Promoting the penetration of agrobiomass in European rural areas

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Part 6: National framework conditions - Greece

Lead Beneficiary: CERTH, INASO-PASEGES

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Abbreviations

Abbreviation	Explanation
CAP	Common Agricultural Policy
CHP	Combined Heat and Power
CRES	Center for Renewable Energy Sources
EAFRD	European Agricultural Fund for Rural Development
EKE	Greek Canneries Association
ELSTAT	Hellenic Statistical Authority
ERDF	European Regional Development Fund
ESF	European Social Fund
GDP	Gross Domestic Product
MP	Member of Parliament
NAPCP	National Air Pollution Control Plan
NECP	National Energy and Climate Plan
NO_X	Nitrogen Oxides
NSRF	National Strategic Reference Framework
PM	Particle Matter
RES	Renewable Energy Sources
RDP	Rural Development Programme
RPR	Residue to Product Ratio
SPEL	Association of Olive Kernel Oil Producers of Greece
UAA	Utilized Agricultural Land
VAT	Value Added Tax
YPAT	Ministry of Rural Development and Food
YPEN	Ministry of Environment and Energy

Project consortium

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12	Agronergy	AGRONERGY

13	Association d'Initiatives Locales pour l'Energie et l'Environnement	AILE

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Country: Greece

Greece has a total surface area of 131,957 km^2 and population of around 11 million (2018). Key geographical features of the country are one of the longest coastlines in the world and the longest in the EU, the numerous islands, of which only 227 are inhabited and the fact that more than 80 % of the country's terrain is mountainous / hilly.

Agriculture is one of the key economic activities contributing about 3.72% to the Greek GDP (2018). The climate of Greece and terrain differences allow for many different cultivations to grow and as a result the agricultural output is quite diverse.

In 2017, the Utilized Agricultural Land (UAA) was 3,221 thousand ha, corresponding to 24.4% of the total surface[1]. The breakdown of UAA use is as follows: arable farming 53.3 %; permanent crops 33.6 %; fallow land 11.0 %; vegetables 2 %. EUROSTAT reports that Greece is the EU member state with the highest share of permanent crops in the UAA and the one out of three (along with Cyprus and Portugal) with a share higher than 20 %.

A key feature of the agricultural sector in Greece is its fragmentation; the average number of hectares per holding was only 6.6 (2016 data), while more than 90 % of the holdings were smaller than 20 ha. This has implications to the overall competiveness of the agricultural sector: low level of level of mechanism and use of new technologies, low productivity and low income of agricultural holdings[2]. Historically, Greek farmers have been organized in cooperative schemes in order to overcome these restrictions; in recent years, other collaborative schemes (e.g. producer groups associated with agro-industries, contractual farming, etc.) are also gaining in popularity. For the purposes of AgroBioHeat, the fragmentation is directly reflected on the average volume of agrobiomass residues that each holding can mobilize. Regarding the crops of interest for AgroBioHeat:

- **Cereals**: although not amongst the top-EU producers, cereal cultivation is relevant for the Greek agricultural sector. The most popular crop is durum wheat.
- **Industrial crops**: Greece is the only EU-member state with a sizeable area devoted to cotton cultivation. Sunflower and rapeseed for biodiesel production are growing in popularity.
- **Olive trees**: 3rd largest olive oil producer in the world, behind Spain and Italy. It is also the 2nd largest producer of edible olives in the EU, a market segment which undergoes rapid expansion.
- **Citrus trees**: 3rd largest orange producer in the EU, significant producer of lemons and tangerines.
- **Fruit trees**: 3rd largest peach and nectarine producer in the EU, leader in peach processing. 4th largest apricot producer, 2nd largest producer of kiwis, significant producer of pears, cherries, apples and figs.
- **Nut trees**: 3rd largest producer of almonds and walnuts in the EU, 1st largest producer of pistachios.

[1] ELSTAT, Annual agricultural statistical survey: 2017, https://www.statistics.gr/en/statistics/-/publication/SPG06/-
[2] http://iobe.gr/docs/research/RES_05_F_02122019_REP_GR.pdf

- **Vineyards**: 6th largest EU member state in terms of areas cultivated with vineyards. The only EU-member state where a significant vineyard area is dedicated to production of raisins.

Considering the extent of the agricultural sector, the agrobiomass technical potential in Greece is quite significant. However, utilization of agrobiomass for energy production is currently limited to:

- Firewood from larger pieces of pruning wood or plantation removals.
- Agro-industrial processing residues. Of these, the most significant domestic resource is exhausted olive cake. Sunflower husk pellets are also used, especially in Northern Greece, but most of the quantities are imported. Other agro-industrial residues (e.g. peach stones, nut shells, etc.) are mostly used locally.

The Table below summarizes the main uses of solid biomass in Greece; the major consumers are households (for space heating) and food/tobacco industries.

- Firewood is the most important solid biofuel used in the domestic heating sector amounting to 23.8 % of the total thermal energy consumption of households for the heating period of 2011-2012[3] (95.41 % of the household biomass consumption); a significant amount of firewood actually originates from agricultural holdings (e.g. pruning wood). Wood pellets were estimated to correspond to 0.7 % of the total thermal energy consumption of households (3.39 % of household biomass consumption), while exhausted olive cake was 0.4 %. (2.34 % household biomass consumption). Other biomass fuels, e.g. wood briquettes, represent only a marginal share of household biomass consumption.
- The largest amount of biomass consumption in the food/tobacco sector is assumed to originate from self-consumption of agro-industrial residues; the most important of those is the self-consumption of exhausted olive cake by pomace mills. Other low –cost agro-industrial resources, either self-produced (e.g. peach stones, rice husks, cotton ginning residues) or imported (e.g. sunflower husk pellets) also contribute.

Table 1: Role of solid biomass in the final energy consumption of Greece, 2017 (Source: Eurostat, CERTH analysis)

Sector	Final Consumption / FC (ktoe)	Share of solid biomass in sector FC	Sector share of total solid biomass
Residential	4,413.31	15.75 %	80.63 %
Agriculture / Forestry	291.22	9.36 %	3.16 %
Commercial and Public Services	2,191.69	0.40 %	1.01 %
Industry (total)	3,128.0	5.8 %	17.85 %
- food & tobacco	*423.57*	*24.79 %*	*12.18 %*
- paper, pulp and print	*48.43*	*6.12 %*	*0.34 %*

[3] ELSTAT (2013). Development of detailed statistics on Energy consumption in households-2011/2012: Quality report. Grant Agreement Eurostat n° 30304.2010.002-2010.373. Available online at: https://ec.europa.eu/eurostat/cros/system/files/SECH_final_report_Greece.pdf

Sector	Final Consumption / FC (ktoe)	Share of solid biomass in sector FC	Sector share of total solid biomass
- wood and wood products	*27.13*	*54.51 %*	*1.71 %*
- non-metallic minerals	*680.46*	*0.48 %*	*0.38 %*
Gross inland consumption	**16,501.8**	**3.53 %**	**99.42 %**[4]

Further details as to the biomass market in Greece and the status of the permanent crop sector, especially as regards potential for biomass production / use, can be found in the following project deliverables:

- Biomasud Plus D2.1 - Residential heating biofuels market state of the art. Available at: http://biomasudplus.eu/wp-content/uploads/2017/09/D2.1-Market_report_Consolitated-6.pdf
- uP_running D2.2 - Sector Analysis and Strategic Plan at National and EU level. ANNEX A3 – Greece. Available at: https://www.up-running.eu/wp-content/uploads/2016/10/D2.2_Sector-Analysis-and-Strategic-Plan-at-national-and-EU-levels_compressed.pdf

[4] Remaining share is connected to electricity production from solid biomass and charcoal production.

1. Agrobiomass availability

Agricultural residues – Annual Crops

Annual crops of interest for the purposes of AgroBioHeat project include arable crops such as cereals, maize and rice, and industrial crops such as cotton, sunflower and rapeseed. Crops that are harvested whole (e.g. maize silage and fodder crops for animal feeding) or that leave very wet residues, unsuitable for direct combustion (e.g. tobacco, sugar beet) are not considered in this analysis.

Data on crop areas, production and geographical distribution are taken from the Annual Agricultural Statistical Survey of the Hellenic Statistical Authority for the year 2017[5].

The calculation of the technical biomass potential from crop residues has been performed by CERTH based on the methodology outlined by the S2Biom project[6], using suitable Residue-to-Product (RPR) coefficients, typical moisture contents and straw to stubble ratios (for cereal crops). For cotton, the RPR values of Apostolakis et al. (1987)[7] are used.

It should be noted that the sustainable potential of annual crop residues in Greece is often lower than the technical potential considering that the soil organic carbon level of Greek soils is quite low.

