause problems, and clearing them can have important benefits.

The practicality of using reeds as biomass largely depends on local conditions. Reed has a lower calorific value than wood, but compares favourably to other sources of biomass such as wheat straw, Miscanthus and rice husks. In addition, the chemical characteristics of reed largely fulfil the criteria of the European wood pellet standard EN-plus.

In short, wood, as in the case of the use of wood prunings described in the previous chapters, is a more efficient source of biomass than reeds. Reeds, however, can be a very attractive alternative in specific conditions. Primarily in the steppic areas of Eastern Europe where the cost of transporting wood chips or wood pellets is high and reeds are widely available. Or in cases where the collection of reeds is necessary for other reasons.

One such case, the municipality of Novaci, in the southern part of North Macedonia, is used below to provide a practical example when outlining the different steps to be followed by local authorities to use reeds for setting up a sustainable supply chain for heating fuel.

5.1 Map the existing management scheme

The first step towards setting up a new supply chain is to map the management scheme currently used for reeds (if one is used). As in the previous chapters, a simple way to perform the mapping is to obtain the information that addresses the questions of who, what, when and how. In the case of Novaci, there is another important question concerning why.

Why: As explained in the start of the chapter, the use of reeds is a better alternative source of biomass under specific local conditions. The first question to be considered, then, is whether such conditions exist in the case being examined. The area of the municipality of Novaci contains several sources of biomass which might be more efficient than reeds. Therefore, the harvesting of reeds is not done with the primary aim of obtaining biomass, but for other, more important reasons. The area has an extensive network of canals used for irrigation and drainage. Reeds growing in these canals can slow down the water flow, making irrigation of fields more difficult or severely increasing the risks of floods. This makes their removal very crucial, and making use of the removed reeds for biomass can be a very important and sustainable side benefit of this.

Who: Reedbeds are present in natural or artificial water features which usually belong to the local municipality or fall under its authority. The question is whether the harvesting of the reeds will be undertaken by the municipality itself or by subcontractors. In the case of Novaci, the municipality uses a tractor with a special boom arm and a trailer, to harvest and collect the reeds.

What: The mapping should include an estimate of where the reeds are and what are the estimated annual quantities which will be produced. The area belonging to the municipality of Novaci has a highly developed hydrographic network, crossed by numerous river flows and including an extensive network of canals used for drainage as well as irrigation. These canals are around 35 km in total length, and there are several reedbeds growing along them.

When: It is important to decide on the best period for the harvesting of reeds. This can depend on several different factors. Since the moisture percentage of reeds differs according to the time of year, and the lowest percentage is reached between January and March (18%-20%), this can be considered a good period for harvesting them. However, due to their composition, reeds dry very quickly after they are removed from the water, so other periods can be suitable as well. In the case of Novaci, reeds were harvested in November to ensure that the drainage canals would be clear of obstacles ahead of the spring flood period, as this is the

primary purpose of harvesting the reeds anyway.

How: "How" is another crucial practical question which refers to the equipment used for harvesting the reeds, and to the current management process regarding their collection and processing (if one is in place). The harvesting of reeds requires some kind of specialised equipment. The simplest and most efficient solution, as in the case of Novaci, is to fit a tractor with a 10-metre-long boom arm (pictured), which can be used for clearing reeds from reedbeds.

5.2 Ask critical questions

In addition to the questions above, another significant question concerns the current commercial exploitation of the reeds, if one is already in place. That is because the new supply chain has to replace any existing chains. If the reeds are not being exploited then the new supply chain will be established from scratch.

The critical questions to be asked are: ***Are reeds already being commercially exploited and by whom? If yes, what is the final product? Who are the customers? What is the price?***

In the case of Novaci, the reeds collected from the local canals were not being exploited in any way until recently, but simply treated as waste. This provides no obstacle to the creation of a new supply chain, built from scratch.

5.3 Map potential end-users

Before a new supply chain is set up, it is crucial to identify the potential end-users of the municipal prunings. This way, it will be possible to estimate the current and potential demand for biomass, calculate costs, establish what technical solutions are needed, and create an overall plan for the supply chain.

For example, in a typical small-scale municipality, potential end-users can include the following:

- Municipal or public buildings (schools, gyms, the town hall, tax office etc.) which can use the reeds for heating
- Existing solid fuel district heating plants, to be directly supplied with the reeds
- A large commercial boiler, if one exists in the area, which can buy the reeds produced

- Construction plants, since reeds are increasingly being used to produce composite building materials such as moisture-resistant MDF boards or granulate panels
- Directly supplying a pelletizing or briquetting plant, since reeds can be pelletized – note however that reed pellet properties are well within the limits for commercial, but not domestic, use in biomass boilers

5.4 Examine available technical solutions

The final key step needed is to examine the available technical solutions that could serve the new supply chain, from the moment the reeds are harvested to when they will be converted into energy. After they are collected from the riverbanks, reeds need some time to dry (reach a percentage of humidity around 12%), even if they were harvested at the time that their moisture content was the lowest possible. Usually, however, the required drying period is very short and can even be covered in the time it takes to transfer the reeds to the place where they will be further processed. Since reeds normally grow to about 2 metres high, they usually require some kind of processing to make handling them and feeding them into biomass boilers more convenient. Reeds can be chopped, baled or palletised.

