Policy Guidelines and Roadmap

+ Specific National Roadmap

Deliverable 2.3
WP2. Supporting local supply bioenergy chains

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

Grant agreement: 691748
From April 2016 to June 2019

Prepared by: UFG

Date: 8/10/2018

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: D2.3 Policy Guidelines and Roadmap

+ Specific National Roadmap

Responsible Partner: University of Foggia (UFG)

WP: 2. Supporting local supply bioenergy chains

Task: 2.4 Sharing policy guidelines and recommendations

Deliverable nº: 2.3

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Version: 1

Version Date: 08/10/2018

Approvals

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ABBREVIATIONS

APPR	Agricultural pruning and plantation removal
CAP	Common Agricultural Policy
CHP	Combined Heat and Power
EU	European Union
GHG	Green-House gases
LCA	Life Cycle Assessment
MS	Member States of the EU
NECP	National Energy and Climate Plans
NREAP	National Renewable Energy Action Plan
RED II	Recast of Renewable Energy Directive
RED	Renewable Energy Directive

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DOCUMENT SCOPE

The use of agricultural residues as a source of biomass is an opportunity for supporting the expansion of bioeconomy in Europe. Among the multiple kind of agro-residues, those produced directly in the field from pruning operations on vineyards, olive groves and, more generally, orchards or specialized fruit plantations represent a significant potential for many EU countries.

The wooden biomass residues from Agricultural Pruning and Plantation Removal (APPR is the corresponding acronym) is a typical example of agro-residues obtained annually or periodically due to tree care and maintenance. Unfortunately, in most cases, these residues are not utilized as a resource to obtain added-value products, such as energy, biochemicals or other biocommodities.

The *uP_running* project [1] is a Horizon 2020 initiative (performed under the call LCE-14-2015, Low-Carbon Energy.) bringing together 11 partners from 7 European countries, allied in pursuing one main goal: promoting the take-off of APPR biomass in Europe.

uP_running is deploying an effective collaboration among technological and research centers, universities, agricultural associations, agricultural chambers of commerce and productive clusters to drive a real change towards an increased utilization of APPR biomass, by sustaining the start-up of new initiatives, but also promoting a more favorable framework and social perception.

This document is a public deliverable of the project itself, prepared as a specific activity of the following Work Package: "Supporting local bioenergy supply chains". It is the third one, issued after the release of two previous deliverables: "Sector Analysis and Action Plan for the Demo Regions" (D2.1) and "Sector Analysis and Strategic Plan at National and EU level" (D2.2).

This final document (a "key" project deliverable) spring out from the outcomes of the APPR sector analysis previously performed and is perfectly in tune with the results obtained from many participative events (such as focus groups, forums, workshops, etc.) in each of the 7 partnering country.

- The first objective is to provide the set of *missions* addressing the final *vision* of the APPR/bioenergy sector.
- Secondly, to offer a list of *key messages* (together with *facts and figures*) highlighting the relevance and benefits of APPR/bioenergy.
- Thirdly, propose a set of *policy recommendations* in consequence of a list of *actions to be taken* that are warmly suggested to boost the sector development.
- Finally, a *roadmap* will guide the systematic implementation of those actions according to a scheduling plan.

A *vision* is an idea or concept we wish to realize; therefore, it pertains to the ultimate goal we are striving to achieve. The *missions*, differently, are a set of reasons and beliefs pertaining to the people or organizations within the sector, having that vision as a common intent. A mission explains

[1] *uP_running* - Take-off for sustainable supply of woody biomass from agrarian pruning and plantation removal. H2020 project, LCE-2014-3. Topic: Market uptake of existing or emerging sustainable bioenergy. Project website: www.up-running.eu.

the reasons why and, of course, it supports the vision. We can also say that the vision focuses on tomorrow and what the sector wants to become ultimately, while the mission focuses on today and what the sector could contribute to achieve its vision.

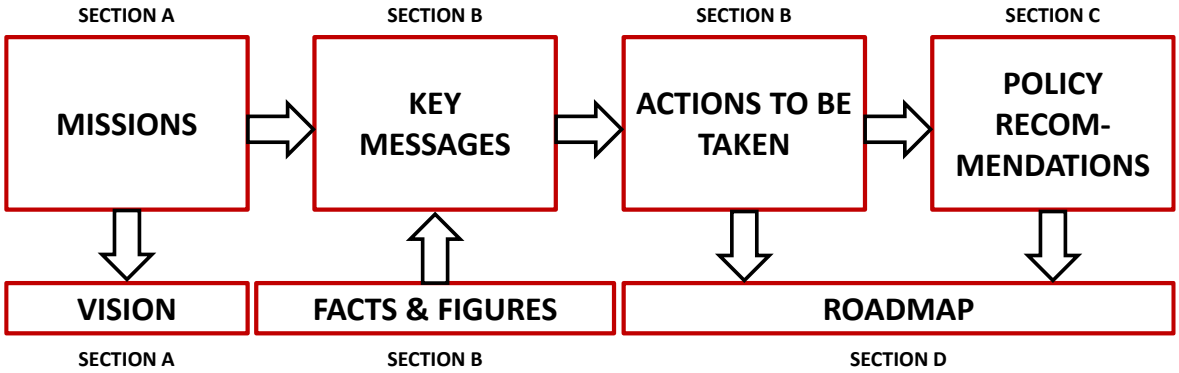
The *policy recommendations* are for policy makers in governments (at regional, national and EU level) but also for the sector operators (in agriculture and industry), particularly considering representatives in sector associations and professional organizations as well as opinion leaders. They serve to capture the right instruments and allow their implementation, trying to overcome technical and non-technical barriers or reinforce the drivers promoting the progress of the APPR / bioenergy sector. They should be considered also a guide in designing strategies of sector development, from inside (considering its internal stakeholders) or from outside (by policy makers and public administrations), looking for the best-fitted policy measures needed to support biomass and bioenergy as an integrated agro-industrial sector.

The *roadmap* is a tool defining, step-by-step, the progress to be made along a well-defined path of development. It helps in monitoring the progress performed by gradually matching short-term targets, through a secure, affordable and coordinated long-term plan.

In very simple words, this final document could be used (we really hope so) as a reference for both sector representatives (in industry and agriculture) and policy makers to implement the steps necessary to achieve the suggested vision and its consequent goals.

Moreover, these selected recommendations could be the objectives of an advocacy action aiming at influencing decisions within the political, economic, and social milieu.

The following is the schematic structure of the document; its several sections were organized according to the previous defined arrangement.



For those who are interested in deepening the topics presented in this document, wishing to understand how these issues were originated and largely discussed within the project framework, then the reading of the two previous deliverables may be advisable [2].

In our intention, this document should be agile and quickly readable, concise and possibly schematic, in order to represent an effective tool to obtain a readily but comprehensive view about biomass, bioenergy, crop residual feedstock (such as APPR) and several issues revolving around such a complicated subject.

Therefore, it was preferred a quick "beat of wings" on the most relevant and effective topics, thus offering at glance the overall picture, rather than a detailed analysis, certainly more exhaustive, but much more demanding in terms of reading-time. We really hope this was the right decision.

Soon after the first draft of the document was prepared, it was submitted to the critical consideration of 16 experts from several European countries and EU wide organizations. With respect to the experts' background and affiliation: 7 were the experts from sectorial Associations (4 from Biomass Associations and 3 from Agricultural or Farmer Associations), while 9 were the experts from academia or research institutions on biomass and energy. The reviewing outcomes were very useful in order to fine-tuning the document, reach a wider and general agreement, stressing the most relevant issues, thus preparing a final and definitive document to be released.

Just a concluding note about the most used acronym of the whole document. *APPR* stands for "agrarian pruning and plantation removal". It is meant the residual wood biomass obtained from pruning operations and from the trees removed at the end of the plantation lifespan, in both specialised plantations and orchards, optionally useful in renewable energy generation, especially heat and power. This acronym will be used repeatedly all across the document. You will become familiar with it.

[2] The previous two aforementioned deliverables (D2.1 and D2.2) can be retrieved from the project website: http://www.up-running.eu/project-materials/. In order to catch the most benefit from this document, the best approach would be to have a reading of D2.1 and D2.2. However, this is not necessarily a prerequisite. In any case, the three deliverables are standing-alone documents and might be read independently.

SECTION A. THE VISION AND THE MISSIONS OF BIOENERGY/APPR

A range of fundamental beliefs about biomass and bioenergy is presented as expressed by stakeholders. Biomass is a biological energy source and bioenergy is a renewable energy system solution. Some basic statistics and a quick analysis about the energy sector in Europe is offered, specifically considering the role played by biomass and bioenergy. Finally, some policy recommendations are suggested, by indicating the objectives to be reached together with measures and instruments to promote the bioenergy sector.

Suggestions and proposals about the "things to do" are forwarded to encourage mindful actions by policymakers (at EU, national, and regional level), energy planners, representatives of the energy, agriculture and industrial sectors and, more in general, all stakeholders directly or indirectly involved in the APPR supply chain.

A comprehensive range of stakeholders, at regional, national and EU level, has expressed a firm confidence about the contribution biomass / bioenergy should offer in the future energy mix. This mix, indeed, will be mostly represented by renewable energy sources, and the share of bioenergy (in terms of both energy production and consumption) could remain significant in the years to come. The multiple and diversified forms of energy carriers potentially offered by biomass and the APPR kind of feedstock can further contribute to a larger application of these renewables. Energy for households, large buildings, district heating, heat & cooling for industrial applications, as well as for agro-food processing, together with advanced biofuels, can be sustainably obtained from a stronger biomass mobilization, a more efficient biomass-to-energy conversion, and a wider and stable bioenergy market.

