The Biofuels Market in Greece and Regulatory Framework

A Study Prepared by IENE on behalf of APICAL Group Limited and in cooperation with KG Law Firm

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Preface

The present review study was prepared by IENE in close cooperation with the office of Mr. Gus Papamichalopoulos at the KG Law on behalf of the APICAL Group Ltd. The first part of the study contains an overview of the situation prevailing today in Greece's Biofuels Market focusing on the current quota system and the opening of the Biodisel market, while the second part deals with policy and regulatory issues and the challenges which lie ahead for the prospective investor. The study is well referenced so as to enable further investigation by the principal.

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Executive Director, IENE

1. Overview of Greek Biofuels Market

Also known as agrofuels, biofuels are mainly derived from biomass or biowaste. These fuels can be used for several applications, but today their main use is in the transportation sector. Most vehicles require fuels which provide high power and are dense so that storage is easier. Their internal combustion engines require fuels that are clean and in the liquid form.

The most important advantage of using liquid as fuel is that it can be easily transported, stored and pumped. In other words, it can be handled easily. This is the main reason why almost all vehicles use liquid fuels for combustion. For other forms of non-transportation applications, there are alternative solid biomass fuels like wood. These non-transportation applications can bring into use solid biomass fuels as they can easily bear the low power density of external combustion.

Biofuels, such as fossil fuels, come in a number of forms and meet a number of different energy needs. The class of biofuels is subdivided into two generations, which will be elaborated further below. Appedix 1 presents biofuels by generation and then explores their uses, energy densities and greenhouse gas (GHG) emission impact.

First Generation Biofuels

The dramatic rise in oil prices seen in the last decade has also enabled liquid biofuels to become cost-competitive with petroleum-based transportation fuels, and this has led to a surge in research and production around the world. The three main types of first-generation biofuels used commercially are biodiesel (bio-esters), ethanol, and biogas of which large quantities have been produced worldwide so far and for which the production process is considered 'established technology'. Biodiesel is a substitute of diesel and is produced through transesterification of vegetable, residual oils and fats, with minor engine modifications; it can serve as a full substitute as well. Bioethanol is a substitute of gasoline and it is a full substitute for gasoline in so-called flexi-fuel vehicles. It is derived from sugar or starch through fermentation. Bioethanol can also serve as feedstock for ethyl tertiary butyl ether (ETBE) which blends more easily with gasoline. Biogas, or biomethane, is a fuel that can be used in gasoline vehicles with slight adaptations. It can be produced through anaerobic digestion of liquid manure and other digestible feed-stock. At present, biodiesel, bioethanol and biogas are produced from commodities that are also used for food.

Second Generation Biofuels

Second generation biofuels are produced from biomass in a more sustainable fashion, which is truly carbon neutral or even carbon negative in terms of its impact on CO_2 concentrations. In the context of biofuel production, the term 'plant biomass' refers largely to lignocellulosic material as this makes up the majority of the cheap and abundant non-food materials available from plants. At present, the production of such fuels is not cost-effective because there are a number of technical barriers that need to be overcome before their potential can be realized. Plant biomass represents one of the most abundant and underutilized biological resources on the planet and is seen as a promising source of material for fuels and raw materials. As it is most basic, plant biomass can simply be burnt in order to produce heat and electricity.

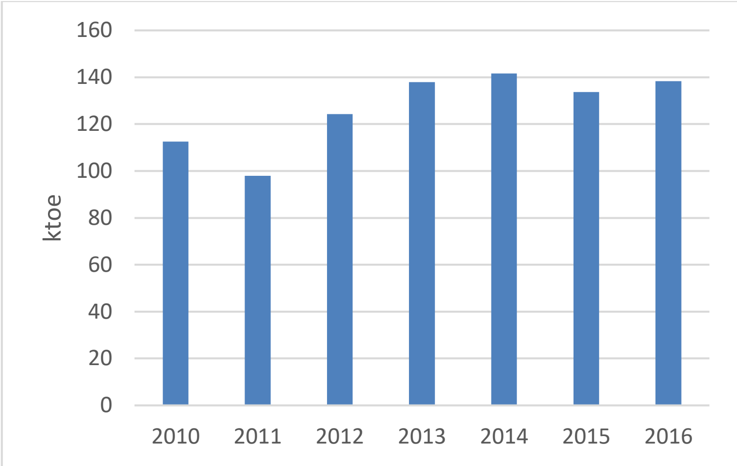
However, there is great potential in the use of plant biomass to produce liquid biofuels. Plant biomass is comprised mostly of plant cell walls, of which typically 75% is composed of polysaccharides. These polysaccharides represent a valuable pool of potential sugars, and even in traditional food crops such as wheat (Triticum aestivum), there is as much sugar tied up in the stems as there is in the starch of the grains. To date, the potential of many crop residues, such as straw and wood shavings, to provide sugar feedstocks for biofuel production has not been realized. However, biofuel production from agricultural by-products could only satisfy a proportion of the increasing demand for liquid fuels. This has generated great interest in making use of dedicated biomass crops as feedstock for biofuel production.

The Greek Biofuels Market

The Greek national policy on biofuels satisfies the country's commitment to achieve the EU targets in order to reduce CO_2 emissions, more specifically in the transport sector. In Greece, biodiesel is used as liquid biofuel and substitute for automotive gas oil, and bioethanol, in a very small or negligible degree. In Greece, the only marketable biofuel now is biodiesel.

In 2016, the production of biodiesel in Greece stood at 138.3 ktoe, close to about 138 ktoe in 2013, according to Eurostat's data. The almost stable production of biodiesel over 2013-2016 corresponds to roughly 1.29% of the total EU-28 production of biodiesel (10,762 ktoe in 2016). As shown in Map 1, there are 12 biodiesel plants in Greece and the biodiesel is mostly produced from sunflower and some rapeseeds, which correspond to 93% of the biodiesel consumed.

Figure 1: Biodiesel Production in Greece (2010-2016)



Source: Eurostat

Map 1: Locations of Biodiesel Plants in Greece

Source: CRES

Industry sources indicate 85% of the produced capacity in the market is distributed via the government-controlled quota mechanism, while 15% is supplied to the free market. The total nominal installed capacity of the 12 Greek biodiesel plants is 901,290 kL/yr (718 ktoe), from which only 16% (130,017 kL/yr) was utilized under the quota mechanism in 2015. The installed capacity corresponds to 58% of 2030 forecasted demand (1,232 ktoe), whereas it already exceeds by 7% the 2020 national goals (670 ktoe) if there were no blending limitations. Current utilization, however, covers only 17% of 2020 goals and 9% of forecased demand due to blending limitations to the diesel pool, while these targets correspond to both diesel and gasoline pools, causing many assets to be considered stranded.

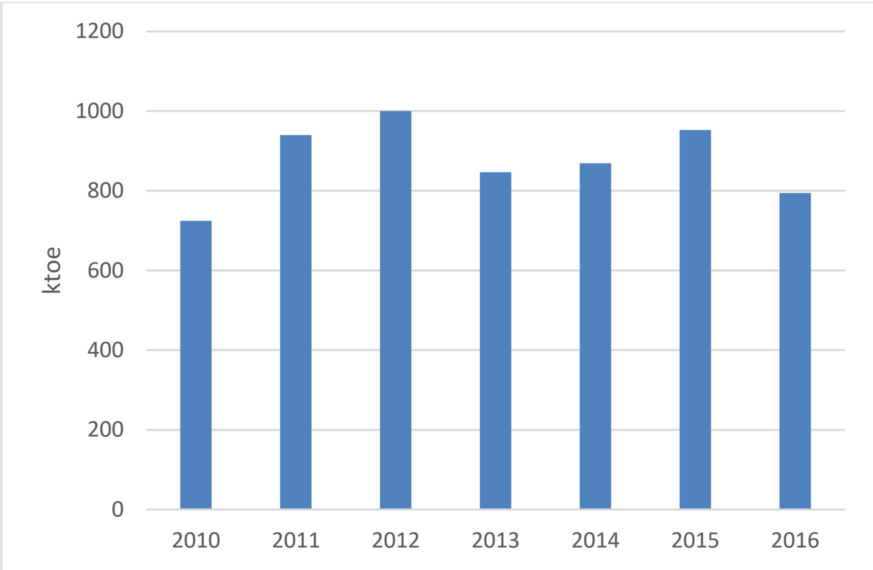
The allocated quota represents only 35% of the total biofuels demand to meet the RES penetration plans, due to blending limitations of 1st generation biofuels in the diesel pool. Overall biofuels penetration to the transport fuels market is 2.2% (2.6% including the quantity sourced to free market), well below the 2015 target of 6.3% RES. One factor for this is that there is no current indigenous bioethanol production nor any foreseen to cover the additional demand unit the 2020 horizon.

Feedstock used for indigenous production originates mainly from 1st generation sources such as sunflower, rapeseed and soy, as well as 2nd generation sources such as residual cotton seeds, used vegetable oils (UVOs), used cooking oils (UCOs) and animal fats. According to the raw material supply in 2015, approximately 2/3 of biofuels are produced from 1st generation sources and only 1/3 from 2nd generation sources (corresponding to 0.7% demand coverage of transport fuels).