There is no streamlined market for agricultural residues from annual crops in Greece. Cereal straw and occasionally maize residues are collected for animal feeding, animal bedding or other practices. Cereal stubble and the bulkier residues of other crops (cotton, sunflower, etc.) should be handled according to the Code of Good Agricultural Practices and open-field burning should be avoided. However, the practice still occurs.

[5] https://www.statistics.gr/en/statistics/-/publication/SPG06/2017
[6] https://www.s2biom.eu/images/Publications/D1.6_S2Biom_Spatial_data_methods_data_sources_Final_Final.pdf
[7] K.S. Apostolakis M, Sooter C, The biomass potential from agricultural and forest residues, ELKEPA (In Greek), (1987). The RPR value of 2.0 is used for cotton, while the typical moisture content of cotton residues is given as 45 %

Agricultural residues – Annual Crops	
Cereal Straw	**PRODUCTION:** Cereal (soft wheat, durum wheat, rye, oat and barley) cultivation is important in Greek agriculture. In 2017 the surface dedicated to cereal cultivation was 653.6 kha, amounting to 20.3 % of the total utilized agricultural area in Greece. Harvested production of grain was 1,874.3 kt. **GEOGRAPHICAL DISTRIBUTION:** The major centres for cereal cultivation are located in the plains of Macedonia, Thrace and Thessaly. **ESTIMATION OF BIOMASS PRODUCTION**: The technical potential of cereal straw is around 1,039 kt dry matter. **USES**: Cereal straw is generally used as material for animal feeding and bedding, substrate for mushroom growing, etc. It can be collected in small or larger bales. **Prices:** There are wide variations of straw bale prices; values from 30 to 100 EUR per ton can be found in various online market places.
Maize (stalks, cobs)	**PRODUCTION:** Maize cultivations amounted to 126 kha (3.9% of the total utilized agricultural area in Greece). Production was around 1,461.7 kt. **GEOGRAPHICAL DISTRIBUTION:** The major centres for maize cultivation are located in the plains of Macedonia, Thrace and Thessaly, as well as in Etoloakarnania in Western Greece. **ESTIMATION OF BIOMASS PRODUCTION:** The technical potential of maize residues is around 915 kt dry matter. **OTHER USES:** No major alternative uses have been identified. Maize residues are occasionally used for animal feeding. **PRICES:** There is practically no market in Greece.

Agricultural residues – Annual Crops	
Rice Straw	**PRODUCTION:** Rice was cultivated in 30.9 kha (1.0 % of the total utilized agricultural area in Greece). Rice production was around 255.4 kt. **GEOGRAPHICAL DISTRIBUTION:** Rice is mostly cultivated near Thessaloniki; there are some other centres of production in Macedonia (Serres, Kavala, Pieria) and Western Greece (Etoloakarnania). **ESTIMATION OF BIOMASS PRODUCTION:** The technical potential of rice straw is around 241 kt dry matter. **OTHER USES:** No major alternative uses have been identified. **PRICES:** There is practically no market in Greece.
Cotton Residues (stalks)	**PRODUCTION:** Cotton is cultivated in Greece on 260.1 kha (7.6 % of the total utilized agricultural area in Greece). Cotton production was around 808.9 kt. **GEOGRAPHICAL DISTRIBUTION:** Cotton cultivation mostly takes place in Thessaly, Central Macedonia, Thrace and Central Greece. **ESTIMATION OF BIOMASS PRODUCTION:** The technical potential of cotton residues is around 890 kt dry matter. **OTHER USES:** No major alternative uses have been identified. **PRICES:** There is practically no market in Greece.

Agricultural residues – Annual Crops	
Sunflower straw	**PRODUCTION:** Sunflower is cultivated in Greece on 75 kha (2.3% of the total utilized agricultural area in Greece). Sunflower production is around 202.9 kt. **GEOGRAPHICAL DISTRIBUTION:** The major centers of sunflower cultivation are Evros in Thrace and Serres in Central Macedonia. Others areas of Thrace, East and Central Macedonia also have important shares. **ESTIMATION OF BIOMASS PRODUCTION:** The technical potential of sunflower straw is around 257 kt dry matter. **OTHER USES:** No major alternative uses have been identified. **PRICES:** There is practically no market in Greece.
Rapeseed straw	**PRODUCTION:** Sunflower is cultivated in Greece on 10.4 kha (0.3% of the total utilized agricultural area in Greece). Rapeseed production is around 18.9 kt. **GEOGRAPHICAL DISTRIBUTION:** Almost 73 % of the rapeseed cultivations are located in Central Macedonia. **ESTIMATION OF BIOMASS PRODUCTION:** The technical potential of rapeseed straw is around 20.1 kt dry matter. **OTHER USES:** No major alternative uses have been identified. **PRICES:** There is practically no market in Greece.

Agricultural residues – Permanent Crops

Considering the high share of permanent crops in the utilization agricultural area of Greece, biomass productivity from tree prunings represent a significant part of the agrobiomass potential in Greece and are of particular interest for the AgroBioHeat project.

Data on crop areas, production and geographical distribution are taken from the Annual Agricultural Statistical Survey of the Hellenic Statistical Authority for the year 2017[8].

[8] https://www.statistics.gr/en/statistics/-/publication/SPG06/2017

The calculation of the technical biomass potential from agricultural prunings has been performed by CERTH using the Residue-to-Product (RPR) coefficients from Apostolakis et al. (1987)[9] (with the exception of vineyard prunings). Typical moisture contents of 35 % for olive tree prunings and 40 % for all other pruning types are used.

It should be noted that the actual biomass productivity from agricultural prunings is subject to great variations, not only depending on tree type, but also on variety, age, local conditions and agronomic practices. The RPR values for Apostolakis appear to be generally suitable for overall, strategic assessments (with the exception of vineyard prunings), however for local conditions field measurements should be performed and there is a need for further research in that area[10].

Larger pieces of agricultural prunings (or plantation removals) are used as firewood – these fractions are generally excluded from the assessment of the biomass potential. Open-field burning is still the major disposal method for agricultural prunings, but lately practices such as chipping and mulching are gaining in popularity.

The possibility of using agricultural prunings for energy production in Greece was investigated in the framework of the H2020 projects uP_running (http://www.up-running.eu/) and AGROinLOG (http://agroinlog-h2020.eu/en/home/), in which several demonstration activities were performed.

Agricultural residues – Permanent Crops	
Olive tree prunings	**PRODUCTION:** Olive groves were spread over an area of 792.6 Kha, or 24.6 % of the UAA. 2,410 kt of olives were used for olive oil production, while 428 kt were table olives. **GEOGRAPHICAL DISTRIBUTION:** The major centres of olive oil production are in Creta and Peloponnese. Table olives are mainly produced in Chalkidiki (Central Macedonia), Fthiotida (Central Greece) and Aetoloakarnania (Western Greece). The islands of Lesvos in the Aegean and Corfu in the Ionian Sea are also important areas for olive production. **ESTIMATION OF BIOMASS PRODUCTION:** Potential of olive prunings are assessed as 1,881.4 kt dry matter. **OTHER USES:** Olive prunings are mostly burned in open fires or less frequently chipped or mulched. Occasionally,

[9] K.S. Apostolakis M, Sooter C, The biomass potential from agricultural and forest residues, ELKEPA (In Greek), (1987). The RPR value of 2.0 is used for cotton, while the typical moisture content of cotton residues is given as 45 %

[10] E. Karampinis, V. Gavidou, M.A. Kougioumtzis, P. Grammelis, E. Kakaras, Measurement of biomass potential from agricultural prunings. Proceeding of the 10th Panhellenic Conference on Agriculture Engineering, Athens, Greece 28-29 September 2017, pp. 320 – 328. Available online: https://egme.gr/wp-content/uploads/2018/05/EGME-10o-proceedings.pdf

	the leaves of olive tree prunings are used for animal feeding purposes, but the practise is usually implemented at a very local scale. **PRICES:** There is practically no market in Greece.
Pomefruit tree prunings	**PRODUCTION:** Pomefruit trees (pears, apples, kiwis, pomegranates, figs and others) are spread over 28.6 kha or 0.9 % of the UAA. Production is 100.0 kt for pears, 253.1 kt for apples and 202.5 kt for kiwis. **GEOGRAPHICAL DISTRIBUTION:** Apple trees are cultivated mostly in Macedonia and Thessaly, pear trees in Thessaly and Central Macedonia and Corinth (Peloponnese), kiwis in Pieria (Central Macedonia) and Arta (Ipirus). The geographical distribution depends on tree type and local climatic conditions. **ESTIMATION OF BIOMASS PRODUCTION:** Potential of pomefruit tree prunings is assessed as 173.5 kt dry matter, from apples and pears alone. The biomass availability of other pomefruit tree types has not been assessed in detail; quite high volumes are expected from kiwi plantations however. **OTHER USES:** Same as with other prunings, mostly burned in open fires or less frequently chipped / mulched. **PRICES:** There is practically no market in Greece.
Stonefruit tree prunings	**PRODUCTION:** Stonefruit trees (peaches / nectarines, cherries, apricots, etc.) cover 65.7 kha, which is about 2.0 % of the UAA. In terms of production, 641.0 kt are peaches and nectarines, 113.8 kt apricots and 80.5 kt cherries. **GEOGRAPHICAL DISTRIBUTION:** Peaches and nectarines are cultivated mostly in Macedonia and Thessaly. Apricots are cultivated mainly in Argolida and Corinth (Peloponnese) but also in Thessaly, Macedonia and Crete. Cherry trees are spread all over Greece, including the islands, however, mostly are cultivated in Pella and Imathia (Central Macedonia). **ESTIMATION OF BIOMASS PRODUCTION:** Potential of stonefruit tree prunings is assessed as 217.8 kt dry matter. **OTHER USES:** Same as with other prunings, mostly burned in open fires or less frequently chipped / mulched.