The sustainable use of biomass resources, with particular reference to vineyard, olive grove and other fruit-tree residues, may form the "unifying vision" in fostering a vigorous decarbonisation path, setting free our society from fossils, and promoting a further social progress in EU. This progress should be focused on the bioeconomy model, based on the multifunctional approach of agriculture, chiefly targeting rural development and achieving a more efficient agro-industrial integration.

A "vision" defines the optimal desired future state, is a mental picture of what we want to achieve, it provides a guidance and an inspiration, it works like a "north star". On this respect, a *vision* is the idea or concept we wish to realize, it pertains to the ultimate goal we are striving to achieve, or the future successful state we want to reach.

The stakeholders' vision about biomass (APPR) and bioenergy

Bioenergy participates in the ecological shift of society targeting a full sustainable quality of life

Bioenergy is an integral part of a general ecological transition that our societies are gradually implementing, from the side of both productive structures and consumption models. This ecological

shift is now pressing and extremely urgent; it is made of several tesserae, all of them crucial but complementary; they are jointly oriented towards achieving long-term well-being for humankind, overcoming several environmental problems originated by man.

GHG emissions in pace with carbon sinks, the recovery of residues and the recycling of waste, energy saving and higher energy efficiency, durably use of renewable resources, high natural forms of agriculture, farming operations preserving soil fertility and favouring food quality and, finally, technological innovation in a sustainable key.

Agreed that expanding the availability of renewable energy and displacing fossil fuels is not only useful but also extremely necessary, achieving a post-fossil condition of our energy systems cannot be obtained indiscriminately or arbitrarily. Therefore, the true value of the energy derived from biomass resources is not simply expressed by the amount of renewable energy produced, but rather by the effective improvement of the quality of life, in terms of a complex and comprehensive set of indicators (i.e. social equity, public health, environmental restoration, community reinforcement, job opportunities, and so on). In simpler words, we can say that the way in which renewable energy from agro-forestry biomass is produced is much more decisive than the quantity of its production.

Moreover, a nexus perspective increases the understanding of the interdependencies across the water, energy and food sectors, influences policies in other areas of concern such as climate and biodiversity, informs management integration and governance across sectors and scales.

The stakeholders' missions about biomass and bioenergy

The *vision* is based on the deep convincement and clear evidence about the positive traits offered by the bioenergy/APPR sector. Therefore, the following is a concise list of the focal aims (*missions*) making-up the bioenergy vision according to opinions expressed by a wide range of stakeholders.

Mission 1:

Biomass plays a relevant part in the set of renewable energy sources

The sustainable use of biomass for energy conversion generates several positive effects, optimally framed in the process of ecological regeneration at local / regional scale. In order to cope with climate change, we must quickly adopt all possible and effective solutions. Among these solutions, a large variety of bioenergy value chains and business models are available and ready to be implemented. Biomass mobilization is based on a well-balanced and properly planned feedstock supply, carefully employing the current land and biomass resources (such as food, feed and fibre) without decreasing their long-term availability. Geography traits and territorial characteristics shape every locally conceived bioenergy project towards favourable environmental and socio-economic standards. In this way, a participating local community can recognize and improve its economic potential, environmental goodness and social value. Community participation can to be

effective when the local population is involved not only as co-operating users or providers, but also as natural resource managers or owner managers.

Mission 2:

Bioenergy is triggering new forms of agro-industrial integration

A close and worthy link is established between agricultural activity and industrial processing. This integration should not be exclusively restricted to the agro-food sector, but also expanded to include non-food biomass as source of biological feedstock and energy carriers.

Apart renewable energy, such as heat, power and biofuels, a wide range of industrial uses of biomass are also possible (green chemicals, platform chemicals, pharmaceuticals, cosmetics, bioplastics and plastic resins, technical oils, composite materials, carbon fibres, and many others), thus displacing products obtained from fossil fuels.

According to the fundamental pillars of a bio-based economy, a biological raw material can be further transformed into new products, following “circular” processes, but it ultimately remains a source of organic nutrients to be used as agricultural inputs (fertilizer) unless converted in energy.

Mission 3:

Bioenergy is a bioregional, land-tailored process

Bioenergy value chains are connected and included within the territorial milieu, as well as in the socio-economic fabric of a “place”. This place (the land) is special and unique; it expresses historical, cultural and natural values that cannot be overridden by an exogenous model (i.e. determined by decisions from above and from outside). “Land-tailored” means use the land respecting the sense of the place, not only its natural resources, but also in conformity with the cultural traditions of society.

No bioenergy project should be overruled on both the land and the human community is living there. Conversely, it should be planned in accordance with the most evident “traits” of the place and the community needs.

Bioenergy value chains should offer new opportunities and services, in a complementary relationship with pre-existing agricultural and forestry activities.

Mission 4:

Bioenergy primes a self-sustained local development

Bioenergy projects, being rooted in the regional fabric, are promoting a community oriented, self-reliant, and self-sustaining models of development. They represent a powerful and effective lever of productive diversification in the rural sector, allowing an alternative source of farm income,

reinforcing farming activities in marginal rural areas, generating added-value from non-conventional productions, although still connected to agriculture. Hence, bioenergy significantly contribute in promoting socio-economic development at local scale.

Mission 5:

Bioenergy value chains participate in an open and multifunctional socio-economic model

If the "local" dimension of bioenergy value chains is confirmed, the sector development can be achieved without detrimental effects on other agricultural activities (e.g. by subtracting arable land, resources and investments to the food sector), or jeopardizing the environmental quality.

The term "local" does not necessarily mean "small scale"; it rather means that the project is conceived, planned, implemented in accordance with, and relying on the participation of the local rural community.

For sure, to be "local" is not the only sustainability criterion to be applied and then feel safe, but "local" bioenergy projects can be not invasive, and they can be harmonized with pre-existing activities, specifically considering territorial constraints and drivers.

At the same time, a plurality of broader objectives can be met thanks to well-tailored bioenergy projects: sustainable agro-forestry management; energy use of waste, residues and by-products; diversification of farming systems; increase of agricultural income; soil protection from hydrogeological instability; finely tuned rural development processes; employment and new business settlement.

This considering, bioenergy value chains can be recognized as a fundamental component of the multi-functional asset of agriculture, and the production of renewable energy from biomass one of the features, among many others, of a self-centred and multidimensional rural development.

Stakeholders' vision about APPR biomass

When considering the APPR feedstock, the advantages offered by the biological and renewable nature of this feedstock further highlight the positive characteristics and the thorough sustainability of the bioenergy value chains that can be planned and implemented starting from this kind of biomass.

The bioenergy value chains based on APPR clearly shows the potential benefit to be assigned to bioenergy models "done-right". Indeed, considering the residual origin of the biomass obtained from APPR, it can represents a very suitable candidate as an energy carrier.

Although the fuel quality standard is lower than wood from forestry, it represents a useful and competitive energy carrier with respect to similar solid biofuels (such as pomace, nuts, marc, lees, etc.).

Mission 6:

Energy from APPR contributes significantly to the "decarbonisation" of the energy system

The energy use of APPR can contribute (especially in some regions of large availability) to replace and minimize the consumption of fossil fuels and to reduce the emissions of GHG responsible for global climate change.

No GHG emissions or energy consumptions are assigned to the agricultural phase of a bioenergy value chain if crop residues (such as pruning) are removed from the agricultural land with the purpose of energy conversion. This property significantly decreases the “carbon footprint” of the energy obtained from pruning and impressively increases the GHG emission savings.

Mission 7:

APPR biomass can be conveniently used as a renewable energy carrier without claiming additional resources

Since APPR is a residual kind of biomass (i.e. not obtained as main product, but as a crop residue), its use as energy carrier does not compete with food production, nor it subtracts agricultural land from surfaces ordinary dedicated to food crops. Conversely, it represents a totally new and supplemental resource to be mobilized successfully.

This considerable biomass availability should be added to the biomass obtained from other residual biomass sources as well as from dedicated energy crops (both annual and perennial). Dedicated energy crops can be cultivated on marginal farmlands or according to effective and useful crop rotational schemes, thus effectively contributing to the ecological farming management, promoting crop diversification, soil conservation from erosion, the organic matter build up in the soil, low farming inputs and protection wild animal and plant biodiversity.

Mission 8:

Energy from APPR lessens the energy dependence of the agricultural sector

The energy derived from APPR significantly decreases the energy dependence of the farms from which this kind of biomass is obtained. APPR bioenergy provides self-supplied energy and assure energy self-consumption.

APPR bioenergy can greatly contribute to the energy supply in favour of agro-food or agro-industrial processing activities in the rural areas where the farm itself is operating.

This renewable energy carrier also reduces the energy needed for transport and distribution, ending up with few losses along the supply chain.

Mission 9:

APPR supply enhances the farm productive diversification, also favouring income integration

APPR collecting and sale contribute to the diversification of farm production and, therefore, to the increase of farm income. At least, it significantly reduce the costs resulting from the APPR management if these residues are wrongly treated as a kind of waste to be disposed.

New value chains can be setting up and innovative logistics supply services activated (at single farm or farm cooperative level) in order to decrease the harvesting and transportation costs and maximize the biomass quality as energy carrier and final renewable biofuel.