Based on market data and estimated demand for the biofuels sector, either imports and/or radical reformation of the biofuels industry will be required in order to meet RES energy targets by 2020.

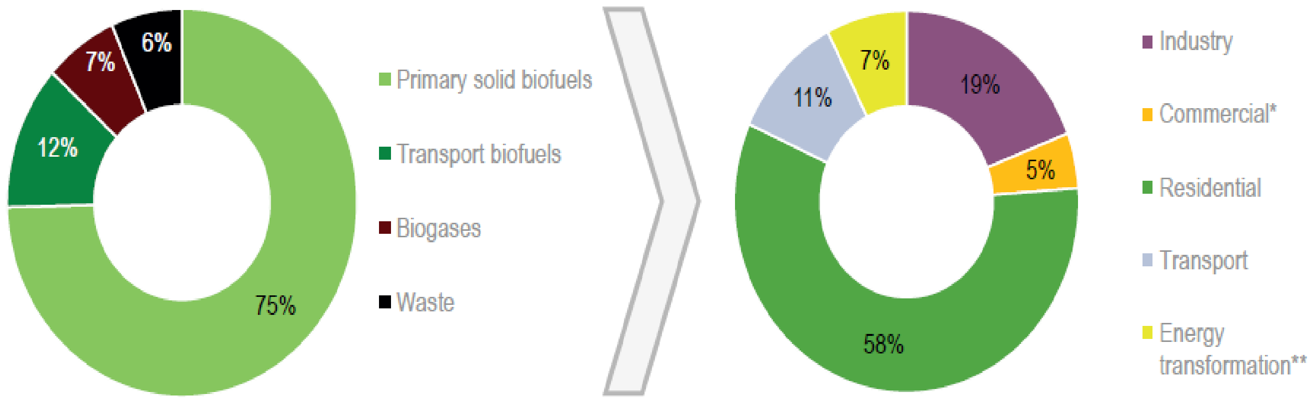
In 2016, the production of solid biofuels in Greece, excluding charcoal, stood at 794.1 ktoe (see Figure 2), 20.6% lower than the 1000.3 ktoe in 2012, according to Eurostat's data, corresponding to 0.84% of the total EU-28 production of solid biofuels (94,125 ktoe in 2016). Solid biofuels are used for heating in residential boilers, as a means to combat energy poverty. Residential consumption accounts for the largest share of biofuel demand in Greece (see Figure 3). Biomass from straw, olive pruning and olive kernels, cotton stalks, and wood residues is used in the food and wood industries for space and process heating. We should note that Greece has installed 2 MW electrical from biomass, with seven plants. CRES estimates that around 1,746 TWh remain unexploited, with a potential for carbon dioxide mitigation of approximately 460,000 tonnes. Biomass co-combustion in lignite plants and small district heating plants also present opportunities.

Figure 2: Solid Biofuels Production (Excluding Charcoal) in Greece (2010-2016)



Source: Eurostat

Figure 3: Supply and Consumption of Biofuels and Waste in Greece, 2015



* *Commercial* includes commercial services and agriculture.

** *Energy transformation* includes power generation and charcoal production.

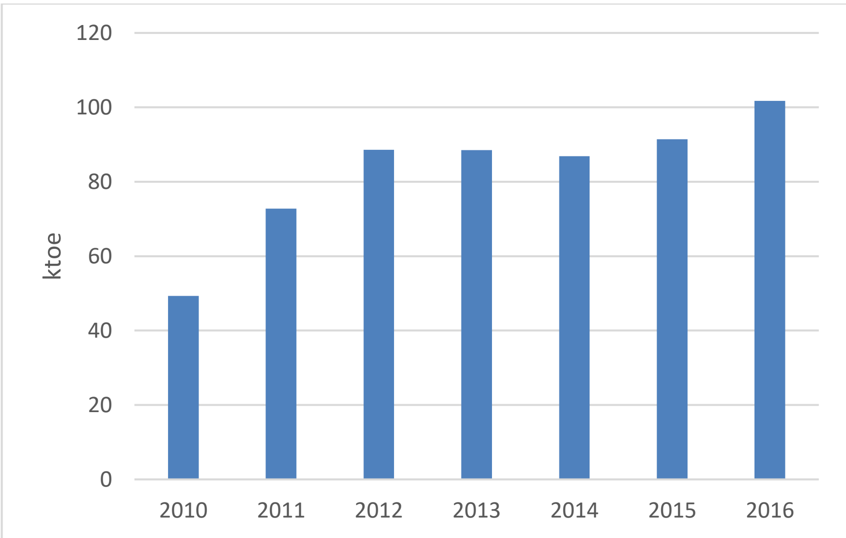
Source: IEA (2017)

In 2016, the production of biogas in Greece reached 101.7 ktoe, 17% higher than the 86.9 ktoe in 2014, according to Eurostat's data, corresponding to 0.61% of the total EU-28 production of solid biofuels (16,600 ktoe in 2016). In 2017, the installed capacity of the 44 biogas/biomass facilities stood at 63 MWe. The biogas facilities are 37 with a capacity of 60.17 MWe. Also, there are 4 landfill sites (XYTA) in Greece, which support power generation, with an installed capacity of 31.2 MWe, while there are 22 farm-breeders with a capacity of 14.07 MWe, according to Zafeiris (2018).

Biogas production from energy crops technology is not well adapted to the Greek conditions yet and is still immature. It turns out that the energy use of biogas is accompanied by many dilemmas which make up a vicious cycle that leads to inaction in Greece. The construction of a biogas facility is delayed because there is not the necessary amount of raw material and farmers postpone the cultivation of energy crops, until the construction of the facility that will absorb their production, has finished. The same applies to all the interest parties involved in the biomass supply chain, which will have to introduce changes in the way they work in order to generate, collect, harvest or cultivate biomass for energy use.

There is a large number of studies that propose new viable biogas facilities using different kind of substrates as input material, however, most of these projects have not proceeded to implementation, according to Xydis et al. (2013), Sotiropoulos et al. (2015) and Kretzschmar et al. (2012). Through this study, one of the most significant benefits was the ability to use geostatistical methods in the certain area.

Figure 4: Biogas Production in Greece (2010-2016)



Source: Eurostat

In terms of biofuels consumption in Greece, biodiesel consumption for transport reached 151.0 ktoe in 2017, of which 23% was certified (CRES), increased by 1.34%, compared to 2016 level, as shown in Table 1. Only a small share of biofuels is used for transport (11%), while the largest share (58%) is used by the residential sector. Biofuels accounted for 2.5% of the final energy consumption in the transport sector in 2015. Biofuels are mainly first-generation biodiesels produced from raw materials such as oil seeds, mainly sunflower, used cooking oils, and cottonseed. Six thousand tonnes were produced from waste and residues. There are 16 biodiesel producers (125,600 kilolitres (kL)) and six importers (6,400 kL).

Table 1: Biofuels Consumption for Transport in the EU (2017)

Country	Bioethanol	Biodiesel***	Biogas fuel	Total consumption	% certified sustainable
France	539 000	2 796 000	0	3 335 000	100.0%
Germany**	730 868	1 843 890	33 438	2 608 197	99.0%
Sweden	104 185	1 431 141	111 111	1 646 436	100.0%
Spain	139 597	1 148 074	0	1 287 672	99.0%
Italy	32 890	1 027 458	0	1 060 348	100.0%
United Kingdom	385 791	548 100	0	933 891	100.0%
Austria	53 860	618 420	358	672 638	99.9%
Poland	159 583	421 514	0	581 097	100.0%
Belgium	90 284	374 702	0	464 985	100.0%
Finland	87 059	303 764	2 603	393 427	99.3%
Czech Republic	75 141	244 077	0	319 218	100.0%
Netherlands	128 953	174 143	0	303 095	98.2%
Hungary	64 058	199 317	0	263 375	100.0%
Romania****	81 300	175 900	0	257 200	100.0%
Portugal	2 924	252 172	0	255 096	100.0%
Denmark	44 000	173 000	0	217 000	100.0%
Bulgaria	38 690	156 722	0	195 413	100.0%
Slovakia	39 338	136 094	0	175 432	100.0%
Ireland	30 168	130 104	0	160 272	100.0%
Greece	0	151 000	0	151 000	100.0%
Luxembourg	6 688	104 686	0	111 374	100.0%
Lithuania	7 356	53 597	0	60 953	91.5%
Slovenia	0	35 161	0	35 161	100.0%
Latvia	7 971	2 895	0	10 866	100.0%
Cyprus	0	8 570	0	8 570	100.0%
Malta	0	3 988	0	3 988	100.0%
Estonia****	2 600	0	0	2 600	100.0%
Croatia	0	324	0	324	100.0%
Total EU 28	**2 852 305**	**12 514 812**	**147 511**	**15 514 629**	**99.7%**

*Estimate. ** Germany consumption figures include consumption of 2 388 toe of pure vegetable oil. *** HVO biodiesel figure included **** As consumption

Source: EurObserv'ER (2018)

The new investment law (4399/2016) provides investment support for the production of sustainable biofuels other than food-based biofuels and for the conversion of existing food-based biofuel plants into advanced biofuel plants in accordance with European Commission guidelines. However, biofuels that are subject to supply or blending obligations are excluded from receiving investment support. In addition, subsidies, leasing subsidies, and subsidies for the creation of new jobs are provided, while they can be substituted with tax regulation mechanism under the investment law.