	PRICES: There is practically no market in Greece.
Citrus tree prunings	**PRODUCTION:** Citrus tree cultivation (oranges, lemons, tangerines) covers 42.0 kha of land in Greece representing about 1.3 % of the UAA. Production is 727.5 kt of oranges, 76.2 kt of lemons and 176.6 kt of tangerines. **GEOGRAPHICAL DISTRIBUTION:** Citrus tree cultivation is common in all national territory but the majority of production takes place in the coastal areas of Peloponnese. Etoloakarnania (Western Greece) is also an important centre of orange cultivation. **ESTIMATION OF BIOMASS PRODUCTION:** Potential of citrus tree prunings is assessed as 237.9 kt dry matter. **OTHER USES:** Same as with other prunings, mostly burned in open fires or less frequently chipped / mulched. **PRICES:** There is practically no market in Greece.
Nut tree prunings	**PRODUCTION:** Nut tree cultivation (almonds, walnuts, hazelnuts, chestnuts and pistachios) cover 38.3 kha, about in Greece representing about 1.2 % of the UAA. The major products are almonds (43.0 kt), walnuts (35.8 kt) and chestnuts (30.3 kt). **GEOGRAPHICAL DISTRIBUTION:** Almond trees are cultivated mostly in Macedonia and Thessaly. Walnuts are often cultivated in hilly / mountainous areas, including parts of Achaia and Arkadia (Peloponnese), Kozani (West Macedonia), Trikala, Larissa (Thessaly) and the island of Evoia (Central Greece). Pistachio is mostly cultivated in the island of Aegina near Athens, Fthiotida (Central Greece) and Larissa (Thessaly). **ESTIMATION OF BIOMASS PRODUCTION:** The biomass potential of almond tree prunings is assessed as 92.7 kt dry matter. There are no studies about the pruning potential of other nut tree types in Greece. **OTHER USES:** Same as with other prunings, mostly burned in open fires or less frequently chipped / mulched. **PRICES:** There is practically no market in Greece.

Vineyard prunings	**PRODUCTION:** 90.4 kha are areas under grapes, 8.1 % of the UAA. 531.0 kt of grapes were used for wine production, 244.3 kt were for table consumption and 52.2 were for raisin production. **GEOGRAPHICAL DISTRIBUTION:** Vineyards can be found almost all over Greece. Peloponnese is the major wine and raisin producing region, but other regions like Macedonia, Crete, Central Greece and Attica are not far behind. **ESTIMATION OF BIOMASS PRODUCTION:** Potential of vineyard prunings is assessed as 49.7 kt dry matter[11]. **USES:** Prunings from vineyards are mostly burned in open fires or less frequently mulched onto soil (organic fertilizer). In some cases, vineyard prunings may also be used for cooking purposes (e.g. grilling). **MARKET:** There is practically no market in Greece.
Other tree prunings	**PRODUCTION:** Various other trees are cultivated in Greece, such as avocado, mastic, medlar, banana and carob trees. The total area for such crops is around 25.2 kha, representing 0.8 % of the UAA. **GEOGRAPHICAL DISTRIBUTION:** The geographical distribution for such crops varies widely depending on the tree type. **ESTIMATION OF BIOMASS PRODUCTION:** Pruning potential from such trees has not been assessed so far. **USES:** Same as for other agricultural prunings. **MARKET:** There is practically no market in Greece.
Plantation removals	**PRODUCTION:** Plantation removals take place whenever a farmer wishes to remove an established permanent crop. To our knowledge, there are no statistics or surveys as to area of permanent crops that is removed every year in Greece.

[11] A conservative RPR of 0.1 value was used and a typical moisture content of 40 %. Surveys from the uP_running project indicated a very high variability of biomass productivity from vineyard prunings depending on factors such as variety, location, etc.

	GEOGRAPHICAL DISTRIBUTION: Changes of cultivated varieties appear to be more frequent in the stonefruit areas of Central Macedonia; hence higher rates of plantation removals are expected there. **ESTIMATION OF BIOMASS PRODUCTION:** Biomass productivity from plantation removals varies depending on tree crop type and variety, age, agronomic practices and other factors. The company EAMEB[12] estimates that on average 50 t/ha can be generated, 80 % of which is the aerial part of the tree and 20 % is the root system. **USES:** Plantation removal biomass can be used as firewood or, if properly processed, as wood chips. **MARKET:** Firewood from plantation removals can be purchased from various retailers. To our knowledge, EAMEB is currently the only commercial supplier of wood chips from plantation removals; most of the quantities produced are used in a nearby 1 MWe biomass gasification plant.

[12] EAMEB (www.eameb.gr) is a specialized agro-service company offering plantation removal services and sales of biomass in the area of Veria. EAMEB is one of the uP_running project "flagship" cases of utilization of agricultural pruning and plantation removal biomass; further details on its operation are available on this report: http://www.up-running.eu/wp-content/uploads/2016/10/uP_running_D6.4_Flagship_cases_report_v2_FV.pdf

Agro-industrial residues

Agro-industrial residues differ from agricultural residues of annual and permanent crops because they are already available at a specific point and no efforts are required for their harvesting. Considering that several of these residues have low moisture contents and a quite high calorific value, they are already used in various energy applications.

Despite the fact that there are already uses and markets for agro-industrial residues, there are no official statistics as to their production volume. CERTH has performed estimations at to their production level considering the following: a) production volumes of related agricultural products from official statistics, b) estimations as to processed volume based on own expert knowledge and contacts with producing companies, c) Residue-to-Product Ratios and typical moisture content from literature, own expert knowledge or contacts with producing companies, d) levels of self-consumption based on contacts with producing companies.

The H2020 project BIOmasud Plus (www.biomasudplus.eu) had a closer focus on the Greek market of solid biofuels, including several agro-industrial residues such as olive stones and nut shells that are of interest also for the residential heating market.

Agro-industrial residues	
Exhausted Olive Cake and Olive Stones	**PRODUCTION:** Exhausted olive cake and olive stones are solid by-products of the olive oil production process. In principle, exhausted olive cake consists primarily of the olive pulp and skin, while olive stones of the fruit pit. The production process is a little more complicated compared to other agro-industrial residues, since it involves two levels of processing. Olive mills perform the primary olive pressing for olive oil production. Their main residue is the olive pomace, which is given to olive pomace mills for secondary oil extraction. Olive stones can be separated by both olive mills and pomace mills. Exhausted olive cake is produced by pomace mills. In Greece, olive stone separation is actually rare. In most cases, the olive stone fraction and the exhausted olive cake fraction are available together as the solid residue of pomace mill. This biomass fuel is commonly known as “kernel wood” (Greek: πυρηνόξυλο). **GEOGRAPHICAL DISTRIBUTION:** There are about 35 pomace mills in Greece, mostly located in the olive oil

Agro-industrial residues	
	producing areas of Peloponnese and Creta. Some pomace mills operate in other areas as well (e.g. in Fthiotida, Lesvos, Corfu). There are about 2,500 olive mills spread throughout the olive producing areas; however, only a limited number actually produce olive stones. **ESTIMATION OF BIOMASS PRODUCTION:** Considering that olive stones constitute on average 8.3 % of the olive fruit and exhausted olive cake 19.7 %[13] and a typical moisture content of 15 %, the production for 2017 is estimated as 170.0 kt of dry matter for olive stones and 403.5 kt dry matter for exhausted olive cake. As explained before, in practice these fractions are actually jointly produced by pomace mills. **USES:** A very high share of the produced "kernel wood" is self-consumed by pomace mills in order to dry the incoming pomace and produce steam for the secondary oil extraction. In the last years, the self-consumption share has increased, since many olive mills have switched to the two-phase production system which results is a wetter pomace. This means that more kernel wood has to be consumed in order to dry the incoming pomace before its further processing. The Association of Olive Kernel Oil Producers of Greece (SPEL) currently estimates that there is a 60/40 split between the two-phase and the three-phase systems currently. For a typical year in which olive oil production reaches 250,000 t, the Association estimates that the kernel wood available for the market is 70,000 and 65,000 t coming from two-phase and three-phase olive mills respectively. Such quantities are used for various applications, including greenhouses, agro-industries or even domestic heating. **MARKET:** The market for both exhausted olive cake and olive stones are quite developed. Exhausted olive cake "kernel wood" prices often range from 50 – 80 EUR/t, although they are subject to seasonal variations. Olive stones, being a higher quality fuel, are available in some locations for prices in the range of 150 EUR/t (indicatively).