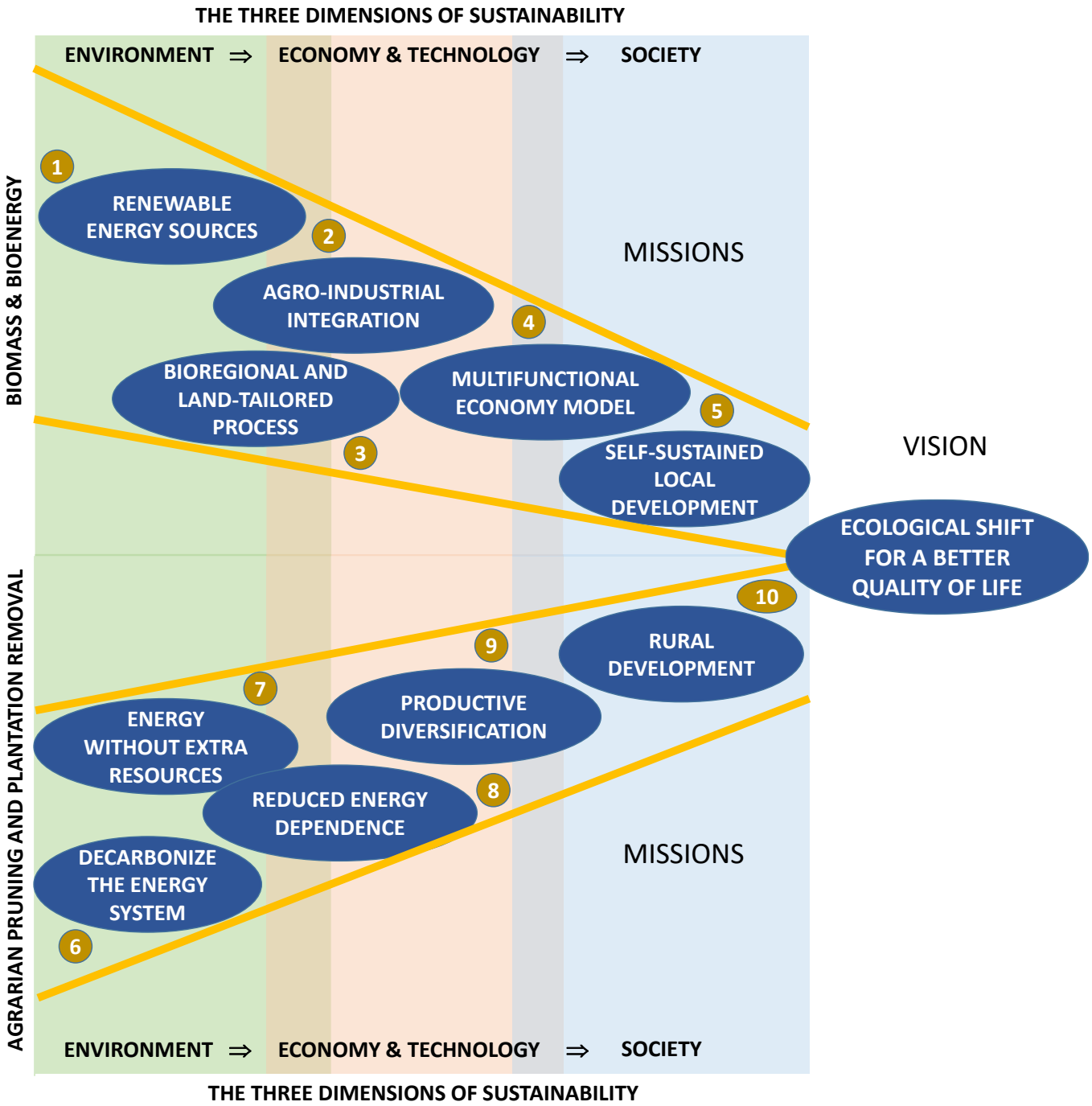
Alternatively, depending on soil conditions, fruit tree management and climate, pruning can be shredded in the field, then left on the soil surface or subsoiled. Intermediate conditions (shredded pruning partly left on the soil, partly removed) can also be applied, according to the specific conditions observed.

Mission 10:

APPR valorisation represents a flywheel for rural development

Bioenergy models focused on the use of APPR can boost local economic development when locally structured within the regional rural areas. These models can act as a positive driver, leveraging new forms of agro-industrial integration, this time giving the main advantage on the side of agriculture rather than industry (unlike what happened in the agri-food sector).

Depending on the local energy demand, APPR could be used as a renewable energy fuel at spot. Alternatively, it can be sold on markets in forms of pellets or woodchips, as well as heat and electricity.

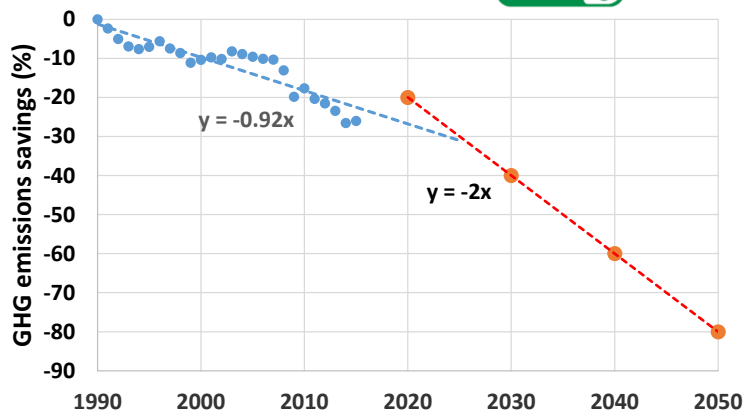

THE THREE DIMENSIONS OF SUSTAINABILITY
ENVIRONMENT ⇒ ECONOMY & TECHNOLOGY ⇒ SOCIETY
BIOMASS & BIOENERGY
AGRARIAN PRUNING AND PLANTATION REMOVAL
1
RENEWABLE ENERGY SOURCES
2
AGRO-INDUSTRIAL INTEGRATION
4
BIOREGIONAL AND LAND-TAILORED PROCESS
3
MULTIFUNCTIONAL ECONOMY MODEL
5
SELF-SUSTAINED LOCAL DEVELOPMENT
MISSIONS
VISION
ECOLOGICAL SHIFT FOR A BETTER QUALITY OF LIFE
10
RURAL DEVELOPMENT
9
7
ENERGY WITHOUT EXTRA RESOURCES
PRODUCTIVE DIVERSIFICATION
8
REDUCED ENERGY DEPENDENCE
DECARBONIZE THE ENERGY SYSTEM
6
MISSIONS
ENVIRONMENT ⇒ ECONOMY & TECHNOLOGY ⇒ SOCIETY
THE THREE DIMENSIONS OF SUSTAINABILITY

SECTION B. KEY MESSAGES

1st Message:
Climate change is the absolute planetary priority to be tackled

Potential drivers	Connected to Mission 1	Possible risks or barriers
Transition to a low carbon, climate resilient, sustainable development is an imperative target to manage effectively the risks associated with climate change	Biomass plays a relevant part in the set of renewable energy sources	Climate change poses a severe threat to future sustainable development unless anthropogenic effects driving GHG emissions are fully reconciled

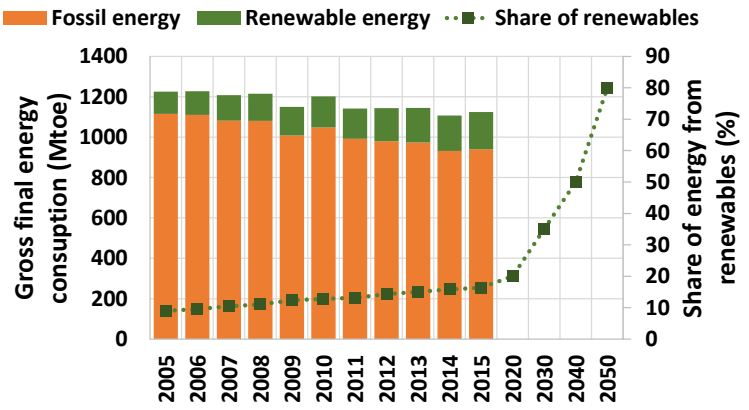
Facts & Figures



GHG reduction over time

- ✓ The European Union is currently on track to achieve its GHG emission reduction target of a 20 % decrease by 2020.
- ✓ Faster decreasing rates of GHG emission are necessary to achieve 80%, or even 95%, decrease by 2050.

Data source: Eurostat.
Calculation: "uP_running"



EU Parliament and Council provisionally agreed on a share of energy from renewables of at least 32% of the Union's gross final consumption in 2030, with an upwards revision clause by 2023.

Share of renewables over time

- ✓ The European Union is currently on track to meet its renewable energy target, i.e. that 20% of its energy should come from renewable sources by 2020.
- ✓ In view of the EU's longer-term target for 2050, the RES deployment rate should increase significantly.

Actions to be taken:

- ➢ The Paris agreement on GHGs reduction (COP 21) is very demanding and needs to be implemented as soon as possible, carefully planned and also monitored ongoing.

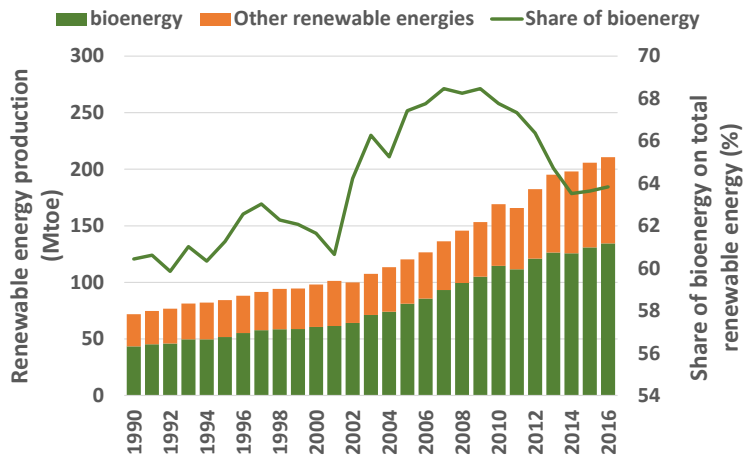
- Renewable energy must continue to play a fundamental role in the transition towards a more competitive, secure and sustainable energy system. This transition will not be possible without significantly increase the share of renewable energy.
- An exceptional effort needs to be deployed in order to boost transition towards renewable energies, on both supply and demand side. This requires a strong and rapid strengthening of the renewable energy installed capacity, specifically considering the role of biomass as sustainable energy source.
- In parallel, considerable efforts are requested in improving the energy conversion efficiency as well as the energy end-use efficiency in order to save energy and increase the energy intensity of the economy in Europe. RED II is leading the way in this direction. Similarly, "eco-design" standardization is also offering further improvements in energy efficiency and emission savings. Industry should take a prominent role in these issues.
- Potential great synergies can be established between the circular economy and various biomass uses for a range of products with higher added-value than just energy. In this regard, APPR are biomass source ready at hand to be included in circular economy and bioeconomy vision.