Eligible for support are biofuels which are not based on edible plants and are not subject to a supply obligation or blending (art.9 par.8 Law No.4399/2016). To be eligible for support, minimum investment should amount to (art.5 par.3 Law No. 4399/2016):

- Large enterprises: €500,000
- Medium enterprises: €250,000
- Small enterprises: €150,000
- Very small enterprises: €100,000
- Cooperatives: €50,000

The following types of support are alternatively offered by the Development law (art. 10 Law No. 4399/2016):

- 1 Subsidy
- 2 leasing subsidies
- 3 subsidies for the creation of new jobs

Renewable Energy Sources (RES) are supported in the following investment categories:

- General entrepreneurship (art.38 Law No.4399/2016). Only income tax relief is eligible
- New independent SMEs (art.43 Law No.4399/2016). Only income tax relief is eligible
- Supporting innovation for SMEs (art.48 Law No.4399/2016). Only income tax relief is eligible
- Major investment plans (art.66 Law No.4399/2016). Tax relief can be provided for 12 years and stabilisation of income tax coefficient is provided for 10% of the total investment cost, up to a maximum amount of €5 million.

Biofuels are eligible for support, subject to the following limitations (art. 11 par.3 subpar.2h Law No. 4399/2016): For biofuels (art. 11 par.3 subpar. 2h Law No. 4399/2016) there are two options:

Option 1: If extra investment costs necessary to promote the production of energy from renewable sources are eligible costs under art. 41 par. 6 cases a and b of the EU Regulation 651/2014:

- 45% of the eligible expenditure for large enterprises
- 55% of the eligible expenditure for medium enterprises
- 65% of the eligible expenditure for small enterprises.

Option 2: If extra investment costs necessary to promote the production of energy from renewable sources are eligible costs under art. 41 par. 6 case c of the EU Regulation 651/2014:

- 30% of the eligible expenditure for large enterprises
- 40% of the eligible expenditure for medium enterprises
- 50% of the eligible expenditure for small enterprises.

2nd Generation Resource Availability in Greece

Based on an analysis of supply and demand in Greece, there is ample opportunity for the penetration of 2nd generation biofuels in the Greek market, since the established industry seems to be struggling to secure 1st generation feedstock. In order to generate a nation-wide master plan for penetration of 2nd generation biofuels, it is of paramount importance to identify availability of resources that can be converted to biofuels.

Availability of resources is a necessary pre-condition regarding feasibility of investments in the field of biomass exploitation. Areas in Greece with rich biomass potential and relevant infrastructure (agricultural production) are at the forefront of such investments. According to the national industry roadmap for the RES penetration in Greece by 2020, forestry and agriculture present by far the greatest potential as shown in Table 2. Other potential sources for production of 2nd generation biofuels are by-products from the food industry (e.g. molasses and bagasse from sugar industry), waste oils and animal fats. Collection of reliable and systematic data for biomass potential is, however, not actively carried out in Greece and existing estimates show great variability.

Table 2: Energy Supply Potential of 2nd Generation Sources by 2030

Biomass from Forestry (ktoe)	1,361
Biomass from Agriculture (ktoe)	1,500
Olive Husks (ktoe)	89
Waste Oils & Animal Fats (ktoe)	85
Sugarcane byproducts (ktoe)	24
Municipal Solid Waste (ktoe)	23
Cotton Ginning Residues (ktoe)	19
Fishery byproducts (ktoe)	13
Sewage sludge (ktoe)	10

Note: Availability and recoverability of forestry resources is uncertain.

Source: Mitkidis et al. (2018)

There is huge potential for further growth of the biofuels sector in the years to come, as market penetration needs to increase eight-fold by 2030 (from 2.1% to 17.4%) to meet mandates of the European directive. The forecasted demand for 2030 can be fully met or even exceeded by 2nd generation resources, thus contributing significantly to economic and sustainable development of the country.

The abundance and accessibility of biomass feedstock together with the availability of agriculture infrastructure and agriculture labour are competitive advantage indicators for the Greek biofuels industry. Eventually, these indicators can translate to competitive advantage provided that biofuels cost remains lower than elsewhere in Europe, through supply chain optimization and continuous access to cheap abundant feedstock.

Agriculture is a significant sector in the Greek economy as it contributes 4.1% to the Greek Gross Domestic Product (GDP) accounting for 70% of agricultural products and 30% of animal product, according to the International Trade Administration (2017). Agricultural waste biomass is an excellent feedstock for the production of fuels and chemicals. Although only a small part of the available feedstock is exploited in Greece, so far, the RES industry directly employs more than 25,000 rural families today or about 100,000 rural residents, as well as a large number of relevant activities like agronomists, transport companies, oil seed factories, etc. The animal waste is characterized by a high organic and inorganic load; however, its content in pathogenic microorganisms is very high. The uncontrolled disposal of these wastes has a significant effect in the environment and humans. Therefore, with proper management, animal waste may be considered as a source of energy.

Greece has a particularly high fish consumption per person, reaching 19.6 kg/year, of which 66% is imported, 22% of domestic aquaculture products and 12% of domestic fishery products, based on Eurostat's data. In Europe, the average consumption per person is 22.9 kg/year, while the global average is 19.2 kg/year. According to an ELSTAT survey (September 2017), the production volume of fishing and aquaculture reached 197,704.7 tons in 2016, bringing an income €781.3 million. Greece has the largest fishing fleet in the EU (i.e. 15,188 vessels out of a total of 83,792 within EU). The vast majority (95.1%) are small or very small vessels operating with stationary gears in the coastal zone (only 1.6% are purse seiners and 1.7% are trawlers). The processing of fish creates up to 70% liquid and solid waste, while data for pelagic fish show that solid waste resulting from their filleting is 44%. From the above data, it is obvious that the amount of waste biomass from the fish, which is very rich in high added value biological components. Adding the amount of waste from the processing of the imported fish, it is clear that marine waste based on aquaculture is a significant biomass source, according to Papadopoulou et al. (2018).

An additional advantage is protection from external sources, shown from the very low imports presented in Table 4, due to the regional nature of the market with low competition from neighbouring countries. Furthermore, assuming government intervention becomes limited in the future, penetration of low-cost producers of 2nd generation biofuels should retain a competitive advantage, while incentives to enter the market will shrink and hence imports will be further limited.

Finally, since future demand and availability of most 2nd generation resources is not compatible with the current supply and existing installations, new conversion technologies should come into play. The production cost of these will play a major role in the exploitation of 2nd generation feedstocks and the installation of new plants. Most importantly, technologies that use cellulosic biomass are needed to meet the full biofuels demand with domestic resources.

Therefore, market analysis has clearly demonstrated that 2nd generation biofuels can have a major impact on the transport sector in Greece and contribute significantly towards meeting national RES targets. In addition, their implementation is in line with the Renewable Energy Directive (RED) II proposal that supports advanced biofuels and drives reduction of food crop based biofuels. Current biofuels penetration, solely based on 1st generation biodiesel (FAME), corresponds to only 2.2% of the transport fuels market. This is based on the distributed quota for 2015, which is well below the targeted 6.3% RES by the Greek government for 2015 and the mandates of the EU Directive. It has been shown that Greece holds sufficient resources to support indigenous production of 2nd generation biofuels. The available lignocellulosic biomass resources exceed the 2030 demand and could potentially support export of biofuels based on surplus feedstock supply. Approximately 40% (range 29-47%) of the total 2nd generation resources are required to meet forecasted average biofuels demand for 2030, although recoverability of certain resources remains uncertain. The abundance and accessibility of biomass feedstock together with the availability of agriculture infrastructure and labour are important competitive advantage indicators of the Greek biofuels industry.

Current supply from existing installations is insufficient to meet future demand, due to incompatibility of 2nd generation resources. New conversion technologies should be introduced, the production cost of which will play a major role in the exploitation of 2nd generation feedstocks and the installation of new biofuel units. Most importantly, technologies that use cellulosic biomass are needed to meet the full demand of biofuels from domestic resources.

According to Mitkidis et al. (2018), economic evaluation of the various 2nd generation biofuel production routes concluded that fast pyrolysis of biomass, combined with hydrotreating (HDT), is the most advantaged technology in order to produce biofuels from lignocellulosic biomass. The quality of the drop-in biofuels produced by this technology (renewable gasoline and diesel) alleviates the blending constraints, compared to 1st generation biofuels, while reducing the overall GHG emissions in line with the Fuel Quality Directive (FQD) and RED II. Additionally, it provides positive investment criteria based on a high-level economic evaluation that was carried out using a discounted cash flow analysis. On the other hand, sensitivity analysis showed the investment to be somewhat vulnerable, especially with respect to low oil prices (<60-65 $/bbl), making policy support and green credits via an Emission Trading Scheme imperative to minimize investment risk and incentivize investors to take advantage of opportunities driven by climate change policy.