[13] Rodero, P., Esteban L., The olive oil industry: Main by-products and their characteristics as fuels. Presentation from the Biomasud project (SOE2/P2/E414). Available online at: http://biomasud.eu

Agro-industrial residues	
	It should be noted that prices are generally higher in islands such as Creta and Lesvos.
Sunflower hulls	**PRODUCTION:** Sunflower hulls are produced from sunflower oil producing plants that integrate a hull removal step. **GEOGRAPHICAL DISTRIBUTION:** Sunflower oil production in Greece is mostly connected with biodiesel production. There are about 11 biodiesel producers in Greece working with sunflower as a feedstock. The larger ones are located in Achaia, Fthiotida and Central Macedonia. **ESTIMATION OF BIOMASS PRODUCTION:** Assuming that 100 % of the sunflower produced in Greece is processed by biodiesel plants, the sunflower hull potential is estimated in the range of 36.5 kt dry matter. However, based on contacts with biodiesel producers, only a limited number of producers integrate hull removal in their process, hence the quantities produced in Greece are actually much lower. **USES:** If hull removal is implemented, then some quantities of sunflower hulls are self-consumed for own heat demands. The rest is usually pelletized and sold to the market. **MARKET:** The market size for sunflower husk pellets in Greece estimated to be in the range of 100,000 tons. Of these, the majority (around 80,000 tons) are imported mostly from Ukraine, Russia and Bulgaria. There is also a smaller domestic production from some of the larger biodiesel producers. Prices are subject to seasonal variations and quality level; values ranging from 80 to 120 EUR/t have been noted.
Rice Husks	**PRODUCTION:** Rice husks are produced from rice mills. It is estimated that rice husks are around 20 % of the processed rice and have a typical moisture content of 10 %. **GEOGRAPHICAL DISTRIBUTION:** Most rice mills are located in Central and East Macedonia, in the major centers for rice production. **ESTIMATION OF BIOMASS PRODUCTION:** Assuming that 100 % of the rice produced in Greece is processed by rice

Agro-industrial residues	
	mills, the rice husk potential for 2017 is estimated as 46.0 kt dry matter. **USES:** Rice mills self-consume rice husk for their own process needs (e.g. rice cooking). One rice mill has installed a small biomass CHP unit (440 kWe). Left-over quantities are available for other agro-industries. **MARKET:** Rice husk are available for prices in the range of 60 – 80 EUR/t. It should be noted that rice husk ash is almost pure silica and has in fact a market value, unlike the ash of most other agro-industrial residues.
Cotton Ginning residues	**PRODUCTION:** Cotton ginning residues are produced from cotton ginning plants. Around 10 % of the incoming cotton is available as residue, with a typical moisture content of 13 %[14]. **GEOGRAPHICAL DISTRIBUTION:** Cotton ginning plants are located in the main centers of cotton cultivation in Greece: Thessaly, Central Greece and Central Macedonia. **ESTIMATION OF BIOMASS PRODUCTION:** Assuming that 100 % of the cotton produced in Greece is processed by cotton ginning plants, the cotton ginning residues for 2017 are estimated as 70.4 kt dry matter. **USES:** These residues are used as fuel in the cotton ginning plants for steam production for various internal uses (drying of cotton, wetting of lint, treatment of cotton seeds, etc). A 1 MWe power plant in Imathia uses cotton ginning residues as part of its fuel mixture[15]. **MARKET:** There is no information about prices of cotton ginning residues.
Grape Marc	**PRODUCTION:** Grape marc is the solid remain of the pressed grapes for wine production. It is around 20 % of the pressed grapes, consisting of the grape pulp, seed, stalk and skin[16]. The moisture content is quite high, a typical value of

[14] http://web2.vtt.fi/virtual/afbnet/greece_biosurvey.pdf
[15] https://nphilippopoulos.gr/gr/projects/power_plant_orc_to_fuel_biomas_power
[16] uest.ntua.gr/athens2017/proceedings/presentations/12_45Presentation_ATHENS_2017_Kavvadias_V_F1.pdf

Agro-industrial residues	
	60 % is assumed. The annual wine production in Greece for 2017 was 2.5 million hectolitres[17]. **GEOGRAPHICAL DISTRIBUTION:** There are around 1,000 wineries spread throughout Greece in all the wine producing areas. Bigger units are located in the wine areas of Macedonia and Nemea. **ESTIMATION OF BIOMASS PRODUCTION:** Considering the volume of grapes used in 2017 for wine production, grape marc production is estimated to be in the range of 42.5 kt dry matter. **USES:** Grape marc is often returned to the fields as a fertilizer. Some projects are considering its use as an animal feed, substrate for vegetable production or for extraction of various chemical compounds. Energetic utilization is a possibility but is more difficult due to the high moisture and ash content of this biomass fraction. **MARKET:** We are not aware of any market for grape marc in Greece.
Nut shells (almonds, walnuts, pistachios, etc.)	**PRODUCTION:** Nut shells are produced from nut crushing plants. Shells are around 60 % of the nut seed weight for almonds and around 55 % for walnuts, pistachios and hazelnuts. Typical moisture content is around 15 %[18]. **GEOGRAPHICAL DISTRIBUTION:** There are a few bigger almond crushing plants in Thessaly, but many other crushing plants are very small and spread in various nut producing regions. **ESTIMATION OF BIOMASS PRODUCTION:** Assuming that 100 % of the almond production of 2017 is crushed, while only 15 % of the pistachio and walnuts produced are crushed, the production of nut shells is estimated to be 25.1 kt dry matter, of which 21.9 kt are almond shells. Walnut crushing is rarer because it is considered more difficult to separate the nut from the edible part. Pistachios are usually sold with the shell, apart from a smaller part of the annual

[17] https://winesofgreece.org/articles/key-production-figures/
[18] http://biomasudplus.eu/wp-content/uploads/2017/09/D2.1-Market_report_Consolitated-6.pdf

Agro-industrial residues	
	production (around 10 – 15 %) which is "closed" and has to be processed. **USES:** Unlike many other agro-industries, nut crushing plants do not have very high heat demands, so most of the crushed nut shells produced are made available for local heating applications. **MARKET:** Market prices of nut shells are in the range of 65 – 120 EUR/t.
Peach kernels	**PRODUCTION:** Peach kernels are produced from peach canning plants. The Greek Canneries Association (EKE) estimates that peach kernels are about 8 % of the incoming material used for compote and puree production. The typical moisture content is 20 %. **GEOGRAPHICAL DISTRIBUTION:** There are about 17 peach canning plants in Greece, mostly located in Central Macedonia. **ESTIMATION OF BIOMASS PRODUCTION:** Considering 2017 production volume, peach kernel production is estimated to be around 19.7 kt dry matter. **USES:** Peach kernels are currently mostly consumed by a number of peach canning plants that have installed biomass boilers. Some left-over quantities are available for local heating markets. **MARKET:** Peach kernels are sold for prices in the range of 60 – 80 EUR/t. However, as they are currently mostly self-consumed, limited quantities are available for other uses.

Energy crops

Energy crops for biodiesel production, in particular sunflower and rapeseed, are gaining ground in Greece and are often cultivated under contracts. Cultivation of energy crops for solid biofuels only takes place within the framework of research or demonstration projects.

Energy crops	
Woody varieties - SRC (Poplar, Willow, Robinia, etc.)	There are no statistical data regarding SRC cultivations in Greece. There are a few companies (e.g. plant nurseries) advertising SRC such as paulownia and eucalyptus, however the market uptake seems to be extremely limited.
Grassy Varieties (Arundo Donax, Miscanthus, Switch grass, etc.)	There are no statistical data regarding grassy energy crops for solid biomass production in Greece. Some small pilot fields are maintained by the Center for Renewable Energy Sources (CRES). Historically, there has been interest in the cultivation of cardoon (*Cynara Cardunculus*) as a solid biofuel. In 2010, a demonstration project for the cultivation of 400 hectares in Kozani, Western Macedonia was established; the biomass harvested was used as a co-firing fuel in a large-scale lignite-fired power plant. The project has been discontinued and local cultivation is abandoned.