2nd Message:

Bioenergy and solid biomass are playing a very crucial role in contributing in the EU energy mix

Potential drivers	Connected to Mission 1	Possible risks or barriers
Bioenergy (also including advanced biofuels) represents the largest proportion of the EU renewable energy mix, and it will continue to be important also in the future	**Biomass plays a relevant part in the set of renewable energy sources**	Although other forms of renewable energy sources are remarkably increasing their contribution, there is a high risk of failing to achieve long-term climate goals without considering bioenergy provision

Facts & Figures



EU-28 gross inland energy consumption of solid biomass

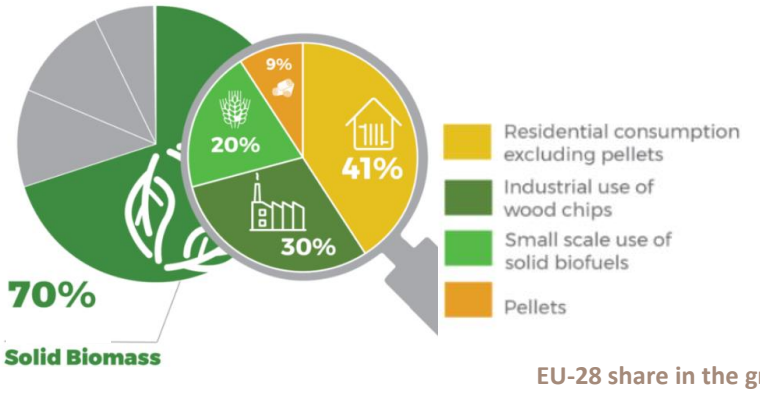
Data source: Eurostat; AEBIOM calculation

The great relevance of bioenergy

Bioenergy is by far the most significant renewable energy source in the EU. It accounts for 64 % of all renewable energy production in 2016

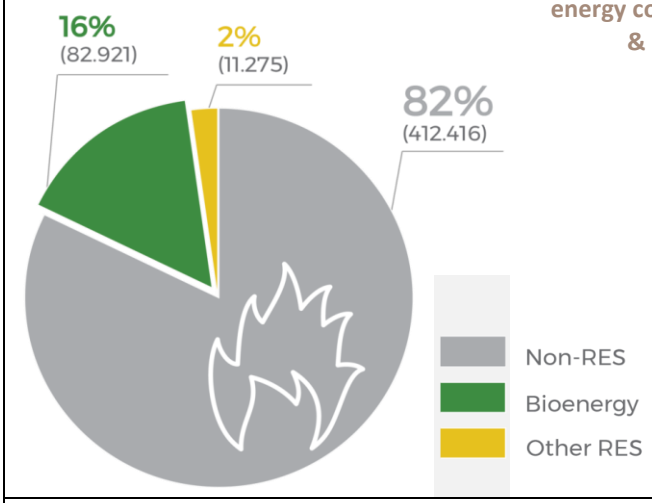
Solid biomass is the most important energy carrier

More than two thirds (70 %) of biomass consumed in Europe consists of **solid biomass** being mostly forestry residues but also agro-residues such as APPR biomass



Heating and cooling represents around 50% of total EU energy consumption, of which 82% is powered by fossil fuels Bioenergy is currently the leading renewable in heating and cooling (88%) representing 16% of European gross final consumption of energy in this sector

EU-28 share in the gross final energy consumption for heating & cooling biomass



Renewables in heating and cooling are becoming a key priority for EU policy, specifically in buildings, a sector which is essential to address in order to reach EU decarbonisation objectives

Data source: Eurostat; AEBIOM calculation

Actions to be taken:

- The contribution of bioenergy to a low-carbon scenario is of crucial importance. Energy from solid biomass is a strategic asset in EU. Therefore, EU and MS national policy should consider with great care and attention the biomass / bioenergy sector and the large influence it has on the energy system and in the economy at large.
- Sustainable bioenergy is an essential component in the portfolio of measures for a low-carbon energy system. This relevant condition should be confirmed also in the years to come.
- Considering that the electricity obtained from biomass (biopower) is programmable (i.e. continuously produced in a stable form), it can effectively contribute to integrating non-programmable renewable sources (such as photovoltaic systems and wind turbines) without altering the electrical grid. In the meanwhile that "smart grids" are implemented routinely, biomass contribution in feeding the grid should remain substantial.
- Biomass addressed to heating and cooling are the best candidate in contributing significantly in decarbonisation; both the building and industrial sectors could be rapidly decarbonized, if solid biomass systems are implemented.
- A faster turnover of outmoded biomass plants together with the scrapping and substitution of old bioenergy systems (stoves, boilers, thermal appliances, etc.) can promote new high-efficiency technologies and a better monitoring of atmospheric emissions (with particular reference to PM10 and PM2.5). These conditions would also promote a larger use of biomass for energy purposes.

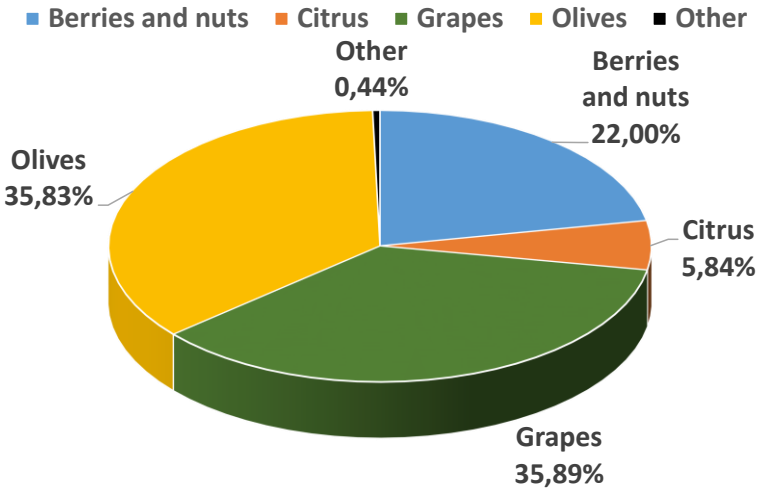
- A large amount of energy (heat or cold) is lost by leakage from buildings of low constructing quality. Two-third of the EU's buildings were built when energy efficiency requirements were non-existent. A large and pervasive requalification plan of old buildings should be implemented.
- As can be observed, biomass energy sources can make heating and cooling an efficient and sustainable priority for Energy Union. Unfortunately, the heating and cooling sector remains underestimated, showing great room for improvement.
- Conversely, subsidies to fossil fuels should be removed, in both their direct and indirect forms of support, as well as a "carbon tax" to sectors outside ETS should be applied, considering appropriate accounting procedures (see "policy recommendation").

3rd Message:

Impressive, unexpected and largely distributed is the amount of renewable energy potentially obtainable from APPR biomass in Europe

Potential drivers	Connected to Mission 1, 8	Possible risks or barriers
A wide range of biomass feedstock can be supplied, a wide range of final energy products can be obtained, and a wide range of energy services can be offered	**Biomass plays a relevant part in the set of renewable energy sources** **APPR energy use lessen the energy dependence of the agricultural sector**	A slower-than-expected growth in APPR bioenergy is still observed, but biomass extraction rate should be in tune with soil conditions and its carbon content. Moreover, dispersed sources of APPR poses a feasibility challenge due to logistics

Facts & Figures



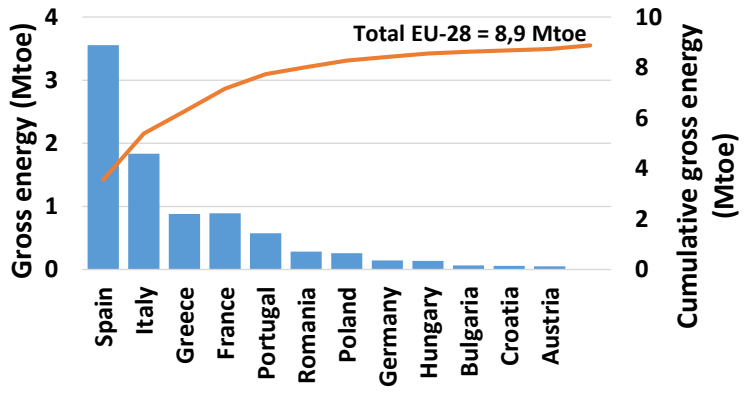
Breakdown (%) of fruit tree surfaces in EU-28

Data source: Eurostat. Calculation: "uP_running"

Some meaningful estimates

- ✓ Fruit tree cultivation surfaces ~ 11.33 Mha
- ✓ Theoretical potential pruning availability ~ 25 Mt/y (dry matter). No possible alternative uses are considered.
- ✓ Potential gross energy content ~ 8.9 Mtoe/y
- ✓ More than 80% of the potential gross energy can be obtained from the first 4 countries in the rank

Read *Note 1* for explanations about estimates



Contribution by country to the potential availability of gross energy from pruning in EU-28

Data source: Eurostat. Calculation: "uP_running"

- ✓ Potential power generation (considering all the available biomass):
  ~ 23.9 TWh/y
  ~ 3 GW electrical installing capacity;
  ~ 4.9 Billion Euro of value;
  ~ 15 Million people served.
- ✓ Potential heat generation (considering all the available biomass):
  ~ 57.9 TWh/y
  ~ 7 GW installing capacity
  ~ 3.6 Billion Euro of value.