Implementation of a strategy mix is key to enable an optimal supply-chain network for deployment of 2nd generation biofuels. The proposed strategy mix consists of multiple large-scale decentralized pyrolysis plants located close to the 2nd generation biomass sources. The produced pyrolysis bio-oil shall be transported to world-scale HDT plants centrally located in the two main supply centres (Athens, Thessaloniki), within or next to the existing oil refineries. The HDT plants can be optionally fed with waste oils from the two main centres. The biofuel products are then directly blended to the refinery fuel pools and sent to the domestic market. When installed plant capacity exceeds domestic demand, the biofuel products can be potentially exported to neighbouring international markets.

2nd generation biofuels certainly have the potential to close the biofuels market penetration gap and they can possibly be produced economically, presenting significant growth and investment opportunity. To pursue this growth potential, careful central planning and policy support from the government is required as well as a radical reformation of the biofuels industry as a whole.

Implementation of competitive advantaged 2nd generation biofuels presents an opportunity to meet the EU RED directives, support the Greek economy and stimulate job creation. Hence, support by the Greek government should aim to incentivize investments and expansion of the 2nd generation biofuels industry.

The role of government through the implementation of robust policies is important to accelerate penetration of 2nd generation biofuels to the market. The policy goals should focus on stimulating investments rather than protectionism that minimizes competition. This could be potentially achieved by gradually transforming the current quota system and increasing investment incentives, i.e. via national or EU subsidies and tax reliefs. Provided robust and competitive technology performance, the industry should be able to develop in the long run solely based on green policies without heavy government intervention.

Finally, future research to enable better understanding of various factors that impact the industry development is required. These include a better understanding of the locally available biomass feedstock, its geographic distribution, recoverability and production. It is also important to understand its transport, storage and processing costs, to arrive to more accurate pricing figures that reflect the local market. To determine the optimum 2nd generation biofuels production network and geographical location of facilities in Greece, detailed techno-economic analysis and supply-chain modelling are recommended.

2. Current and Future Biodiesel Mandate in Greece

Blending of Biodiesel

In Greece, the actual blending of biodiesel with diesel began at the end of 2005 by the two local refinery groups (i.e. Hellenic Petroleum and Motor Oil) at a rate of 2.5%. Within five years, it was progressively increased at 5.75% and from 2013 until now it is regulated at 7%[1]. However, fuel retailers are allowed to offer automotive diesel with even higher than 7% biodiesel blend, provided that there is a respectively special labelling at the selling points (although this option has not been utilized yet). Initially and until the end of December 2007, in order to promote the consumption of biodiesel, a tax exemption from automotive diesel's excise duty for the amount of biodiesel in the final blend was in force. After the tax exemption termination, the quota of biodiesel blended with diesel bears the same excise duty with diesel (the excise duty was 293 €/1,000 Liters in 2008). **Excise duty, which was €330 per 1,000 litres in 2014, increased to €410 in 2017 and will gradually reach €438 per 1,000 litres by 2030. Note that the current excise duty of €330 is the minimum allowed in accordance with the Energy Directive (Council Directive 2003/96/EC).**

[1] The no. 30/005/795/12.20.2012 document of the Directorate of Petrochemicals of the General Directorate of the State General Laboratory states that with respect to the maximum deviation on the fatty acid methyl ester contained in a mixture of automotive diesel with pure biodiesel, the laboratory differential method for mixing is 7% + - 0,3 (EN 14078), so that that the mixture is considered within specification.

Biodiesel Allocation Program

Biodiesel Call

According to Law 3054/2002 and its amendments, it is mandatory for the producers and distributors of petrol and diesel to blend their fuels with a certain amount, "quota" of biofuels which is specified in the distribution scheme, reviewed every year (art. 15A par. 3 Law No. 3054/2002 which was incorporated in Law 3054/2002 amended by the art. 3 of Law 3423/2005, the art. 55 of Law 3653/2008 and art. 22 of Law 3769/2002). Every year, before the 15th of April, a Ministerial Decision by the Ministry of Environment and Energy is issued that determines the total quantity of biodiesel to be allocated to beneficiaries for the coming year (from July 1st of current year to June 31st of coming year) and calls any candidate beneficiaries to submit their will to participate in the allocation program. Based on the latest Ministerial Decision, the quantity was set at 133.000 M3 **(for further information see Table 3)** to cover the mandatory blending quota of 7%. **Despite the fact that there was a reference price to use during the submission of the tender to the quota system until 2012, it is worth noting that such a price currently does not exist in Greece.**

For the determination of the total allocation quantity of biodiesel, the following two parameters are mainly taken into consideration: **(a)** the maximum blending rate of biodiesel with diesel as defined by the Supreme Chemical Council (SCC) and **(b)** the 85% of the estimation of automotive diesel consumption for the year to come[2], as submitted by the two local Refiners (Hellenic Petroleum S.A. and Motor Oil Corinth Refineries S.A.). The 85% is allocated to the beneficiaries, consisting of Greek producers and importers. However, the remaining 15% may be imported from third countries, which are non-EU Member States, provided they comply with the following requirements:

1. their products comply with the quality requirements set by the REACH Regulations and
2. they possess the required Category A' petrol product trading License or the License for the Sale of Biofuels.

[2] Determination of criteria and methodology of pure biodiesel allocation and regulation of any related issue, according to the provisions of art. 15A of Law 3054/2002, as is in force (2013), Δ1/Α/οικ.2497, p.3, Ministry of Environment and Energy, Athens, Greece.

Table 3: Yearly Biodiesel Allocation Quantity and Blending Rate with Automotive Diesel

Year	Biodiesel Quantity (L)	Blending Rate (%)
2005	2.500	2,00
2006	91.000	3,00
2007	114.000	4,00
2008	123.000	4,50
2009	154.750	5,00
2010	164.000	5,75
2011	132.000	6,50
2012	132.000	6,50
2013	92.000	7,00
2014	133.000	7,00
2015	140.000	7,00
2017-2018	133.000	7,00

Sources: Data retrieved from Ministry of Environment and Energy (www.ypeka.gr) and Foundation for economic & industrial research, The sector of renewable fuels in Greece: issues and prospects, p.16, Athens, Greece

Following the determination of the total allocation quantity, the process of the beneficiaries' qualification and allocation per beneficiary begins, led by a joint ministerial committee assembled by three members one from each ministry (Ministry of Finance, Ministry of Rural Development and Food, Ministry of Development).

<u>Beneficiaries' Qualification</u>

Beneficiaries ought to be Biofuels Marketing Licensees, whereas such a license can be acquired by EU-based Biofuels Producers or by EU-based Limited Liability Corporations (SAs) which are actively contracted with EU-based Biofuels Producers within or outside Greece, for the purchase of biofuels or other renewable fuels. The Biofuels Marketing Licensees can produce or import biofuels and other renewable fuels and provide them locally to Refiners, Oil Marketing type A Licensees and end consumers. In the case of liquid biofuels destined for blending with crude oil products, the Biofuels Marketing Licensees can only provide them to Refiners or Oil Marketing type A Licensees. Biofuels Marketing Licensees must also have adequate storage capacity of 100 cubic meters per minimum for storing pure biofuels or other renewable fuels.

<u>Allocation Determination</u>

This particular leg of the Biodiesel Allocation Program incorporates the most complex process. In order to determine the final allocation per beneficiary, the criteria below are taken into account:

(1a) Current purchase contacts of raw materials for the production of pure biodiesel within Greek territory from energy crops of Greek origin.

(1b) Invoices and/or accounting records of purchases of cotton seed and/or seed oil.

(1c) Invoices of raw materials from used vegetable oils, cooking oil and animal fat of Greek origin, qualified for the production of biofuels.

(2) The capacity of the EU-based Biodiesel Plant or the import contracts of biodiesel from Biodiesel Plant installed in other EU member state.

(3) The existence or non-existence of biodiesel production and distribution ISO 9000 Certificate.

(4) The maximum offered premium from the candidate beneficiary, which represents the total production cost and profit margin in € per 1.000 litres on top of the reference price. The reference price is the average of the "Reuters Biodiesel ex Works" quotation and of the low price of "Biodiesel" for the winter period. For the summer period, the reference price is quotation "FAME0" (under column Barges FOB Rotterdam). These quotations are published by the Platt's European Marketscan.

(5) Current cooperation agreements between the candidate and research centres or participation in research programs within the EU, related with biofuels and biomass.

(6) Sum of pure biodiesel deliveries, in cubic metres, from the allocation of the last two years.

(7) Performance indicator of delivering pure biodiesel to refineries during the last year.