2. Rural Development

Rural Development	
How is Rural Development managed?	Rural Development is managed through the Rural Development Programme (RDP), funded under the European Agricultural Fund for Rural Development (EAFRD) and national contributions. The RDP 2014-2020 (http://www.agrotikianaptixi.gr/) includes 16 Measures and 37 Sub-measures, some of which are further refined in 29 Actions. The Measures can be grouped into five main categories: Private Investments / Entrepreneurship Agro-environmental Training/Consulting/Cooperation (horizontal interventions) Public Investments LEADER/CLLD (local development interventions leaded by local communities) Two more categories are intended for Technical Assistance and actions continued from the previous RDP 2007-2013. The Managing Authority of RDP 2014-2020 is headed by the General Secretary of Agricultural Policy and Management of Community Funds of the Ministry of Rural Development and Food.
Are agrobiomass feedstocks suitable for bioheat included in the Ecological Focus Area? (for example, Short Rotation Coppice, Miscanthus, Silphium perfoliatum)	Eligible crops for Ecological Focus Areas in Greece are nitrogen-fixing legumes of the following species: i. Medicago sativa, ii. Phaseolus spp., iii. Vigna spp., iv. Lotus corniculatus, v. Cicer spp., vi. Trifolium spp., vii. Vicia faba, viii. Lens culinaris, ix. Lupinus spp., x. Pisum spp., xi. Vicia spp. Miscanthus, Silphium perfoliatum or SRC are not included in the list of eligible crops.
Are there any restrictions on the cultivation of dedicated energy crops (woody or grassy varieties)?	No.
Are there any restrictions or mandated practices covering agricultural residues collection?	There are restrictions regarding the burning of agricultural residues, see below.
Is there any support for the valorization of agricultural residues at national level? Or at local level?	Sub-measure 16.6 “Co-operation among actors for sustainable provision of biomass” is not programmed in the Greek RDP 2014-2020.

Rural Development	
	There are no explicit measures targeting valorization of agricultural residues at national or local level. However, some sub-measures of the RDP 2014-2020 offer this potential. The most relevant that have been identified include: **Sub-measure 4.1.3**, providing support for the investment in RES at agricultural holdings, on the basis of covering their energy demands, good practices for the handling of wastes and by-products and their utilization for energy production. **Sub-measures 4.2.1, 4.2.2 and 4.2.3** support investments related to processing, trade and/or development of agricultural products. Investments in RES are not supported as stand-alone actions, but as parts of a complete investment scheme. **Sub-measure 16.1-16.2** promotes the establishment of cooperation in actions related to the development of new products, processes and technologies in the agricultural sector for enhancing the competiveness of primary sector (agricultural holdings) and food sector enterprises. The list of actions includes the utilization of agricultural by-products for energy production. **Sub-measure 16.1-16.5** promotes the establishment of cooperation for the development of new agricultural and production practices aiming to protect the environment and adapt to climate change. The list of actions includes the use of RES for the reduction of fossil fuel inputs. A specific action of Sub-measure 4.4 (Agro-environmental non-productive investments) of the RDP 2014-2020 was drafted to support the purchase of shredders, chippers or mulchers for the treatment of olive tree prunings. The measure foresaw either to leave the material on the soil; an amendment considering the removal of the material for energy production was also introduced. The foreseen support to olive tree growers was 140 €/ha for a five-year period. The measure was expected to result in the purchase of 100 chippers. Following a negative assessment of the Benaki Phytopathological Institute on the basis of the risk of fungi attacks from shredded prunings remaining on the field, the Ministry for Rural Development and Food withdrew the

Rural Development	
	measure in June 2018[19]. At least one Greek MP has requested that this measure is reinstated in order to avoid the uncontrolled burning of prunings on the field[20].
Is there a ban on burning stubbles, prunings or other agricultural residues?	Ministry Degree 125347/568 "Codes of Good Agricultural Practices" (142 ΦΕΚ Β' 29-1-2004) establishes some guidelines for the management of agricultural residues. Burning of residues is not strictly forbidden in most cases. Proper treatment of arable crop residues is suggested to protect soil erosion and increase organic matter: immediate soil incorporation, soil incorporation after forage, or cutting, mulching and soil incorporation in the next spring are the three suggested methods. Burning of stubbles is forbidden in the following cases: ecological sensitive areas (NATURA 2000), fields with more than 10 % slope, soils with organic matter exceeding 4 %. If removal by burning is used, then precautionary measures to avoid fires should be implemented. It is also suggested to incorporate the ash back in the soil within two days after burning, if possible. For prunings of permanent crops open-field burning is a tolerated practice. The following limitations / considerations for this activity apply: Prunings should be burned during winter months, after taking necessary precautionary steps to avoid fires. Prunings are forbidden to be disposed via burning at fields located in a 500-meter radius from forests of ecological sensitive areas, unless a special permission is obtained from the fire brigafe. Prunings are suggested to be used for energy production at the domestic sector (fireplaces & stoves) or used for compost after chipping. Local / regional fire departments typical regulate the activity of pruning field burning and only allow the practice to take place during the winter months. In most cases, burning any type of agricultural residues is banned from 1st May to 31st October); exceptions may be given but only if

[19] https://www.agro24.gr/agrotika/pliromes/programmata/katargeitai-me-tin-3i-tropopoiisi-toy-paa-metro-gia-tin-hrimatodotisi
[20] https://www.hellenicparliament.gr/Koinovouleftikos-Elenchos/Mesa-Koinovouleutikou-Elegxou/?pcm_id=0c44b785-b9a1-4381-9cbc-ab2c00ecdc7e

Rural Development	
	very strict measures for the avoidance of fires are be applied. Ongoing discussions related to the CAP revision hint at stricter policies regarding banning of residues burning (including prunings); if implemented they will indirectly promote energetic utilization as an alternative.

3. Logistics and other market considerations

Logistics	
Are harvesters/balers for agricultural residues readily available in the market?	Studies indicate that the level and quality of mechanization in Greece could be improved, considering that the average age of tractors is higher than then EU-average, while average horsepower is lower[21]. That being said, large machines for management of series are well available – these also include baling systems for cereal straw. These machines are imported from abroad. Regarding management of prunings from permanent crops, integrated harvesting/shredding or baling systems are very hard to find. One possible reason for this is the small size of Greek holdings, which does not justify such investments from solitary holdings. Moreover, such machines are more expensive and not so attractive to contractors offering services to multiple farmers considering that there are no established pruning-to-energy value chains. It is however interesting to note that at least one Greek manufacturer offers a modified mulcher series with the capacity to collect the shredded prunings in a big-bag for energy utilization[22]. However, the need for alternative disposal methods for prunings has created a market for mulching machines or small, manually-fed chippers/shredders. Such systems have much smaller investment costs and are even purchased by individual farmers. There are also several manufacturers of such machines in Greece, as well as imported machines.
Is there an investment support available to cover the cost of these machines?	Sub-measure 4.1 (Improvement Plans) of the RDP 2014-2020 gave for the first time the possibility to fund the purchase of machinery such as combine harvesters, etc., provided that the purchase was performed by a cooperative scheme. A specific RDP measure for the purchase of chipper for olive tree growers was retracted (see Section 2).
Are there any specialized service companies for agricultural residues harvesting and logistics?	Some services related to residues collection or disposal (e.g. straw harvesting, mulching of prunings) are often performed by local contractors – usually farmers

[21] http://iobe.gr/docs/research/RES_05_F_02122019_REP_GR.pdf
[22] https://fotopoulosagro.gr/georgika-mihanimata/katastrofeis/katastrofeis-thrymmatismoy-kai-syllogis-fsr

	themselves – that provide services within a narrow geographical area. Only rarely are such contractors involved in agrobiomass value chains for energy production. One notable exception is EAMEB (www.eameb.gr), an agro-service company located in Veria, Central Macedonia that offers specialized uprooting services to local farmers of fruit trees. The uprooted trees are transformed into wood chips and sold to industrial consumers (e.g. a 1 MWe gasification plant in the area)[23].
How does the biomass market usually operate?	The biomass market in Greece is quite small compared to other European markets. As explained before, the consumption of biomass takes place at two main market segments: domestic, agro-industrial; greenhouses are often quite important local biomass consumers. The domestic biomass market is fully driven by heat demand / weather. Consumption level per individual consumer is quite low. Despite this, it seems that the price of products such as wood pellets have remained mostly stable over the last years. Some agro-industries (e.g. pomace mills) produce agro-industrial residues; after covering their own self-consumption needs, the remaining quantities are made available to the market for domestic or larger consumers. The level of production of these residues depends on the production level of the primary agricultural products. Bad years combined with cold weather may drive up the demand while minimizing the production; price increases are detected in such cases. Other industries and greenhouses use biomass but are not producers themselves. As a result, they are more susceptible to variations of agrobiomass availability and prices. It should be noted that in the previous years, the market of sunflower husk pellets has expanded; most of the quantities consumed are imported.
Are there companies producing agro-pellets?	The main type of agropellet used in Greece in sunflower husks, which is estimated to have a market size of 100,000