Read *Note 1* for explanations about estimates

Actions to be taken:

- Agro-residues (and particularly APPR) are a relevant renewable energy source, but still not used or largely under-used. Further efforts should be made in promoting bioenergy value chains, disseminate the knowledge about the best available technologies, contribute to increase the level of information on biomass valorisation opportunities.
- Farmers generally regard pruning as a waste, not a resource; this considered, their main concern is simply to get rid of them as quickly and as cheaply as possible. A stronger awareness about the value of APPR biomass should start, first, from the farmer category, and then be spread at every level in society.
- The renewable energy obtained by mobilizing APPR biomass in EU is potentially remarkable and should be sustainably tapped. The first commercial outlet for APPR would be heat production at local scale (drying facilities, household heating, food processing at farm or cooperative level, etc.). Standardized fuel production (like chips and pellets) to be supplied to local markets is another option. The second commercial outlet could be the supply of CHP systems (combined heat and power). In this latter case, logistics of supply would play a crucial role and only a well organised agro-business could be effective and competitive.
- APPR are considered to be of low quality and uncompetitive if compared with wood obtained from forestry. Chips and pellets from APPR should be matched with solid biofuels of similar quality, such as olive pomace, olive stones, different kind of nuts and husks, marc, lees, etc. According with the type of energy plants (stoves, boilers, larger thermal appliances, etc.), different kind of solid biofuels can be supplied and a wide range of possible uses can be supposed.
- End-users can be informed and encouraged in diverting from their conventional fuel in favour of APPR biomass if they find the right convenience and the proper quality, perfectly matching the standard they need.
- The labour intensity of APPR collection, together with logistic costs, are the major problems in biomass mobilisation, while production per hectare is often low and still somehow uncertain. The costs associated with pruning harvesting, transport and storage may be considered too high to allow a profitable business. Innovative business models that share the costs amongst several collection sites together with the creation of logistically improved biomass platform should be implemented in those areas were APPR availability is quite large (*Note 2*).

4th Message:

Renewable energy value chains based on solid biomass are climate friendly energy solutions and can effectively save large GHG emissions

Potential drivers	Connected to Mission 6	Possible risks or barriers
Maximising the efficient use of APPR biomass in order to deliver robust and verifiable GHG emission savings, effectively replacing fossils	**Energy from APPR contributes significantly to the "decarbonisation" of the energy system**	Ensuring long-term climate benefits will require the application of well-defined sustainability criteria on biomass supply (such as the ones reported in the RED II) avoiding any kind of possible environmental pressure on natural resources

Facts & Figures

How much GHG emissions are potentially saved?

- ✓ Energy value chains based on pruning reach a 90 % at least of GHG savings as compared with fossils (through *Life Cycle Assessment*)
- ✓ 23.9 TWh of electricity are theoretically able to substitute approximately 8.4 Mt of CO_2 equivalent

How much CO2 is theoretically sequestered?

This overall amount of CO_2 emission saved approximately corresponds to the annual growth in wood of 560 kha of a new-forested area.

Read *Note 2* for explanations about estimates

Actions to be taken:

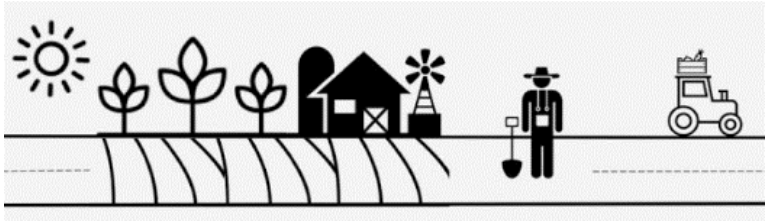
- The carbon footprint of agro-pruning energy value chains is very low as compared to other renewable energy sources and GHG savings are very high as compared to fossils; for this reason energy projects based on APPR biomass should be prioritized and promoted through an intelligent and flexible financial support (see “policy recommendation”).
- Clear evidence of the environmental benefits should be given considering each single bioenergy projects. Specific and well-based estimates about the fates of carbon equivalent emissions and savings should be presented along the project permitting procedure; alternatively, baseline or default values agreed upon at EU and national level should be assumed as reference. The LCA approach and calculation procedures should be definitely applied (according to the EU RED II).

5th Message:
APPR kind of biomass represents a side-stream feedstock and a supplementary energy source to be used sustainably, but also plentifully and successfully

Potential drivers	Connected to Mission 7, 8, 10	Possible risks or barriers
APPR biomass should be considered an "advanced" energy carrier (according to the RED II definition) because it reaches very high GHG emission savings and, therefore, it performs according to very good levels of sustainability	**APPR biomass can be conveniently used as a renewable energy carrier without claiming additional resources** **Energy from APPR lessens the energy dependence of the agricultural sector** **APPR supply enhances the farm productive diversification, also favouring income integration**	Pruning utilization for energy purposes should imply a comprehensive rearrangement in the management of the fruit plantation and a enhancement in the technical and logistic farm organization. This could represent a strong challenge.

Rethinking the conventional agricultural practices

APPR energy valorisation is a reliable and profitable alternative to the conventional management of pruning residues.
Free pruning burning in open-air conditions, directly on the field should be banned definitely or, at least, drastically limited.



- ✓ Drive a change towards more sustainable agricultural practices: soil amendment with manuring and compost, green soil cover and cover cropping, no- or minimum-soil tillage.
- ✓ Reduce farmers' costs avoiding traditional operations.
- ✓ Reduce the risks of pest and diseases propagation.

Actions to be taken:

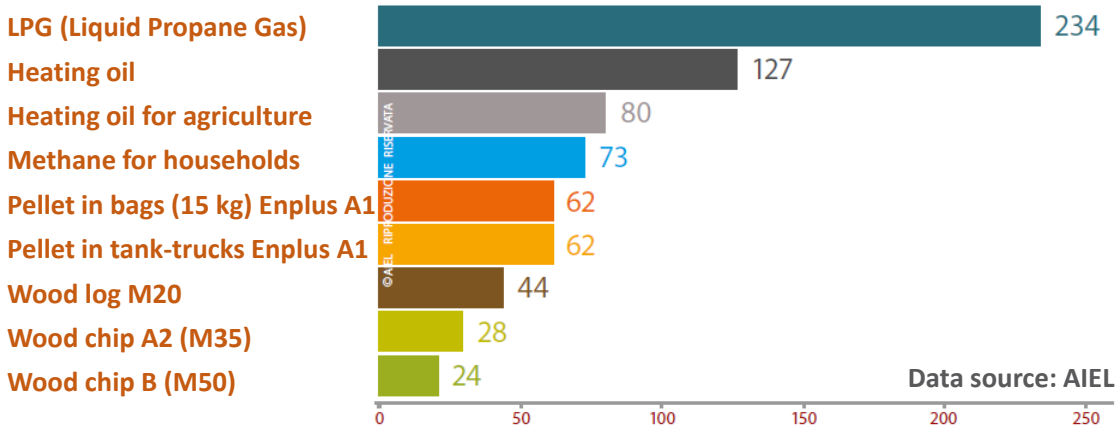
- According to the RED II and specifically considering its residual character, the APPR biomass should be considered the proper feedstock to obtain "advanced" biofuels. Therefore, zero life-cycle greenhouse gas emissions is assigned to APPR up to the process of collection. This point fully justifies the priority to address pruning to energy conversion (as compared to other possible and alternative uses) and the consequent policy actions focused on promoting and sustaining the bioenergy value chains based on APPR (see "policy recommendation").
- Farmers should be gradually introduced in applying "conservation agriculture" as an innovative farming system, not only to save energy and money, but most of all to protect the soil carbon content (organic matter) and properly allowed the pruning removal from the field, avoiding a decline in soil fertility, thus safely addressing APPR to energy conversion.
- Pruning shredding followed by mulching or subsoiling shall be considered a good agronomic practice, but unfortunately it offer some risks of pest and disease propagation and, unless certainly healthy, pruning should be better removed from the field. Information should be given to farmers about these possible risks and how they can be detected and managed.

- The free burning of pruning in open-air conditions, directly on the field or at the field margin, is, unfortunately, still usual and frequently applied by farmers. This improper operation should be avoided, finally forbidden, possibly without exceptions or derogations at national or regional level. It is currently well known that this is a very hazardous operation, it generates polluting emissions, reduces soil carbon, also worsening soil quality. Farmers should be informed and be aware about the alternatives to be applied. Pruning removal for energy conversion is one of them. Probably the best option.

6th Message:
Solid biomass from APPR is an affordable renewable energy carrier

Potential drivers	Connected to Mission 8, 10	Possible risks or barriers
APPR biomass is a low value feedstock but offers potential cost saving to farmers and an alternative management of crop residues producing additional income	Energy from APPR lessens the energy dependence of the agricultural sector APPR supply enhances the farm productive diversification, also favouring income integration	The profit margins foreseen for all the players along the supply chain can be small considering the limited unit value of the feedstock. This requires an excellent logistic organization and, possibly, a larger economy of scale

Facts & Figures



Comparison of primary energy costs (Euro/MWh) produced by fossil fuels and solid biomass energy carriers in Italy in 2017

Actions to be taken:

- Considering that wood biomass is one of the most affordable energy carrier to be applied in heating appliances, household boilers, district heating systems, etc. its general use should be promoted, smoothed, expedite, increased and sustained through a well-tuned market policy.
- At the same time, the former policies should be accompanied by a regulation about biomass/APPR quality standards, traceability rules, strict criteria of biomass sustainable extraction and mobilisation.