Following the completion of the allocation process, a joint ministerial decision (JMD) by the same ministries as of the abovementioned committee, is issued yearly by the 1st of June latest, approving the pure biodiesel allocation quantities per beneficiary and setting binding monthly delivery schedule. Table 4 presents Greece's biofuels quota for 2018. **In Greece, until today, there has not been any non-compliance case among the beneficiaries pertaining to the fulfilment of the allocated quantity and criteria as beneficiary.**

Table 4: Biofuels Quota in Greece (2018)

Company Name	Quota 2018 (klt/a)	Quota 2018 (%)
BIOENERGIA SA	4942.492	3.72%
AGROINVEST SA	34359.228	25.83%
MIL OIL HELLAS SA	6642.473	4.99%
COTTON GINNING & SPINNING FRAME SA	1406.558	1.06%
PETSAS SA	899.599	0.68%
EKOTHRAK	40.857	0.03%
BIODIESEL LTD	5.093.455	3.83%
XV IKE	34.019	0.03%
NEWENERGY SA	10871.561	8.17%
ELIN BIOFUELS	10173.139	7.65%
INDUSTRIAL COMPANY OF RESTINE PAPADIMITRAKOPOULOS	39.903	0.03%
PAVLOS N. PETTAS SA	30554.934	22.97%
MANOS SA	3761.196	2.83%
SPA RENEWABLES SA	371.113	0.28%
EL VI AVEE	1371.057	1.03%
TAYLORS CONSULTING AND COLOURS LTD	483.220	0.36%
TAYLORS ENERGY SA	483.220	0.36%
GF ENERGY SA	11467.677	8.62%
AVIN	1371.057	1.03%
MOTOR OIL HELLAS	2132.977	1.60%
HELLENIC PETROLEUM	1197.001	0.90%
STAFF COLOUR ENERGY SA	5303.263	3.99%
TOTAL	**133000.000**	**100.00%**

Source: Government Gazette of The Hellenic Republic. Issue B. Number 4503. October 12, 2018 (in Greek)[3]

In 2012, decision 4062 (FEK 70/A/30.3.2012) harmonized the Greek legislation with Directive 2009/28/EC. **As a result, the increased mandate of 10% in 2020 can be met either by domestic production or imports (the lower mandate was only allowed to be filled with domestic production). Greece has not yet established a comprehensive post-2020 climate and energy strategy, including biofuels blending mandate. The country is not expected to abandon the allocation program due to the serious political implications that may arise.**

Table 5: Biofuels Mandate in Greece

	Overall Percentage (% cal)	Biodiesel	Bioethanol	Double counting
2014-2016	5.75			No
2017-2019	7.00			
2020	10			

Source: USDA GAIN Report (2018)

Biofuels producers in Greece adopt a control system for their operations. For instance, Agroinvest has implemented a control system according to 2BSvs[4] requirements for Biomass Production and Mass Balance System, for its operations concerning:

[3] http://www.ypeka.gr/LinkClick.aspx?fileticket=1Gl%2bvrdAljM%3d&tabid=292&language=el-GR

- 1st gathering entity and receipt of: Soybeans – Rapeseeds (canola) – Sunflower seeds – Cotton seeds – Crude Glycerine – Crude oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil], fatty acids, animal fats, UCO’s, waste and residues. – Refined – semi refined oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil], fatty acids, animal fats, UCO’s, palmoil, palmoilens, waste and residues.
- Oil mill (seed crushing) for the production of crude oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil].
- Oil refinery for the production of refined and semi refined oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil], fatty acids, animal fats, UCO’s, palmoil, palmoilens, waste and residues.
- Esterification plant for the production of esterified fatty acids.
- Biodiesel plant for the production of Biodiesel (FAME), Crude Glycerine and Fatty Acids.
- Trading, for the following products: Crude oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil], fatty acids, animal fats, UCO’s, palmoil, palmoilens, esterified fatty acids. Refined oils – semi refined oils [soybeans oil, rapeseed oil (canola oil), sunflower seed oil, cottonseed oil], fatty acids, animal fats, UCO’s, palmoil, palmoilens, esterified fatty acids. Crude Glycerine – Biodiesel (FAME)

Crops that are being used for biodiesel production are mainly sunflower and rapeseed, with cotton seed also being used by certain biodiesel plants. When no full-fat soybean meals are needed, soybean oil could also be exploited and has actually been used in small quantities. Finally, tobacco and tomato seeds could also potentially be used. Sunflower has been grown in Greece for several years, for both human consumption and livestock feed. However, during recent years, sunflower oil has been utilized primarily as a good feedstock for biodiesel production. Apart from the already existing farmers’ experience, there have been many reports on the yield potential of sunflower under the country’s conditions, for both seed yield and oil content. **The minimum GHG emission savings obtained by substituting a biofuel for fossil fuel must be equal to or greater than 50% for the 2017/18 period and 60% after 2018. As for biodiesel production from sunflower, rapeseed and soybean, the default**

[4] 2BSvs is a consortium that is “aimed to demonstrate through independent audit, compliance of sustainability criteria set by the European Directive 2009/28/EC.

GHG emission savings should be at least 38% and 31%, respectively, if produced with no net carbon emissions from land use change.

Sunflower, rapeseed and soybean are grown mainly in the northern part of continental Greece and more specifically at the prefectures (regions) of Serres, Xanthi, Thessaloniki, Kilkis, Kozani, Drama-Kavala and Evros. Sunflower is grown in all prefectures and rapeseed in all except Kozani, whereas soybean is restricted to Serres, Drama-Kavala and Evros. Serres, Thessaloniki and Kilkis belong to the Central Macedonia periphery, Kozani belongs to the Western Macedonia periphery and Evros, Drama-Kavala and Xanthi prefectures belong to the Western Macedonia and Thrace periphery. These three peripheries constitute the main cultivation zone of sunflower and rapeseed in Greece.

The GHG emission differences among crops due to diesel consumption are small. According to Vlachos et al. (2013), average emissions for sunflower, rapeseed and soybean were 393.3, 372.7 and 393.9 kg CO_2e/ha, respectively in 2017. As expected, the fewer field operations for rapeseed production were accompanied by lower emissions. The average diesel emissions for sunflower were 410.8 and 375.8 kg CO_2e/ha for irrigated and non-irrigated areas, respectively, whereas the emissions for rapeseed were 371.6 kg CO_2e/ha for irrigated and 373·5 kg CO_2e/ha for non-irrigated areas. Soybean is grown only under irrigated conditions. The emission difference between irrigated and non-irrigated sunflower regions resulted from the farmers' efforts to reduce moisture losses when cultivating under dry conditions by minimizing soil cultivation operations. The lowest emissions estimated for sunflower were 298.6 kg CO_2e/ha for both irrigated and non-irrigated fields in the Evros prefecture, where only five field operations were applied during the cultivation period. The respective highest emissions were 496.5 kg CO_2e/ha for irrigated areas in the Kozani prefecture. The lowest emissions in the case of rapeseed were estimated at 308.0 kg CO_2e/ha for the Serres prefecture (five field operations applied), whereas the highest emissions were estimated at 424.3 kg CO_2e/ha for the Evros prefecture. Rapeseed demonstrated almost equal diesel emissions between irrigated and non-irrigated areas, due to the fact that it constitutes a winter crop with more or less fixed farming practices. Farmers are not so concerned about minimizing field operations since the rainy period is expected to come shortly after the preparation of the seedbed. Finally, the lowest and highest emissions for soybean were 345.7 kg CO_2e/ha in the Evros and 449.4 kg CO_2e/ha in the Drama-Kavala prefectures, respectively.

According to Vlachos et al. (2013), the average emissions derived from irrigations were estimated at 664.6, 325.0 and 954.8 kg CO_2e/ha for sunflower, rapeseed and soybean, respectively. Soybean comprised the most demanding crop in terms of energy requirements for irrigation, since its production under Greek conditions requires large quantities of water (at least three irrigations during the cultivation period). Rapeseed was the least demanding crop, since the precipitation during its cultivation period is high and irrigations are applied in only a few regions. Greenhouse gases emitted due to seed quantities applied were also included in the overall estimation of emissions. The seed rates were the same for rapeseed and sunflower (5 kg/ha), resulting in 3.7 kg CO_2e/ha for all regions, while the estimated seed factors for soybean were 1.013, 1.010 and 1.012 for Drama-Kavala, Evros and Serres, respectively.

Emissions from the pesticides applied were estimated at 27.6 kg CO_2e/ha for rapeseed and 22 kg CO_2e/ha for soybean, based on the recommended application regimes that suggest 2.5 and 2 kg/ha of herbicides, respectively. The emissions for sunflower were 55 kg CO_2e/ha for pre-emergence applications (5 kg/ha) and 11 kg CO_2e/ha for postemergence applications (1 kg/ha). A major factor contributing to the total GHG emitted were emissions fromfertilizer applications. Nitrogen fertilizers affected total fertilizer emissions the most, since their application corresponded to a significantly higher emission factor. The highest emission quantity due to fertilizer application was 1046.5 kg CO_2e/ha for sunflower production in irrigated fields of the Xanthi prefecture, where the highest amount of N fertilizers were used.