[23] Further details available on the uP_running Deliverable 6.4: http://www.up-running.eu/wp-content/uploads/2016/10/uP_running_D6.4_Flagship_cases_report_v2_FV.pdf

	tons per year (for industrial / greenhouse / large-scale consumption). Most of the quantities consumed are imported (from Russia, Ukraine and Bulgaria), but there are also a few Greek producers (larger biodiesel plant from sunflower seeds that use the pelletize the industrial residue). In principle, wood pellet producers can also produce agropellets from most materials, while several animal feed facilities with a pelletisation line can produce herbaceous agropellets (e.g. straw pellets). However, only few companies produce or supply agro-pellets for energy. Some detected are: Aenaon Bioenergies (http://aenaon-bioenergies.gr), located in the Industrial Area of Patra, produces agropellets from various agro-industrial residues or prunings. Aegean Biomass (www.aegean-biomass.gr) and EP.YP.EL. (www.olivepellet.gr), both located in Lesvos, produce (or have produced) agropellets from olive tree prunings and exhausted olive cake respectively. BioAlten, located in Tripoli, produces an agropellet made from exhausted olive cake for industrial use. Kechidis-PROMEX (https://thermansi.promex.gr/), located near Thessaloniki, markets under its own brand straw pellets, produced in Serbia. It seems that the main market for these pellets is animal bedding. The AGROinLOG H2020 project (www.agroinlog-h2020.eu) implemented a large-scale demonstration of olive tree prunings harvesting in Central Greece; quantities harvested were also used to produce olive tree pruning pellets (OTP pellets) used for industrial validation. AgroBioHeat project partners CERTH and INASO-PASEGES also participate in AGROinLOG. Preliminary project results indicate that OTP pellets have some advantages compared to other established industrial solid biofuels in Greece (sunflower husk pellets, exhausted olive cake), such as reduced potential for slagging, but their expected cost is higher than the market prices of these alternatives. As a result, it is very hard to promote them on an already established biomass market.
Are there any resistance in the market for this kind of product?	No resistance towards agropellets has been detected, but the market is marginal anyway.

4. Air quality

<table>
<tr><th colspan="2">Air quality</th></tr>
<tr><td>Has the state submitted a NAPCP? (National Air Pollution Control Programme)</td><td>In February 2020, Greece - along with Romania and Malta - got a warning issued by the European Commission regarding the air pollution. Greece has been urged by the EC to disclose information on the gravity of air pollution across its territory and to take effective and immediate measures for the reduction of national emissions of air pollutants. If Greece fails to comply within a period of two months from the warning, the case may be referred to the EU Court of Justice[24].

In 24 June 2020, the Ministry of Environment and Energy launched a public consultation for the Greek NAPCP. The consultation will remain open till 15 July 2020. The draft document names biomass combustion in residential heating as a source of increased PM10 emissions in cold winter days. There are some general references on agricultural residues, but not any quantification of the emissions caused by open-field burning, nor of the targets for their minimization.

The Final National Climate and Energy Plan submitted in December 2019 gave an indication as to the targets of the NAPCP by including the following table:

Table 2: Quantitative targets for reduction on national emissions of certain air pollutants for the period 2020-2029 and for 2030 compared to 2005 (Source: final NECP – Greece).

<table>
<tr><th rowspan="2">Air pollutants</th><th colspan="2">Percentage of emission reductions compared to 2005</th></tr>
<tr><th>Period 2020-2029</th><th>2030</th></tr>
<tr><td>Sulphur dioxide (SO2)</td><td>74%</td><td>88%</td></tr>
<tr><td>Nitrogen oxides (NOx)</td><td>31%</td><td>55%</td></tr>
<tr><td>Non-methane volatile organic compounds (NMVOCs)</td><td>54%</td><td>62%</td></tr>
<tr><td>Ammonia (NH3)</td><td>7%</td><td>10%</td></tr>
<tr><td>Fine particulate matter (PM2.5)</td><td>35%</td><td>50%</td></tr>
</table>
</td></tr>
<tr><td>Competence over air quality related issues is at National or at Local level?</td><td>Competence is shared between national government which sets the limits and provides a framework and regional authorities. Regions have the obligation to monitor quality of air and put in place measures to respect the limits.</td></tr>
</table>

[24] https://www.neweurope.eu/article/commission-calls-on-romania-greece-and-malta-to-adopt-national-air-pollution-control-programmes/

Are performance standards and/or emission limits a possible barrier to deployment of agrobiomass heating systems up to 500 kW?

Ministerial Decree 189533/2011 established requirements for central heating boilers used in the residential and service sector, as well as for hot water / steam plants in service sector buildings.

New biomass boilers have to comply with the requirements of Class 3 / EN303-5 as per the table below (for automatic feeding boilers):

Table 3: National limits for biomass central heating boilers.

Nominal Capacity, Q_n (kW)	Emissions (mg/Nm3, @ 10 % O2, dry) CO	OGC	PM	NOx	Efficiency (%)
<50	3,000	100	150	340	≥ 67 + 6×log(Q_n)**
50 – 150	2,500	80	150		
150 - 300*	1,200	80	150		

* The 2012 revision of EN303-5 extends this range up to 500 kW
** EN303-5:2012 sets a lower limit of 82 % for the efficiency of boiler with capacity range between 300 – 500 kW

The limits are less strict than the Ecodesign Regulation requirements (equivalent to Class 5). Applicable fuels are anything within the scope of European standard EN 14961-1.

As of 1st January 2020, wood boilers up to 500 kW have to comply with the efficiency / emission limits of the Ecodesign Regulation.

Results already available, e.g. from the Biomasud Plus project[25], indicate that:
It should be possible to meet the limits of the Greek legislation – or even the stricter limits of Ecodesign Regulation - with the use of high-quality agrobiomass (e.g. low ash, low nitrogen) fuels such as olive stones, nut shells, etc. in modern boiler systems.
Fuels with higher amounts of nitrogen and ash, such as exhausted olive cake, olive tree prunings and vineyard prunings are expected to exceed the limits of the Greek legislation regarding PM and NOx. PM emissions might be controlled with secondary measures, but NOx emissions are linked to the fuel-N content and cannot be expected to be reduced below a certain level.

It should be noted that up to now, enforcement of the law is rare and many biomass boilers available on the Greek

Air quality	
	market have not undertook proper type testing, even with wood biomass fuels. However, a mass-deployment of agrobiomass heating in Greece might require a revision of the legislation, especially as regards the NOx limit.
Are performance standards and/or emission limits a possible barrier to deployment of agrobiomass heating systems from 500 kW to 1 MW?	There are no performance standards or emission limits in Greece for (agro)biomass boilers with capacities ranging from 500 kW to 1 MW.

[25] http://biomasudplus.eu/wp-content/uploads/2018/12/BiomasudPlus-D5_3.pdf

5. Tax breaks

Tax breaks	
What is the VAT applicable to agrobiomass feedstock?	Since 1/6/2016, the applicable VAT for all types of solid biofuels in Greece, including agrobiomass fuels, is 24 %. Agricultural inputs, e.g. fertilizers, seeds and bulbs, cereals, animal feed (including straw) are subject to the reduced VAT of 13 %.
For comparison, what is the standard VAT rate and the one applicable to fuels used for heating (e.g. heating oil, LPG, natural gas, firewood, pellets, etc.)?	As of April 2020, Greece uses three types of VAT rates: Standard VAT: 24 % - it applies to most fuels used for heating (heating oil, LPG, firewood, pellets, exhausted olive cake, etc.) Reduced VAT: 13 % (applicable for several foods, as well as many agricultural inputs) Extra-reduced VAT: 6 %. Since 1/6/2019, this rate applies to electricity, natural gas and heat from district heating systems (before these products were subject to a 13 % VAT).
Are there any tax detraction on refurbishment of buildings/replacement of heating system that can be potentially applied to agrobiomass heating?	In Autumn 2019, the Greek government has announced its intention to set up a tax reduction of up to 40 % of expenses incurred for the upgrading of energy performance, functional utility or aesthetics of buildings. As of April 2020, this has not materialized yet. In principle, such a scheme could be used for installation agrobiomass heating systems in the residential sector. It is unlikely though that such a scheme would be a major driver for agrobiomass heating systems per se.