- Reducing logistic costs, enlarging the mobilized biomass, organizing treatments and storage platforms, collecting different types of residues in order to avoid strong seasonality of supply; these are some of the measures that, altogether, can produce a reduction in logistic costs.
- Agro-residues, considered as renewable energy carriers, generally have lower quality than solid biomass from forestry, but they can be cost competitive and adaptable to energy plants or appliances after simple technical adjustments.
- The purchase of new, updated and technological advanced energy plants or boilers (properly designed considering APPR feedstock) should be assisted and promoted, while the turnover of old and inadequate boilers (still emitting large pollutants in the air) should be accelerated through subsides to substitution.
- Criteria of "circular economy" and "bioeconomy" should be applied to biomass use. This will ensure that the maximum value is extracted from the biomass resource, and that environmental costs are not externalised. This will support not only the sustainable use of existing biomass resources, but also encourage the use of lower-value and lower-quality biomass, such as pruning for energy (*Note 2*).

7th Message:

Renewable energy value chains based on APPR value chains define a virtuous social-economic model that can be properly applied in promoting rural development at local scale

Potential drivers	Connected to Mission 9, 2, 3, 4, 5	Possible risks or barriers
Bioenergy from APPR can effectively sustain rural development through new forms of agro-industrial integration, in parallel (and not in competition) to food processing industries. 	APPR valorisation represents a "flywheel" for rural development Bioenergy is triggering new forms of agro-industrial integration Bioenergy is a bioregional, land-tailored process Bioenergy primes a self-sustained local development Bioenergy value chains participate in an open and multifunctional model	Each actor operating within the bioenergy value chain should find a benefit in implementing the investment project. Usually, there is the risk that farmer's benefit is not considered as a priority, while large part of the added value associated to energy sale is shifted to the energy company. 

Linking APPR bioenergy with rural development

Bioenergy value chains are connected and included within the territorial milieu, offering new opportunities and services, in a complementary relationship with pre-existing agricultural activities.

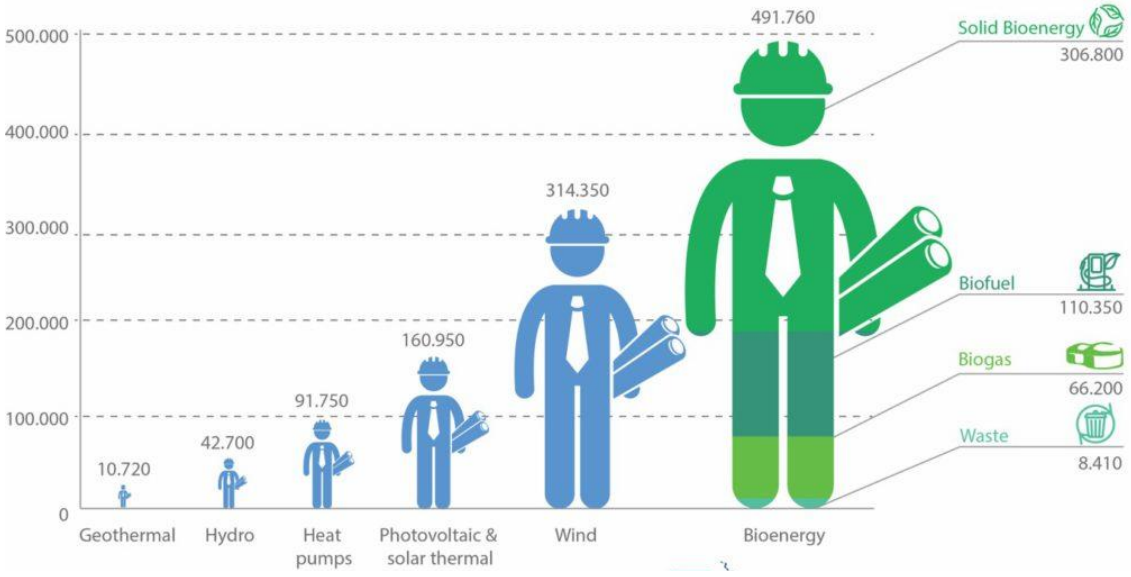
(Source: read *Note 3* for reference)

- ✓ A large variety of bioenergy value chains and business models are available, each according to specific territorial characteristics and socio-economic traits.
- ✓ APPR are generally not suitable for long-distance transportation, unless conveniently pre-treated and densified. Therefore, most APPR value chains are local and biomass is sourced over short or medium distances (5 to 30 km). These conditions are favoring local development, small-scale business, and local markets, particularly connected to rural districts.
- ✓ The concept of "distributed" energy model should be coupled to the concept of "distributed" margins of income all along the bioenergy value chain. It means that a fraction of the higher payment price the energy producer receives from subsidized energy sale (a higher cost payed by the collectivity) should be transferred to the APPR providers (i.e. farmers) all along the value-chain in the upstream direction. More generally, every operator in the value chain should find its proper economic advantage to contribute in the biomass supply and conversion.
- ✓ APPR are widely dispersed across multiple collection sites, therefore logistics and transportation play a relevant role in defining the biomass supply costs and the overall profitability of the business. Some forms of increased scale economy could be required and farmers' association to get a significant higher amount of biomass to be delivered is probably needed.
- ✓ The energy valorization of APPR produces positive social and economic impacts. Bioenergy creates jobs in the region, more than coal, methane, and also other renewables, for which the largest share of value remains in the hand of the final producer company.

Manual pruning and preparation of branches	Integrated collection with shredding	Download on truck at field side	Storage in a roofed facility	Transport to final users	On-site storage and energy conversion

Facts & Figures

EU-28 employment unit distribution in the renewable by sector in 2014. Direct and indirect jobs were considered



Source: Eurobserv'ER. Elaboration: AEBIOM (Statistical report, 2016)

Actions to be taken:

- Promote new forms of agro-industrial integration and lessens the energy dependence of the agricultural sector.
- According to a multifunctional strategy, bioenergy enhances the farm productive diversification and favours income integration. This can be considered a relevant objective of the CAP to be kept as a fundamental target.
- Farmers' associations, farmers' co-operative should be promoted as the most suitable organizations for overcoming scale and investment barriers. CAP Rural Development funding should assist co-ownership of harvesting machineries, storage and logistics platforms.
- Where a region does not have suitable end-users, collective end-use of prunings should be encouraged through community facilities (such as district heating), operating at medium- to large-scale applications (*Note 2*).
- Agro-residues promote rural development. Bioenergy initiatives and projects, based on APPR, are inevitably rooted at local scale, are community oriented, self-reliant, self-sustaining models of development. This development strategy should be fostered by the CAP Rural Development and by other funding schemes.

SECTION C. POLICY RECOMMENDATIONS TO PROMOTE BIOENERGY AND ENERGY FROM APPR

To enhance the role of biomass in the energy sector an effective policy mix, together with a wide set of interventions are needed, rather than a single stand-alone policy or individual measure. Policy measures, economic and financial interventions, the legal framework to be applied, and the market regulations to be promoted are complex decisions that should be properly defined according to a general framework.

A list of possible measures and instruments to promote bioenergy retrieved through an in-depth literature survey, as well from stakeholders' direct suggestions, is summarized hereinafter.

Setting ambitious and long term bioenergy targets

EU targets on GHG reduction, energy efficiency and energy from renewable sources should be strictly observed. Current targets might be still insufficient in drastically reducing GHG emissions and the highest effort should be made to further reinforce these targets. A long-term strategy needs to be deployed, the soonest, and progressively checked to assure that the 1.5 °C target set with the Paris Agreement can be safely reached. A net-zero emissions by 2050 and a timely and general revision of all the targets by 2030 should be firmly decided. If ambitious renewable energy targets are fixed in a short term, biomass and bioenergy will surely have to play a decisive role.

Bioenergy strategic plans and roadmaps

National and regional bioenergy strategies should be considered essential instruments to put into force well-fitted instruments, according to precise targets and a roadmap, also defining the main milestones in the decarbonisation path.

The bioenergy sector is at a crossroad of multiple policy scopes that should be properly integrated. Considering the source of feedstock, the sector is rooted in agriculture, while considering its end-use it is mostly related to the energy industrial sector. This means that the Common Agriculture Policy should be better tuned with the renewable energy mission, supporting and sustaining its economic growth according to a model or rural development.

Bioeconomy should be considered the common playing field. This means (according to our vision) that bioenergy is part of a general societal shift towards a bio-based economy.

Energy planning at regional scale should consider the sustainable use of biomass as a core interest, indicating roadmaps, strategies and sustainability regimes for bioenergy, especially in countries with significant resource and where these plans are not yet in place.

Regions should be encouraged to perform resource assessments, and stakeholder mappings, to understand their real regional potentials and how to reach them. Bioenergy and pruning harvesting should be placed within a broader regional strategy for rural development, to highlight that social benefits are general and do not pertain to the involved actors only.

Biomass is a space-distributed energy source; therefore, “distributed” (i.e. not centralized) should be also the energy conversion plants. APPR allow an energy efficient use of renewable resources in a form of energy prosumers – a simultaneous production and consumption of energy. Supporting transition of a farmer into a renewable energy prosumer, enables not only farm income diversification (local effect) and global GHG emission savings, but also more disposable income to farmers.

Biomass sustainable supply and use

Effective policies and clear regulations agreed among Member States, national and regional authorities, should come into force in order to assure the sustainable supply and use of biomass. RED II introduced and strengthened sustainability criteria to be applied in biomass supply and mobilization, together with energy efficiency targets to be fulfilled. This is relevant, of course, but probably not the end of the story. Industry-led certification schemes are also available today. They certify the sustainable supply and use of biomass at a project level, while demonstrating compliance with sustainability best practices and with the appropriate legislation. These schemes needs to be implemented by provisions at national and regional level, thus ensuring that the project- and the product-level schemes meet minimum standards.