Nitrous oxide emissions ranged from 214.6 to 1379.7 kg CO_2e/ha for sunflower, 327.8 to 1200.9 kg CO_2e/ha for rapeseed and 467.9 to 1162.2 kg CO_2e/ha for soybean. The highest N_2O emissions (1379.7 kg CO_2e/ha) for all crops, as expected, were estimated for sunflower under irrigated conditions in the Xanthi prefecture where 170 kg/ha of N fertilizer were applied. The lowest emissions (214.6 kg CO_2e/ha) were estimated for sunflower under dry conditions, mainly due to the absence of fertilizer use in the Evros prefecture. The above results were expected, since fertilizer use is higher in crops grown under irrigated conditions, owing to higher N leaching (Vlachos et al., 2013).

The average typical emissions were 53.8, 57.6 and 65.5 g CO_2e/MJbiodiesel for sunflower, rapeseed and soybean, respectively. Soybean grown in the Serres prefecture and sunflower grown in the Xanthi prefecture demonstrated the highest typical emissions, due mainly to the number of irrigations and the large quantities of N fertilizers applied. The lowest typical emissions were observed for sunflower grown under dry conditions (D1) in the Evros prefecture. In this case, the absence of fertilizer application and irrigation did not significantly affect the final yields, due to the region's fertile soils with high organic content and the high precipitation that usually occurs. Sunflower grown in the Thessaloniki prefecture was also characterized by low typical emissions (46 g CO_2e/MJbiodiesel), requiring only two irrigations to achieve high yields (i.e. 4000 kg/ha) even at moderate fertilizer regimes.

Greenhouse gas emissions for the transport of sunflower, rapeseed and soybean seeds to the processing plant were estimated at 0.18, 0.18 and 0.21 g CO_2e/MJbiodiesel, respectively. The processing stage included the oil extraction where emissions were estimated at 3.8 g CO_2e/MJbiodiesel for sunflower and rapeseed and 7.6 g CO_2e/MJbiodiesel for soybean, whereas emissions during oil refining and transesterification were estimated at 1.01 and 16.8 g CO_2e/MJbiodiesel, respectively, for all crops. Emissions from biodiesel transport to the filling station (300 km) and energy consumed were estimated at 0.8 and 0.4 g CO_2e/MJbiodiesel, respectively, for all the three crops. The overall emissions during this phase were 23.4 g CO_2e/MJbiodiesel for sunflower biodiesel production, whereas the emissions were 23.4 g CO_2e/MJbiodiesel for rapeseed biodiesel and 26.8 g CO_2e/MJbiodiesel for soybean biodiesel (Vlachos et al., 2013).

In terms of typical GHG emissions, the averages for all regions in Greece were estimated at 53.8, 57.6 and 65.5 g CO_2e/MJ for sunflower, rapeseed and soybean, respectively. A relevant study conducted by Cotana et al. (2010) reported that the respective emissions were estimated at 67 g CO_2e/MJ for rapeseed and 50 g CO_2e/MJ for sunflower. A comparison of these findings showed that the GHG emitted from sunflower biodiesel production were similar to those estimated in the study of Vlachos et al. (2013), while the emissions from rapeseed biodiesel production were significantly higher, mainly due to low yields achieved (1.9 t/ha). As expected, the typical emissions derived from soybean biodiesel production were higher, mainly affected by the excessive water demands of the crop.

Even before the adoption of the RED, a debate around the impact of indirect land use change (ILUC) on GHG emissions has been carrying on: the ILUC relates to the unintended consequence of releasing more carbon emissions due to land-use changes around the world induced by the expansion of croplands for ethanol or biodiesel production in response to the increased global demand for biofuels. The Directive intended to put an end on it by developing "a concrete methodology to minimize greenhouse gas emissions caused by indirect land-use changes. To this end, the Commission should analyze, on the basis of best available scientific evidence, in particular, the inclusion of a factor for indirect land-use changes in the calculation of GHG emissions and the need to incentivize sustainable biofuels which minimize the impacts of land-use change and improve biofuel sustainability with respect to indirect land-use change." Consequently, after the official report about the above impact was submitted and about five years of discussions and negotiations, on April 28 2015, the European Parliament approved the compromise agreement on the reform of the RED, which included a 7% calculation cap on crop based biofuels, also known as conventional biofuels, in the EU's renewable energy target for its transport sector for 2020, and included indirect land use change (ILUC) factors only for reporting purposes. The Council now has to confirm the Parliament's vote, which is expected by the end of 2015. If it is approved, the Member States will have to enact the new legislation by 2017. In Greece, there are no existing ILUC concerns.

3. Current Quota System for Biodiesel Mandate in Greece

Law No. 3054/2002 obliges producers and distributors of petrol and diesel to blend their fuels with a certain amount "quota" of biofuels. The mandatory quota is specified in the distribution scheme, which is reviewed every year (art. 15A par. 3 Law No. 3054/2002). The quota of biodiesel blended with diesel bears the same excise duty with diesel (the excise duty was 293 €/1,000 Liters in 2008, the minimum excise duty adopted by the EC on October 27, 2003 (Directive 2003/96/EC) was set at 330 €/1,000 Liters and the propellant one was set at 410 €/1,000 Liters).

The minimum percentage of biodiesel is 7%, according to the Adoption of the EN 590:2009 Standard by the National Chemical Council (FEK B 67/2009). The National Chemical Council is responsible for defining the minimum percentage of biodiesel (art.1 par.1 FEK B 253/2013). Blends with a higher content of biodiesel are generally eligible under the condition that the general rules of the State Chemical Council are respected and the higher blend is clearly labelled at the fuel stations to inform customers (art. 15A Law No. 3054/2002).

The amount of distributed biodiesel (i.e. blended in) was set at 132,000 kilolitres in 2017 (FEK B 1881/2017). The mandatory percentage of biodiesel is subject to an annual review by the Ministry of Environment, Energy and Climate Change, the Ministry of Rural Development and the Ministry of Finance (art. 15A par. 7d Law No. 3054/2002). **A supplier who fails to fulfil the quota has to pay a fine (art. 15A par. 9, art. 17 par. 1 Law No. 3054/2002).**

The quota obligation applies to companies which have a Biofuels Production Unit Operating Licence and to distributors that possess a Biofuels Distribution Licence. Apart from that, distributors must also possess the necessary storage facilities (art. 15A par. 5 Law No. 3054/2002).

More specifically, as decided in 2012, a new scheme will be applicable or introduced in 2013, as stipulated in the amendments to Law No. 3054/2002 and in FEK B 253/2013. Every year by November 30, the Ministry of Environment, Energy and Climate Change defines the amount of biofuels to be distributed in the following year. Simultaneously, the Ministry invites all interested participants persons to take part in the distribution scheme (art. 15A par. 4 Law No. 3054/2002 in conjunction with art.1 FEK B 253/2013). An assessment committee, consisting of 3 representatives from the Ministry of Environment, Energy and Climate Change, the Ministry of Rural Development and the Ministry of Finance (one representative from each ministry), examines the applications (art. 15A par. 4b Law No. 3054/2002).

The methodology, the distribution scheme, the quota assigned to each registered company and its monthly distribution are approved by the Ministry of Environment, and Energy and Climate Change, the Ministry of Rural Development and the Ministry of Finance by 31 December of every year (art. 15A par. 7 Law No. 3054/2002).

The costs are borne by the consumers. The obliged companies pass on the costs arising from the quota obligation to the consumers by adding a surcharge to their fuel.

The European Commission has not put any restrictions on Greece's biodiesel quota system, leaving it to the discretion of EU Member States to define it with reference to each country's National Renewable Energy Action Plan (NREAP). In addition, there is not any particular agreement/exception the EU has with Greece which may allow the country to focus on developing its economy for a certain period of time or until a certain economic criteria is achieved.

4. The Opening up of the Biodiesel Market in Greece

The term of liquid biofuels in Greece is practically identical to the one of biodiesel. The reason is that there is no bioethanol production locally nor any bioethanol imports have been performed. Despite the fact that the European legislation and regulatory framework regarding bioethanol are present, it seems that no targeted policies aiming to promote the production, import and consumption of bioethanol have taken place.

The first steps were taken with the implementation of four Research and Development projects sponsored by the European Union from 1995 until 2004 respectively, titled ALTENER[5]. Key contributors of these programs were mainly the Fuels and Lubricants Technology Laboratory of the National Technical University of Athens, Elinoil S.A., later parent company of Elin Biofuels S.A., which was established in 2005 in order to engage actively in the Greek biofuels sector and the Centre for Renewable Energy Sources and Saving (CRES - the Greek national entity for the promotion of renewable energy sources, rational use of energy and energy conservation).

In December 2005, the first biodiesel commercial volume output was produced by Hellenic Biopetroleum S.A. Since then, the annual quantity to be distributed for blending with diesel fuel in the Greek market is being defined by a Ministerial Decision of the Ministry of Environment and Energy[6].