6. Other support measures targeting heating

Other support measures targeting heating	
Are there any rural development measure in place to support the production of bio-heat on-farm?	There are no support schemes for renewable heat based on the energy produced (such as the Renewable Heat Incentive of the UK), either on-farm or off-farm. Some measures of the RDP 2014-2020 can be used to install renewable heating systems on farms; further details are available on Section 2 of this report.
Are there national or local incentives to substitute old fossil fuel boilers (investment support)? Are they applicable to agrobiomass heating solutions?	**"Saving at Home" programme** The most important Programme related to the promotion of RES and energy savings at the residential sector is "Saving at Home" ("ΕΞΟΙΚΟΝΟΜΩ ΚΑΤ' ΟΙΚΟΝ" – www.exoikonomisi.ypen.gr), co-funded by the Greek State and the European Union through the National Strategic Reference Framework. The Programme intends to promote energy efficiency in the residential sector by providing incentives for the implementation of energy saving measures. Eligible interventions are grouped into four main types: Replacement of frames Upgrading of thermal insulation Upgrading of heating / cooling system Hot water production system from renewable energy sources The 3rd type of intervention includes both installation of new systems as well as replacement of old, inefficient ones; automated control systems are also eligible. Eligible heating systems are heating oil burners/boilers, natural gas/LPG burners/boilers, heat pumps, geothermal heat pumps, biomass/wood pellet boilers, fireplace inserts and air conditioning units. Eligible costs for biomass boilers range from 6,900 EUR to 25,000, depending on capacity. Agrobiomass boilers are in principle eligible. Interventions should aim to achieve a minimum level of annual primary energy savings. The 2007-2013 Programme finally served 51,659 applications requesting a total budget of around 529 million EUR. 28.05 % of the eligible budget was used in interventions for the upgrading of heating / cooling and hot water production systems[26].

[26] https://slideplayer.gr/slide/11826039/

Other support measures targeting heating	
	The Programme was on hold for several years, having used up all its allocated funds. It was resumed as "Saving at Home II" ("ΕΞΟΙΚΟΝΟΜΩ ΚΑΤ' ΟΙΚΟΝ ΙΙ"). A first call was published in 2018, with a total budget of 503 million EUR; all the allocated funds were used. A second call in 2019 had an allocated budget of 275 million EUR, while a new one is expected within 2020, with a budget of around 250 million EUR. **Other Operational Measures / National Strategic Reference Framework** There are no other explicit measures for substituting fossil fuel boilers, however certain operational measures of the National Strategic Reference Framework (NSRF) provide such opportunities. The "Competitiveness toolkit for Small and Very Small Enterprises"[27] (Total budget 400 million EUR, investment plans from 20,000 to 200,000 EUR, funding rate 50 – 65 %) includes as eligible costs – among many others - procurement and installation of new RES heating and hot water production systems (including biomass), as well as costs for a fuel switch. As of April 2020, 3,182 enterprises requesting almost 224 million EUR of public funds have been accepted in this scheme. The amount given for RES investments is not disclosed. A more specific measure "Promotion of RES heating and cooling systems and combined heat and power production for self-consumption" with a total budget of 35 million EUR, with eligible investments ranging from 20,000 to 1,000,000 EUR per enterprise has been announced has not yet opened. **Regional Funds** Regional Operational Programs co-financed by the European Union's Structural Funds, European Regional Development Fund (ERDF) and European Social Fund (ESF) include support actions for renewable energy production and energy savings at residential sectors or buildings of the regional authorities (e.g. schools). In principle, such schemes can be used to support installation of (agro)biomass boilers.

[27] http://www.antagonistikotita.gr/epanek/prokirixeis.asp?id=42&cs=

Other support measures targeting heating	
	Regional Authorities in areas where the natural gas grid is expanding may provide support for the substitution of heating oil boilers with natural gas ones. A recent example (December 2019) from the Region of Thessaly allocated 6 million EUR for such a program targeting the residential sector[28]. Such specific programmes are obviously not applicable for (agro)biomass boilers.
Are there any specific measures in support of energy communities / renewable energy cooperatives that could be applicable to agrobiomass heating?	The legal framework for the creation and operation of Energy Communities in Greece is Law 4513/2018. Activities that an energy community can implement include among others: Production, storage, self-consumption or sales of electrical, heat or cooling energy from renewable energy plants or combined heat and power plants or hybrid plants Management (collection, transport, processing, storage or distribution) of raw materials for energy production (power, heat or cooling) from biomass, bioliquids, biogas or biodegradable fraction of municipal waste A key feature of energy communities is their local / regional scope of operation and membership structure. Energy communities can benefit from the Development Law and can participate in relevant programmes funded by the EU or the Greek state. In order to promote the take-off of energy communities, the establishing Law allocated several benefits, especially as concerns electricity production from RES. Among those, is a priority for the evaluation of new RES projects as well as grid access. There are indications that the Ministry of Energy and Climate is considering taking back some of these benefits. There are no significant specific benefits as regards activities related to heat production (from biomass or other sources) or biomass mobilization. The vast majority of Energy Communities already established target electricity production from photovoltaics or wind farms. A notable exception is the Energy Cooperative of Karditsa (ESEK) that was established in 2010, even before the legal framework for energy communities

[28] https://www.thessalia-espa.gr/pep-thessalias/proskliseis/549-082.html

Other support measures targeting heating	
	was set in place[29]. ESEK is managing a small-scale pellet plant that started operation in 2017. Currently, ESEK is producing and selling wood pellets, but has also expressed interest in agrobiomass.

[29] https://enercommunities.eu/course/energy-cooperative-of-karditsa/

7. Buildings Efficiency

Buildings Efficiency	
Are there any incentives to renovate buildings integrating renewable heat?	The aforementioned **"Saving at Home"** is up to now the main incentive scheme for building renovation in the residential sector. Further details on the previous / current programme are provided in more details in Section 6. In order to meet the NECP target of refurbishing 12 – 15 of the building stock by 2030 (around 60,000 residences per year), the Ministry is planning a new, long-term strategic framework, with annual calls for refurbishment projects. Technical specifications are expected to be updated and greater emphasis will be placed on mobilizing funds from a variety of sources, including EU-funds, green-bonds, ESCOs, private participation and tax exceptions / reductions. The **"ELECTRA"** programme of the Ministry for Environment and Energy will be the main scheme for the renovation of energy upgrades of public buildings. Established by Ministerial Decree ΥΠΕΝ/ΔΕΠΕΑ/56386/620 of June 2019, the programme has a foreseen budget of 500 million EUR. As of April 2020, the scheme has not opened for applications. The **EEA Grants for 2014-2020** has announced in March 2020 an upcoming 10 million EUR programme[30] for renewable energy production and energy efficiency in public building with a social character (schools, universities, courthouses, correctional facilities, swimming pools, etc.). The EEA Grants 2009-2014 have financed some projects that included installation of biomass boilers[31].
Are agrobiomass systems eligible for support under such schemes?	In principle, (agro)biomass systems are eligible for support under the aforementioned schemes.

[30] http://www.eeagrants.gr/en/programmes/renewable-energy
[31] Further details available here: http://eeares.cres.gr/

8. Policy Coherence

Policy Coherence	
Are policy instruments impacting agrobiomass designed in a coherent way?	
1. Soil considerations vs. Valorisation of residues	For the time being, there is no major conflict in Greek legislation / policy between integrating residues in the soil and valorising them for energy production. The Codes of Good Agricultural Practices promotes soil incorporation as a management method for the residues of arable crops, but does not forbid removals for energy use. For permanent crop prunings, the lack of easy alternatives is more apparent by the fact that open-field burning is tolerated. Removal for energetic utilization is encouraged as a good practice. Some resistance against incorporation of prunings residues in the soil is detected due to the phytopathological risks. It should be noted that Greek soils are generally poor in organic matter. Soil incorporation of residues might be perceived as a way of raising or maintaining the soil organic carbon; if such measures are adopted without discrimination, they might limit the potential of removing residues for energetic utilization.
2. Definition of waste vs. co-products/agri residues	Ministerial Decree 198/2013 set up specifications and test standards for solid biofuels for non-industrial use. Definitions are based on EN 14588, which makes it easy to avoid ambiguities regarding waste vs. co-products / residues. Exhausted olive cake, which is the most used local agrobiomass resource, is explicitly referenced in the Decree. Non-official texts may use the term “απόβλητα” (waste) for agricultural residues, but these do not have any legal bearing.
3. Is the Common Agricultural Policy Strategic plan being developed in harmony with the National Energy and Climate Plan?	As of April 2020, the strategic plan for the Common Agricultural Policy beyond 2020 has not been drafted. The Inter-governmental committee for the drafting of the National Energy and Climate Plan (NECP) included a representative from the Ministry of Rural Development and Food.