Open-air burning of pruning and other crop residues should be radically limited, possibly banned through a specific regulation (if not in force already), and definitively forbidden, without considering exceptions or derogations at national or regional level. Farmers should be aware that

the burning of crop residues is not a proper management operation, it generates hazard, air pollution, soil degradation, indirect costs (externalities) and shadow costs to be directly accounted. Alternative procedures are possible, advisable, preferable, do not necessarily imply expensive operations and can provide extra-income if logistics is carefully optimized.

Fostering biomass mobilization and securing its supply

The need for increased quantities of sustainably obtained biomass for energy requires an integrated approach to biomass production in forestry, agriculture, and residue streams. As bioenergy should play a key role in the decarbonisation of the energy system, this will require an impressive increase in the supply of biomass feedstock as compared to today. The potential of agricultural residues as renewable energy carriers, particularly considering APPR biomass, is still poorly used and almost disregarded. Notwithstanding the impressive biomass sources they can contribute, this very promising opportunity is not expressed yet and should be promptly unlock through “ad hoc” measures in the frame of bioeconomy, energy, and agriculture policies.

On this respect, the most constraining factors should be promptly addressed. Logistics is an essential feature; critical amount of biomass could be mobilized only through properly designed logistic infrastructures. Pivotal relevance is played by a convenient geographical distribution of integrated biomass storage and logistic centres. These centres should be promoted and possibly funded, for example through the Regional Development Plan in the frame of the CAP.

Supporting industrial leadership and technological development

EU should foster its position as a global leader in biomass technologies. A wide range of high quality technologies are provided, such as biomass harvesting machines, conversion installations with high efficiency, controlled and clean combustion, and automated operation for domestic, commercial and industrial uses. To date, technically reliable, sustainable and economically attractive bioenergy solutions and business models exist already.

Anyway, the growth of bioenergy will need to rely on a mix of technologies. Therefore, meeting the long-term potential of bioenergy depends on a number of novel technologies that are not yet fully mature and commercialised (such as biomass gasification, pyrolysis and the production of ethanol from cellulosic feedstocks, hydrothermal liquefaction, advanced biological conversion processes, etc.). To reach the commercialisation stage of these technologies specific policies are still required to support their initial development and subsequent deployment.

Research and development in the biomass / bioenergy sector

In order to maintain the industrial leadership and sustain a continuous technological update, funding in research and development should be addressed to private and public projects; moreover, programmes of innovation transfer into business should be promoted through dedicated initiatives. Agricultural residues (and APPR most of all) showed a lower quality as energy carriers

than wood from forestry. This means that technical adjustments of energy plants, boilers and thermal appliances are needed and further research and development are required to improve the quality of the combustion process and reach good standards of atmospheric emissions.

Favouring profitable and stable investments in the bioenergy sector

The best way to mobilise private finance is to ensure an attractive investment profitability and create a long-term stable regulatory conditions in order to boost investor confidence. A long-term and stable regulatory framework provides certainty about the market conditions; this should be assured for a properly extended period (15-20 years), sufficient to justify investments in a series of business projects.

Incentives should be designed not only for the setting up of new bioenergy plants, but also for investments on the entire supply chain (biomass harvesting mechanization and pre-treatments, collection and transformation platforms, etc.). These funds can be supplied to farmers and other chain actors through the rural development measures in the frame of the CAP.

Promoting an intelligent and flexible financial support

Attractiveness and competitiveness of investments are prerequisites to the sector development. Policy instruments strengthening the market deployment and promoting an effective and fast technological “learning curve” should be launched. As far as technology is less competitive, technology development should be financially sustained, until a technological parity with other renewables is achieved. In other words, appropriate and dedicated financial mechanisms and instruments for advanced, low-carbon bioenergy systems that facilitate technological development and market deployment should be put in the field. Well-tailored supporting scheme, embedding financial profile of the beneficiaries, together with properly targeted financial incentives, are still considered essential to promote investments in the APPR sector, enlarge and stabilize the biomass market, reinforce the technological offering. Again, an integrated set of subsidies and incentives should be deployed, drawing the needed financial resources from a combination of EU and national complementary funding programmes.

Simplifying and harmonizing administrative procedures

The administrative procedures, with particular reference to the permitting operations to setting up a biomass-to-energy plant, should be easier and simpler and, therefore, much faster in the time needed to their accomplishment.

Specifically, the use of agricultural residues should be promoted by avoiding the set of administrative burdens compulsory applied to waste. To this end, the concepts of “end-of-waste”, “by-products” and secondary feedstock (already covered in the EU Waste Directive) should be

properly implemented into the national and regional legislations, clearly allowing preferential paths of recovery and use, without additional constraints. On this respect, a clear harmonization of rules and procedures should be a top priority.

Identifying and removing unnecessary administrative barriers to bioenergy deployment, consistent with sustainability objectives, is a highly required measure to promote the sector development. Particularly urgent are the following actions: promote and sustain decentralized renewable energy production and consumption and attain an increasing system flexibility; removing administrative barriers and introducing simplified grid connection procedures (thereby minimizing investor risks); encourage new business models, such as joint purchasing or leasing models, which make on-site renewable generation accessible to a larger number of consumers. These models should address both tenants and businesses.

Phasing out from fossil subsidies through carbon pricing

Low oil prices hinder the reduction of fossil fuel emissions and accelerate climate change. The lack of competitiveness of biomass / bioenergy projects (particularly those based on APPR residues) is also resulting from subsidised prices of fossil fuels that should be removed.

Phasing out from inefficient fossil fuel subsidies is a required policy measure by introducing a CO_2 emission pricing schemes through appropriate accounting procedures (better if based on LCA approach).

Targeting effective technologies, value chains and business models

Technologies and value chains having the largest potential to displace significant amount of fossils should be selected and readily applied. Significant reductions in GHG emissions, as compared to fossil fuels, must be achieved, through the most promising energy systems.

APPR could be used, first of all, in heat production at local scale (drying facilities, household heating, food processing at farm or cooperative level, etc.) in the form of standardized solid fuel (like chips and pellets). Moreover, larger scale applications can be, for example, bioenergy-based *district heating* networks; CHP biomass plants for industries; industrial steam CHP biomass plants, etc. As can be seen, a large part of the bioenergy system is placed at a very high technological readiness level and several innovations have been already deployed. They need to be implemented as soon as possible.

Quality standardisation of solid biofuels

Biomass and bioenergy markets, and more specifically the APPR biomass market, would significantly gain from more harmonisation and cross compliance on biofuel quality standard, as well as from strengthening energy performance certificates, energy codes and legislative enforcement.

The lower quality of APPR as energy carrier, compared to wood from forestry, should be clearly and honestly recognized, as well as properly certified according to standards. Considering the wide range of unconventional solid biomass from agricultural residues that are currently available on the market (such as olive stones, olive pomace, different kind of nuts and husks, etc.), a use similar to this solid biofuels is possible but should be properly characterized.

Warmly suggested is the establishment of a low-carbon fuel standard approach, providing technology-neutral support, but ensuring significant benefits over fossil fuels and favouring those offering the deepest decarbonisation for the least cost. Sustainability frameworks of governance should be based on appropriate calculation of GHG performance (through a complete life cycle analysis).

Considering that the current alternative in pruning management is open-air burning (with consequent no social, economic or environmental benefits, but only penalties), policies should recognise agrarian residues as a separate category of biomass, with peculiar characteristics, to be properly used in specific kind of energy service, for both household and industry.

Eco-design for energy efficiency and controlled air emissions standards

Considering that small sources of solid fuel combustion can contribute significantly to the total EU emissions of fine particles, black carbon, nitrogen oxides and other pollutants, eco-design product standards are relevant instruments to be implemented and further expanded to reduce these emissions by 2020 and 2030. Even larger emission reductions can be achieved if eco-design standards would also affect energy efficiency standards.

A rapid turnover of existing (and inefficient) devices should be encouraged, also including premature scrapping before the end of the regular appliance lifetime. Such a scenario of very fast replacement of an existing capital stock by a new equipment would be difficult to realize in the short run without considering a strong financial support. By the way, boilers and stoves with better emission standards for heating and healthier technical solutions should be easily accessible and cheap to buy. On this respect, green procurement should be currently be implemented, first of all by public organizations and, progressively extended also to private companies that should be conveniently rewarded for this choice.

Fuel flexibility and retrofitting technologies

Considering large-scale industrial boilers, fuel flexibility and multi-fuel energy units allow the use of more complex and low cost biomass fuels (e.g. agro-biomass, crop residues, and waste recovered fuels) as well as new energy carriers. This wide variety of different feedstock, considered as a blend of wood, agricultural residues, and biodegradable waste material can greatly ensure and stabilize the biomass supply to the energy plant. A substantial improvement of the fuel flexibility of biomass

technologies should be achieved, with a particular focus on increasing the use of residues and wastes (as a non-conventional kind of solid biomass).

Retrofitting of previous fossil-fuelled energy plants is another essential step toward EU decarbonisation, first considering the old and highly impacting thermoelectrically plants still supplied with coal. Co-firing technologies, also targeting the partial use of biomass form agricultural residues can be a possible solution to be considered and technically checked. On this respect, thermally treated biomass can be more suitable for fossil fuels substitution in CHP co-fired conversion process.

Triggering bottom-up social and political innovations

A large participation of farmers and farmer organizations should be promoted, together with other associations, investor groups, civil society organizations, and local and regional authorities. “Stakeholders’ networks” should be established locally, inspired to the concept of “operational groups” within the EIP (European Innovation Partnerships), specifically tailoring projects and investments in the APPR energy use and the valorisation of solid energy carriers from APPR feedstock. Professional training and knowledge sharing is needed to promote a higher level of awareness among farmers, practitioners, and potential investors. A deep change in mindset should assist farmers, facilitating the transition towards more sustainable agricultural practices.