In 2015, out of the 18 companies (down from 20 in 2014) which qualified as beneficiaries of the annual volume, 12 were producers and 6 importers from associated EU producers. The 12 producers accounted for 93% of the approved volume (approx. 130,000 m^3). However, their installed capacity is approximately seven-fold of the total annual volume. It is worth noticing that the capacity of the largest producer, Agroinvest S.A., is more than double compared to the total annual volume and that the capacities of the 2nd, 3rd and 4th largest producers range from 80 to 65% of the total annual volume. Thus, it is very obvious that the installed biodiesel production capacity in Greece is asymmetric with regard to current local demand and greatly underutilized with only 14.4% being used for the local market. It is also clear that there is significant potential, at least in terms of capacity, for exports and/or for higher blending mandates (currently the blending mandate is set at 7%). A SWOT analysis of the Greek production of biodiesel conducted by the Centre for Renewable Energy Sources and Saving (CRES) is presented in Table 6.

[5] European Bioenergy Networks (2003), Liquid biofuels network: Activity Report, p. 23-29, France
[6] Biodiesel Allocation Program

Table 6: SWOT Analysis of the Greek Biodiesel Production

STRENGTHS	WEAKNESSES
✓ Beside a quite high and encouraging awareness about biodiesel among Greek citizens, Greece can count on diverse feedstock options: e.g. sunflower, rapeseed, soy and especially cotton (because of the flourishing Greek cotton industry). Biodiesel production capacities are very high. Uncertain policy framework (CAP reform) leads farmers to seek new cropping options. Another asset is represented by the establishment of some regional support for the first Biofuels Platform (in central Greece).	✓ Semi-arid climate conditions restrict yield potentials and lack of available cultivable land: average yields for rape and sunflower seed are about 1,75 tonnes/ hectare which is nearly half of the EU average. Oil yields of cotton seeds are low (about 325 liters of oil/ ha). Dry arid conditions prevailing in the country restrict yielding potential without irrigation. ✓ Small farming size and low yields prevent cost effectiveness; therefore most of the biodiesel plants rely on imports. It is estimated that only about 1/3 of the feedstock for biodiesel production may be supplied domestically. The current quota system does not create secure market conditions for investors. There is also an ongoing quality debate on biodiesel versus pure plant oil.
OPORTUNITIES	**THREATS**
✓ There is a need to identify low input supply options as part of land use strategies to cope with more stringent future restrictions (e.g. water restrictions, etc.). Optimization of the use of residues and processing of by-products could also be crucial to improve biodiesel economics. ✓ Increase biodiesel uses for heating applications may also provide more market opportunities. The introduction of a 'policy mix' with tax exemptions & mandatory targets will enable to create more certain market conditions.	✓ *Quality:* Variety of feedstock with different physical and chemical properties. ✓ *Market:* not well established, limited end uses (only transport sector in certain areas for certain end users) and inflexible production quotas. ✓ *Policy:* uncertainty deriving from the annual quota system and annual allocation of detaxation. ✓ *Sustainability:* careful selection of crops to minimize risks of erosion, water scarcity, etc. in the future supply chains. 9International trade: low cost supply from neighboring Balkan countries although this is also an opportunity for cheap raw materials use. ✓ *Awareness:* Create communication channels & synergies with the farming community.

Source: CRES

5. The Case of Bioethanol Market in Greece

The global supply of biofuels is dominated by bioethanol, holding a market share of about 80% in 2010, which is estimated to decline to 71% by 2030, according to Fotiadis and Polemis (2018). The other dominant biofuel, biodiesel, currently has a 20% share and is expected to decrease by approximately 40%, being substituted by biomass to liquids. Despite these considerations, liquid biofuels in Greece are virtually identical to that of biodiesel, because there is no bioethanol production locally and Greece does not import any bioethanol. Although there is European legislation and a regulatory framework regarding bioethanol, it seems that no targeted policies aiming to promote the production, import and consumption of bioethanol have been made.

Only recently, in August 2013, technical regulation (D3/A΄/oik.15225) regarding the storage and distribution of biofuels was published prescribing the proper way to store, blend and distribute apart from biodiesel, bioethanol as well. It is worth noting that due to the fact that the bioethanol is very sensitive to any presence of water, whose incidence is frequent in the supply chain of fuels, it is recommended by the regulation to blend bioethanol with gasoline at terminal and depots or refinery truck filling stations, so as to be as close as possible, in terms of storage time, to the retail fuel stations. Furthermore, the regulation suggests that the blending process should take place in specially insulated storage tanks (not in tanks with external floating cover, as most gasoline storage tanks in Greece have), or in the tank trucks during loading at the filling station of the depot or refinery. **There is an obligation to blend bioethanol with gasoline at 1% content for 2019 and 3.3% in 2020, which corresponds to 5% in terms of energy volume, while there is a possibility of further percentage increase beyond 2020.**

After a decade of European Directive implementation, bioethanol plants are yet to be installed and this fact along with the existing legislation implies that the construction of such units could be crucial. The Greek Sugar Company had expressed its interest to convert two of its existing sugar factories in Larissa (continental district) and Xanthi (northern district) to bioethanol production units with an annual capacity of 0.1 Mt each, on beet, grain and corn crops feedstock, which are quite common and easily cultivated in Greece.

The output per acre varies depending on the type of crop, the cultivation method used, the climatic conditions, as well as various production factors. A major challenge of Greece is to expand the amount of energy crops as well as to replace some of the usual existing cultivation options like wheat, which is cultivated without irrigation and with relatively low secondary inputs. According to an experimental study, energy crops like sweet sorghum have a relatively high output, even when cultivated with low imputs (irrigation, fertilization, herbicides), which constitutes a highly beneficial fact for the greek agriculture.

Technical regulations regarding bioethanol storage and distribution are in place since 2013 (Section Δ3/A/15225/7.8.2013 in the decision of the Ministry of Environment, Energy and Climate change titled "Technical regulations regarding storage and distribution of biofuels in refinery installations and in storage and distribution installations for fuels") specifying, that due to bioethanol sensitivity to water, blending should take place as close as possible to points of final distribution e.g. at terminals and depots or refinery truck filling stations in external floater free tanks with special insulation. However, no beneficiary qualifications and allocation scheme has been legislated as yet. According to Law 4546/2018,

(i) Bioethanol mixing percentages and sustainability of their sources

Bioethanol or bioethers will be intermixed with gasoline at 1% and at 3.3 % in 2020, which in the future may increase up to the levels allowed by the 316/2010 decision of the Supreme Chemical Council as legislated in the Common multi-ministry decision 316/2010/24.2.2012. Any bioethanol or bio-source alcohol used is subject to the sustainability criteria as defined by Law 3468/2006.

(ii) Licences: Entities obliged to perform the mixing procedure

- Those with gasoline refinery licences regarding the gasoline quantities outsourced for use within the country.
- Category A' petrol product trading licensees if they trade in indigenously produced gasoline or import gasoline which has not been treated according to (a) above and is to be traded within the country. In order to sell to the final consumer, a certificate must be issued, obtained by the trader from a certified agency empowered to issue such a certificate according to Greek Standards EN ISO 17025, verifying that the gasoline sold obeys the standards set in the 316/2010 decision of the Supreme Chemical Council as legislated in the Common multi-ministry decision 316/2012

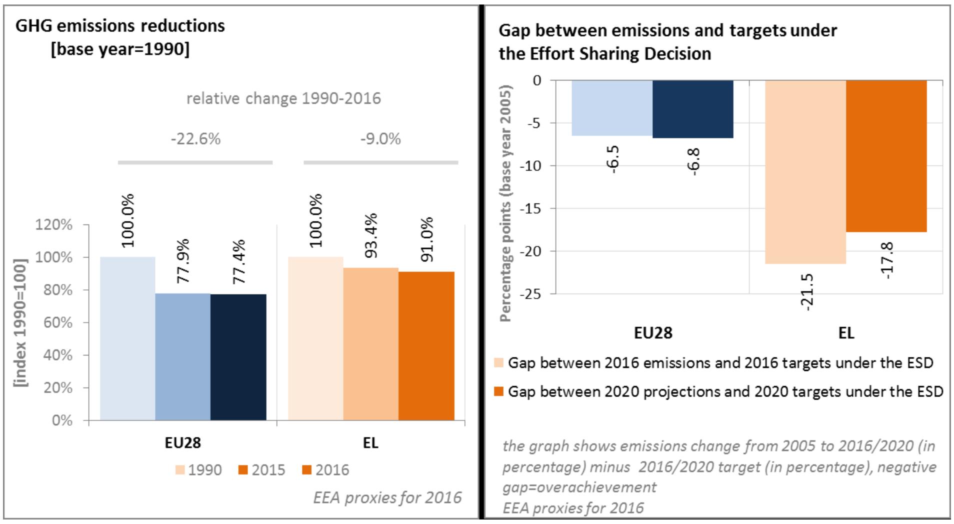
(iii) Bioethanol regulations

Production, possession, chemical processing and sale of ethyl alcohol used as bioethanol take place according to the applicable articles of Laws 2960/2001 and 2969/2001. Those responsible for the mixing process as seen in (b) above receive the necessary biofuel quantities from entities which possess Licences for the Sale of Biofuels. Storing and distribution of bioethanol is conducted according to Section Δ3/A/15225/7.8.2013 in the decision of the Ministry of Environment, Energy and Climate change titled "Technical regulations regarding storage and distribution of biofuels in refinery installations and in storage and distribution installations for fuels".