In the example of the municipality of Novaci, after they are harvested, the reeds are loaded onto a trailer pulled by a tractor and taken to an open space next to the village elementary school. The time between their harvesting, transport and further processing is enough (provided that there is no rain) for the reeds to reach a dry state. To make them easier to handle, the reeds are pressed into small rectangular bales that are light enough to be carried by a single person. Because the whole reeds are too hard to bale without a risk of damage to the machine, they require an intermediary processing stage in which a tractor with a disc harrow drives over them, chopping them up to smaller bits. These bits are then baled and the bales placed in a storage room at the local elementary school. When needed, they are fed into a straw boiler (pictured) which is used for heating the school via the newly installed radiator system.

5.5 Set up the new management scheme

Once all the above steps have been properly addressed, it will be possible to move towards setting up the new management scheme for the reeds, resulting in the new supply chain.

For example, the municipality may run the supply chain itself, producing low-cost biomass for heating its facilities/ buildings/DH plants etc. Or, the local authority may subcontract the whole service (biomass collection, processing, storage and final delivery) to a private operator. In this case, the operator will be paid by selling the final product to the municipality at a pre-agreed price.

The management scheme used by the municipality of Novaci was described in the section above. The scheme is an excellent example of circular economy in practice, as clearing the reeds from canals to prevent floods results in a free heating source for the local school, as well as in increased heat quality, since the installation of the straw boiler necessitated a change from heating panels to radiators.

6. Additional Reading

- BIOEUPARKS project: Steps in setting up wood biomass production chains in protected areas https://www.europarc.org/wp-content/uploads/2015/05/Guidelines_Setting-up-a-wood-biomass-chain.pdf
- Brown, R. C. (Ed.). (2019). *Thermochemical processing of biomass: conversion into fuels, chemicals and power*. John Wiley & Sons.
- Duke, G. & Goriup, P. (2015). Innovation for reed bed biomass fuel and biodiversity by FIELDFARE – ANALYSIS OF THE OPPORTUNITY. EU Business and Biodiversity Platform https://ec.europa.eu/environment/biodiversity/business/assets/pdf/workstream2/fieldfare_en.pdf
- Ghosh, Sadhan. (2016). Biomass & Bio-waste Supply Chain Sustainability for Bio-energy and Bio-fuel Production. Procedia Environmental Sciences. 31. 31-39. 10.1016/j.proenv.2016.02.005.
- Icka, P., Damo, R., & Icka, E. (2017). Reed Biomass, a Possibility of Cultivation and Protection of "Wetland" in Korça Field in Albania. *Annals" Valahia" University of Targoviste-Agriculture*, *11*(1), 1-5.
- Interreg SHIFFT project: A common approach for sustainableheating strategies for partner cities https://shifftproject.eu/wp-content/uploads/2020/04/A-common-approach-for-sustainable-heating-strategies-for-partner-cities_final_13-March-2020.pdf
- ReedBASE project: Sustainable Use of Reed Biomass- Background Paper https://www.umweltbundesamt.de/sites/default/files/medien/1411/beratungshilfe/anlage08_hintergrund_papier_zur_konferenz_0.pdf
- Romero, I., Ruiz, E., Castro, E., & Moya, M. (2010). Acid hydrolysis of olive tree biomass. *Chemical Engineering Research and Design*, *88*(5-6), 633-640.
- Spinelli, R., & Picchi, G. (2010). Industrial harvesting of olive tree pruning residue for energy biomass. *Bioresource Technology*, *101*(2), 730-735.
- uP_running H2020 project, at: https://www.up-running.eu/
- U.S. Energy Information Administration: Biomass Explained https://www.eia.gov/energyexplained/biomass/
- Vaičekonytė, R., Kiviat, E., Nsenga, F., & Ostfeld, A. (2014). An exploration of common reed (Phragmites australis) bioenergy potential in North America. *Mires and Peat*, *13*(12), 1-9.
- van der Sluis, T., Poppens, R. P., Kraisvitnii, P., Rii, O., Lesschen, J. P., Galytska, M., & Elbersen, H. W. (2013). *Reed harvesting from wetlands for bioenergy: technical aspects,*

sustainability and economic viability of reed harvesting in Ukraine https://edepot.wur.nl/282354

- Velázquez-Martí, B., Fernández-González, E., López-Cortés, I., & Salazar-Hernández, D. M. (2011). Quantification of the residual biomass obtained from pruning of trees in Mediterranean olive groves. *Biomass and Bioenergy*, *35*(7), 3208-3217.
- Wrobel, C., Coulman, B. E., & Smith, D. L. (2009). The potential use of reed canarygrass (Phalaris arundinacea L.) as a biofuel crop. *Acta Agriculturae Scandinavica Section B–Soil and Plant Science*, *59*(1), 1-18.
- World Bioenergy Association: Biomass Supply Chains – Harvesting & Collection, pre-treatment and upgrading, storage, transportation and handling https://worldbioenergy.org/uploads/Factsheet%20-%20Biomass%20Supply%20Chains.pdf

Co-funded by the European Union and National Funds of Greece ang Repubic of North Macedonia, via the Interreg IPA CBC Programme

“Greece – Repubic of North Macedonia 2014 – 2020”

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