Policy Coherence

	Regarding overall promotion of RES, the NECP adopts the position that developments in mobilizing biomass resources in Greece are slow in comparison to the biomass potential. It is mentioned that "to further promote bioenergy, specialised support programmes will be designed both for the development of efficient supply chains for residual biomass / biodegradable matter and for the support and implementation of optimal environmental and energy-efficient bioenergy applications". A specific policy measure (M23) is allocated for this. More details are provided in the section on the agricultural sector. Policies and measures for the agricultural sector generally aim to improve the use of biomass for bioenergy and include the following: Priority in the use of waste (and residues). Supply chain organization and land planning of sites for temporary storage of agricultural/forest residual biomass. Maintenance and extension of the sustainability certification scheme for biofuels, bioliquids and solid fuels. Sustainable forest management. Strengthening the primary sector through the promotion of energy crops of woody biomass or coppice plantations. Creation and enhancement of the domestic bioethanol market. Development of the biomethane market. It is clear that several of these measures could be very relevant for agrobiomass heating value chains. More specifically, NECP states that "RES systems for heating and cooling on agricultural and livestock holdings will be promoted, as an indication of the utilisation of geothermal energy and other forms of RES in greenhouses." Although it seems promising, the NECP lacks details on how these targets will be implemented (e.g. quantifiable outputs, specific measures / support to be adopted). As regards the use of agrobiomass in small-scale heating applications, there are no specific measures or even recognition of its potential. In general, the role and potential of bioenergy is the heating sector is underplayed; the

Policy Coherence

following table summarizes its expected contribution in relation to other RES. Bioenergy's contribution is expected to remain "steady", while solar and ambient heat and geothermal increase.

Table 4: RES contribution to meet thermal needs in final consumption (Source: final NECP – Greece).

RES for heating (ktoe)	2020	2022	2025	2027	2030
Bioenergy	1,035	1,060	1,087	1,086	1,142
Solar	296	303	312	326	411
Ambient heat, geothermal	431	590	715	792	906
Total	**1,761**	**1,952**	**2,115**	**2,204**	**2,460**

More specifically, in the residential sector the increase in the use of bioenergy from 2020 to 2030 is marginal. The NECP mentions that "its use will be reduced in urban areas at regional level, with a significant decrease in absolute figures (over 5%) from the historic highs observed in 2012" Naturally, this promotes the application of bioenergy solutions in rural areas. The consumption of petroleum products by 2030 is significantly reduced, but not yet abolished, which indicates a missed opportunity.

Table 5: Final energy consumption in the household sector until 2030, based on the objectives achievement scenario (Source: final NECP – Greece).

Residential sector	2020	2022	2025	2027	2030
Final energy consumption	**4690**	**4555**	**4480**	**4430**	**4465**
Consumption by fuel					
Petroleum products	*1260*	*958*	*676*	*571*	*433*
Natural Gas	*432*	*470*	*618*	*654*	*673*
Electricity	*1719*	*1726*	*1744*	*1729*	*1748*
District heating	*43*	*43*	*41*	*40*	*39*
Bioenergy	*830*	*835*	*843*	*841*	*860*
Solar	*281*	*284*	*288*	*298*	*377*
RES for heat pumps (ambient heat and low enthalpy geothermal energy)	*126*	*239*	*270*	*297*	*336*
CO_2 emissions from the Household sector [Mt CO_2]	**4.9**	**4.0**	**3.5**	**3.3**	**2.9**
Final energy consumption per household [toe/household]	**1.15**	**1.12**	**1.10**	**1.09**	**1.09**

As regards the industrial sector, bioenergy consumption is foreseen to increase by around 30 % from 2020 to 2030. No details as to the biomass sourcing are provided.

Policy Coherence

Table 6: Final energy consumption in the industrial sector until 2030, based on the objectives achievement scenario (Source: final NECP – Greece).

Industry	2020	2022	2025	2027	2030
Final energy consumption	**3011**	**2984**	**2943**	**2928**	**2879**
Consumption by fuel					
Solid fuels	159	162	139	141	153
Petroleum products	964	904	782	735	588
Natural Gas	620	684	718	745	770
Electricity	1093	1045	1102	1108	1140
Bioenergy	174	189	203	199	227
CO_2 emissions from Industry [Mt CO_2]	9.9	9.9	9.4	9.3	8.8
Energy Productivity in Industry [million EUR '10/ktoe]	7.37	7.76	8.43	8.86	9.51

More specific data on the final energy consumption of the agricultural sector are not provided in table format.the i

4. NECPs: 5 dimensions are developed in harmony?

The 2030 targets of the Final Greek NECP, as submitted to the EC in December 2019[32], are actually more ambitious than the core EU objective and the initial draft NECP. The following sections provide more details on each of the dimensions of the Greek NECP and some specific priorities.

Climate change, emissions and removals of GHGs

The NECP aims to achieve a reduction of GHG of more than 42 % compared to the 1990 level and more than 56% compared to the 2005 level.

Regarding climate change, the National Strategy for Adaptation to Climate Change is references, while specific targets for emission reduction are outlined, in anticipation of the National Programme for the Control of Air Pollution. Promotion of circular economy and bioeconomy are also included as priorities.

Renewable Energy Sources

The NECP aims to achieve a minimum share of 35 % RES in gross final energy consumption; the minimum share of RES per sector is as follows:
60 % in gross final electricity consumption
40 % in heating and cooling needs

[32] https://ec.europa.eu/energy/sites/ener/files/el_final_necp_main_en.pdf

Policy Coherence	
	14 % in transport sector The NECP identifies electrification and coupling of final consumption sectors as a key priority to achieve the overall increased share of RES. **Energy Security** Measures aim to diversify energy sources and suppliers from third countries, optimize use of domestic energy resources, transform Greece into a regional energy hub, reduce energy dependency rate, interconnect autonomous island systems, ensure adequate system capacity. **Internal energy market** Priorities include restructuring of the internal electricity market, enhancing electricity interconnectivity and energy transmission infrastructure (including connection of islands to the mainland grid), implementing digitalization, addressing energy poverty issues and promoting net metering and active consumer schemes. **Energy efficiency** The NECP focuses on improved energy efficiency as a driver for reduction of energy imports, lower emissions and job creation. Priority is given to the renovation and replacement of residential buildings with new yearly zero-energy ones (aiming at 12 – 15 % of the residential building stock by 2030), and the expansion of natural gas use (increase of direct use in final consumption sectors by at least 50 % compared to 2017). **Research, innovation and competitiveness** Priorities include improving energy intensity and greenhouse gas emissions intensity, reducing energy costs, increasing the domestic added value of the energy sector, supporting coal regions in transition. **Criticism of the NECP** The Final NECP was open to public consultation from 28 November to 19 December 2019. Some aspects of the NECP have raised more controversy on others:

Policy Coherence	
	The key role allocated to natural gas as a transition fuel and the new investments required for its expansion have been criticized by NGOs[33]. The research for potential of hydrocarbon extractions in Creta and the Ionian Sea (aiming at future commercial exploitation) have also been considered as incompatible with the overall goal of climate neutrality. The huge regional socio-economic implications of the coal phase-out by 2028 and the efforts required for their mitigation are widely acknowledged. Regional stakeholders (mostly) have expressed concern about the phase-out date as well as the long-term implications on Greece's dependency on imported energy sources (from domestic lignite to imported natural gas). Finally, NGOs and others are considering that the NECP is not addressing in an adequate way the energy poverty issue.
5. Is there a national bioeconomy strategy? Are there any measures targeting agrobiomass for energy? Are those measures coherent with rural development and energy and climate related policies?	As of April 2020, there is no national bioeconomy strategy. The Ministry of Environment and Energy has established a National Council for the Circular Economy as well as an Inter-Ministerial Committee. A Circular Economy Roadmap is expected by June 2020 and is expected to include some measures related to biomass. In February 2020, the Hellenic Solid Waste Management Association organized is 6th Conference. A 40-point document on conclusions and suggestions was drafted as a final outcome[34]. Agrobiomass utilization is not directly targeted, but some suggestions (e.g. establishment of collection points for urban green waste, promotion of waste-to-energy coNECPts) might have some positive impact if implemented.

[33] https://www.wwf.gr/images/pdfs/koina_sholia_greenpeace_WWF_gia%20esek.pdf
[34] https://conference2020.eedsa.gr/wp-content/uploads/2020/03/40-%CE%A3%CF%85%CE%BC%CF%80%CE%B5%CF%81%CE%AC%CF%83%CE%BC%CE%B1%CF%84%CE%B1-%CE%A0%CF%81%CE%BF%CF%84%CE%AC%CF%83%CE%B5%CE%B9%CF%82-%CE%95%CE%95%CE%94%CE%A3%CE%91-2020.pdf