A legislative proposal should be put forward on the democratic participation about initiatives on the territories, which will operate at the municipal level, for small projects not included in the current authorization rules related to large public or private procurement. This kind of action would prevent the “nimby” syndrome so frequently encountered when new bioenergy projects are proposed locally.

Far beyond a simple legislative simplification, a sort of "radical change” in the regulation procedures should be promoted, perfectly in tune with the new circularity of the supply chains, rather than in their old “linear” organization. As agriculture and agribusiness are organizing themselves according to new revolutionary paradigms, so regulation must follow this kind of innovation. Too much overlapping of rules, procedures, obligations towards the actors of the value chains and their final users are still detected. These frequently illogical bounds can block the spread of innovations, even with respect to companies that would like to promote new ecological approach to production. This normative ambiguity puts a tombstone on too many virtuous realities.

Finally, the concepts of “frugal innovation” could be assumed as a reference while thinking about bottom-up processes of stakeholders’ participation. Although advanced and effective in technological terms, the new energy devices and appliances should target a reduced complexity, an easy and large application range, autonomy of use, low cost and low market price, small size, generally aimed at low-income consumers (or “prosumers”).

SECTION D. THE APPR ROADMAP

Each recommendation listed previously should represent a specific policy target within an overall policy agenda to promote bioenergy and the renewable energy derived from APPR utilization. Every target shows a common and similar development over time, made up of a particular sequence or succession of steps reported in the table below (see next page). According to its own nature and characters, the development and implementation of each specific target may be different, but the dynamic path to go through is similar for every targets.

The setting of one specific target within the policy agenda represents the first step. It is the time when the target is recognized as relevant and useful to be considered; an open discussion about its effects or contributions on bioenergy development takes hold. It follows a clear formulation of the target, in terms of how it should be applied and the quantitative measure or size it should be achieved. The procedures to be deployed in order to allow an effective implementation of the tool or the policy instrument represents the following step. Without a proper system to monitoring the implementation of a policy intervention (selecting and detecting the proper indicators) there is no possibility to check if the target is reached or what are the gaps still to be fulfilled. Considering the possible external perturbations acting on the system, deviations are detected and possible adjustments should be also considered.

As it can be seen from the previous table, the first set of four targets (from N.1 to N.4) have reached already the stage of “policy implementation” and they should undergo to a “policy adjustment” in order to farther develop the sector and significantly improve its contribution in terms of renewable energy. Two targets (N.5 and N.6) can be considered in the “implementation” stage, while the majority of the targets (8 in number, from N.7 to N.14), in our opinion, need still a proper “policy formulation” and, therefore, are at the very beginning of their implementation path. Finally, just one target, the last one (N.15), is quite new and still little known outside the bioenergy sector (and even within) and it will need time to be effectively inserted in the policy agenda.

Some policy tools have been selected, coded and listed in the footnote of the previous table. These policy measures are still very general and merely indicative, but they help to better define the type of interventions that should be applied.

POLICY AGENDA TO PROMOTE APPR BIOENERGY	Policy Setting	Policy Formulat.	Policy Implement.	Policy Monitor.	Policy Adjustment
Bioenergy strategic plans and roadmaps				R	L, F
Supporting industrial leadership and technological development				R	L,F
Research and development in the biomass / bioenergy sector				K,R	L,F
Setting ambitious and long term bioenergy targets				I,R	L,F
Biomass sustainable supply and use			D	I,R	
Favouring profitable and stable investments in the bioenergy			F	R	
Fostering biomass mobilization and securing its supply		K	D	R	
Promoting an intelligent and flexible financial support		I,R	F	I,R	
Simplifying and harmonizing administrative procedures		I,R	D	I,R	
Phasing out from fossil subsidies through Carbon pricing		R,D	L	R	
Targeting effective technologies, value chains and business models		K	D	R	
Quality standardisation of solid biofuels		K,D	L	R	
Eco-design for energy efficiency and controlled air emission		R,D	L		
Fuel flexibility and retrofitting technologies		R,D	L		
Triggering bottom-up social and political innovations	I,R	D			

Legenda of the **Tools & Instruments:**

I: Information and Dissemination;
R: Reporting, documentation, analysis;
K: Knowledge transfer and training;
D: Demonstration and piloting forerunning experiences;
F: Supporting initiatives through specific funding;
L: Legislation and regulation.

SECTION E. CONCLUSIONS

The potential of APPR biomass in Europe is impressive and this evidence should be taken into account by EU government and by each MS, particularly considering those countries where the availability of pruning is larger (Mediterranean countries such as Spain, Italy, Greece, France, Portugal, but also Poland and Romania).

Member States should steer their sustainable energy development through National Renewable Energy Action Plans (NREAPs) or, alternatively, starting from 2019, with their updated version that corresponds to the National Energy and Climate Plans (NECPs). NECPs are the new framework within which EU Member States have to plan their climate and energy objectives, targets, policies and measures to the European Commission. Countries will have to develop NECPs on a ten-year rolling basis, with an update halfway through the implementation period. The NECPs covering the first period from 2021 to 2030 will have to ensure that the Union's 2030 targets for greenhouse gas emission, renewable energy, and energy efficiency are met.

The local / regional dimension of biomass supply, the territorial value attributed to bioenergy, the socio-economic relevance credited to rural development are the main determinants in addressing the strategy to be implemented in supporting the biomass / bioenergy sector.

If based on local supplied biomass residues, regional bioenergy value chains could allow significant savings in fossil energy and a drastic reduction in atmospheric emissions (effectively contributing to "decarbonisation"). The energy valorisation of biomass also produces positive social and economic effects. Bioenergy creates jobs in the region and gives value to the territory being a powerful lever of rural development.

Considering the biomass/bioenergy sector, a huge playing field and great opportunities to enlarge residual biomass use are prospected. A further biomass mobilization, according to sustainable criteria, is urgently needed to keep the pace on GHG savings and reach the 2030 and 2050 targets set on the international scene.

Considerable amount of available biomass is still not used or significantly under-used. This is the case of biomass derived from residual wood obtained from pruning operations and from the trees removed at the end of the plantation lifespan, in both specialised plantations and orchards. The biomass fuel supply could be widened impressively when compared to its current use through the development of standardised biomass solid fuels, specifically considering APPR characteristics. Sustainable, innovative and cost-effective advanced feedstock production and pre-treatment technologies for different biomass sources need to be developed to meet specific fuel quality requirements in tune with feedstock main traits.

Actions and measures can be promoted and applied with respect to a wide range of issues, related to both agriculture and industry sectors. Apart agro-energy integration and rural development, new business models should be displayed and the energy market should be supported according to a well-planned and collectively agreed policy, together with research and innovation that are essential to offer new and more effective energy conversion technologies (with reduced pollutant emissions into the atmosphere and an increased conversion efficiency).

Positive and truly instructive examples of bioenergy value chains based on the use of pruning as an energy source are available in Europe (*Note 4*). They can serve as a showcase and a clear demonstration of the feasibility of the energy projects put in place. However, these bioenergy projects are still few and not proportionate to the real potential of the sector.

Substantial progress should be made in the following years and a strong support should be deployed, based on both regional/national action plans and strategies agreed at EU and national level.

NOTES AND REMARKS

Note 1. Fruit-tree surfaces data are from Eurostat 2016. Main annual crop statistics: http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=apro_cpnh1&lang=en

Data table:http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=apro_cpnh1&lang=en

Last access: 27/06/2018.

Potential pruning availability per hectare was obtained assuming a reference availability coefficient for each fruit tree category as reported in the "Atlas of EU biomass potential", deliverable of the Biomass Future EU project. Biomass role in achieving the Climate Change & Renewables EU policy targets. Demand and Supply dynamics under the perspective of stakeholders. IEE 08 653 SI2. 529 241.

https://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/biomass_futures_atlas_of_technical_and_economic_biomass_potential_en.pdf - Last access: 27/06/2018.

To convert biomass into gross energy a conversion factor of 0.3577 toe/ton was applied.

The estimate of the potential electrical energy that can be obtained if all the potentially available biomass was used is calculated by assuming the following conditions: harvesting, transporting and storage efficiency: 0.70; Biomass-to-electricity conversion: 0.33 (assuming updated technology standard); Lower Calorific Power of biomass: 4.16 MWh/ton.

The gross economic value of the produced electricity was obtained by considering that 0.204 Euro/kWh is the average costs of electricity for household consumers in Europe as reported by Eurostat.

http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics

Last access: 27/06/2018.

The average electricity consumption per capita in Europe is 1.564 MWh; in this way is possible to estimate the number of people that could be satisfied in their electrical consumption every year.

http://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_and_heat_statistics

Last access: 27/06/2018.

As regards heat, a conversion efficiency of 0.80 was set. The average cost of heat in Europe is 0.058 Euro/kWh was assumed.

http://ec.europa.eu/eurostat/statistics-explained/index.php/Natural_gas_price_statistics

Note 2. Adapted from “Europruning”: “Mobilising pruning residues to expand Europe's biomass market”. http://www.europruning.eu/web/lists/pubfiles.aspx?type=pubdissemination. Last access 26/06/2018.

Note 3. The picture was sourced from “Jobs in Value Chains”. survey for jobs estimation in value chains. November 2016. http://documents.worldbank.org/curated/en/947061496743303573/pdf/115690-WP-JobsinVCUpdateNov-PUBLIC.pdf. Last access: 27/06/2018.

Note 4. The “uP_running” project provides identification and documentation of keys for success and applicable business models and solutions to be transferred to the European value chain actors. http://www.up-running-observatory.eu/en/