6. GHG Status and Agreed Current Targets for Greece

National GHG emissions are reported for every year since 1990. Emissions are measured for energy use and supply, industrial processes and product use, agriculture, land-use, land use change and forestry and waste. According to the national projections, non-ETS GHG emissions in Greece will decrease by 22% between 2005 and 2020. Greece will therefore achieve its 2020 GHG emission reduction target (a 4% reduction in comparison to 2005 emission level).

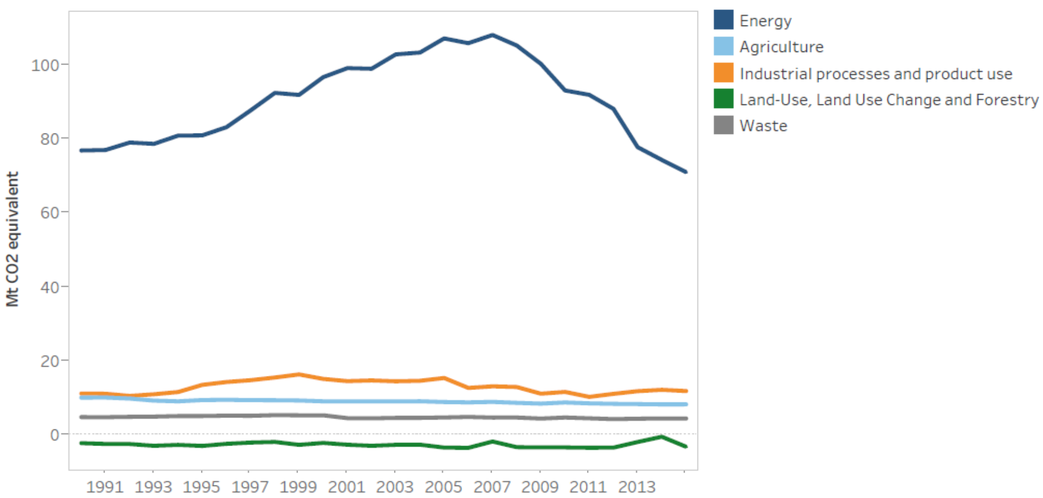
Figure 6: GHG Emission Reductions (LHS) and Gap Between Emissions and Targets Under the Effort Sharing Decision (RHS) in Greece



Source: European Commission (2017)

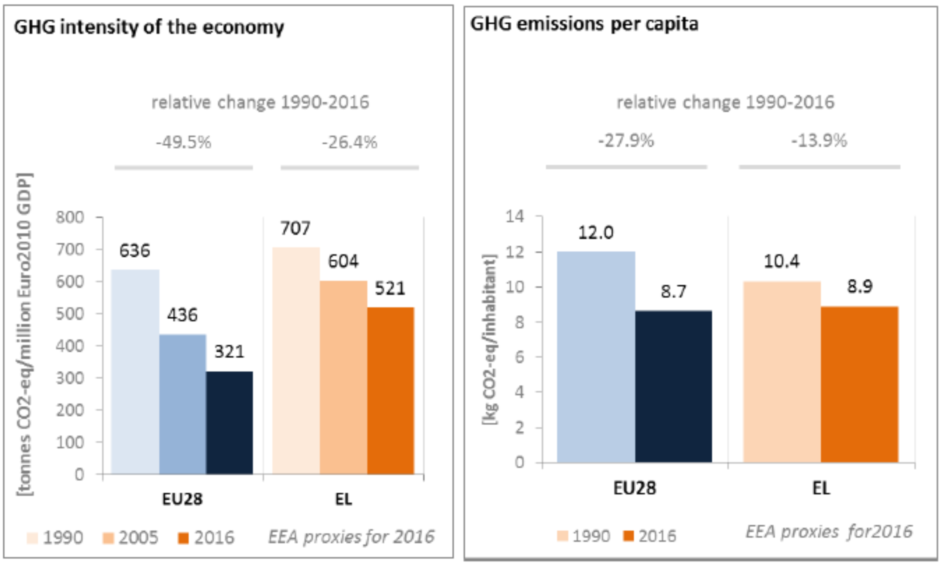
According to 2016 EEA estimates, the GHG intensity of Greece's economy was above the EU average, decreasing at half the pace since 1990. In 2016, the GHG emissions per capita in Greece were slightly above the EU average (only 2%); while in 1990 they were below the EU average by 13%. In 2015, the largest sectors in terms of GHG emissions were the energy sector (43.9 % of total GHG emissions) followed by industry (17.9%), transport (17.9%) and agriculture & fishery (9.3%).

Figure 7: GHG Emissions by Sector in Greece (1990-2015)



Source: EEA (2017)

Figure 8: GHG Intensity of the Economy (LHS) and GHG Emissions per Capita (RHS) in Greece



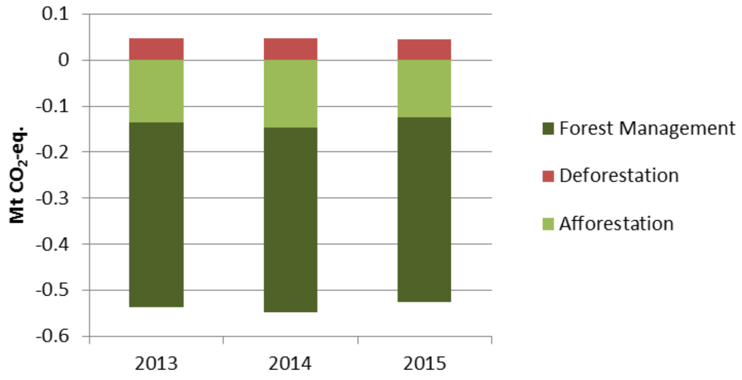
Largest Sectors of GHG Emissions in 2015	EL	EU28
Energy/power industry	43.9%	30.9%
Transport	17.9%	21.0%
Industry	17.9%	19.9%
Agriculture (incl. forestry & fishery)	9.3%	12.0%
Residential & Commercial	6.2%	12.8%
Waste	4.7%	3.2%
Other	0.2%	0.2%

Source: European Commission (2017)

Preliminary accounts under the Kyoto Protocol for Greece show overall removals of 0.5 Mt CO_2eq. as an annual average in the period 2013-2015. For comparison, the annual average of the EU-28 accounted for removals of 119.0 Mt CO_2eq. It should be noted that in this preliminary simulated accounting exercise, removals from Forest Management by far did not exceed the accounting cap.

Removals by Afforestation are notably higher than emissions by Deforestation; however, removals by Forest Management contribute the highest share. Overall, there is a no notable trend in removals; only removals by Afforestation show minor variations. Emissions by Deforestation and removals by Forest Management remain constant over the course of the three-year period.

Figure 9: Land Use, Land Use Change and Forestry (LULUCF) GHG Accounted Emissions and Removals in Greece



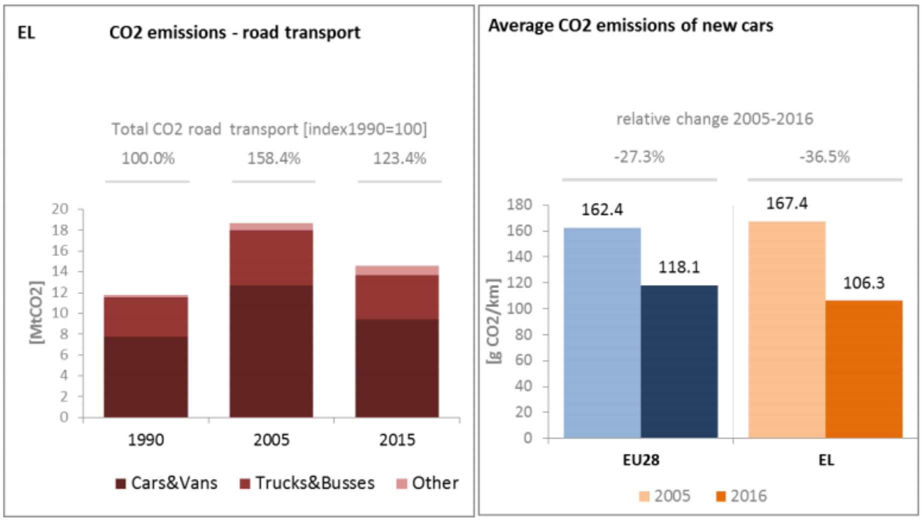
Note: Forest Management credits are capped and presented as yearly averages when the total Forest Management credits of the considered period exceed the simulated cap over the same period.

Source: European Commission (2017)

CO_2 Emissions in Transport and Alternative Fuelled Vehicles

The average CO_2 emissions of new cars in Greece were in 2016 below the EU average and significantly decreased (more than the EU average) between 2005 and 2016.

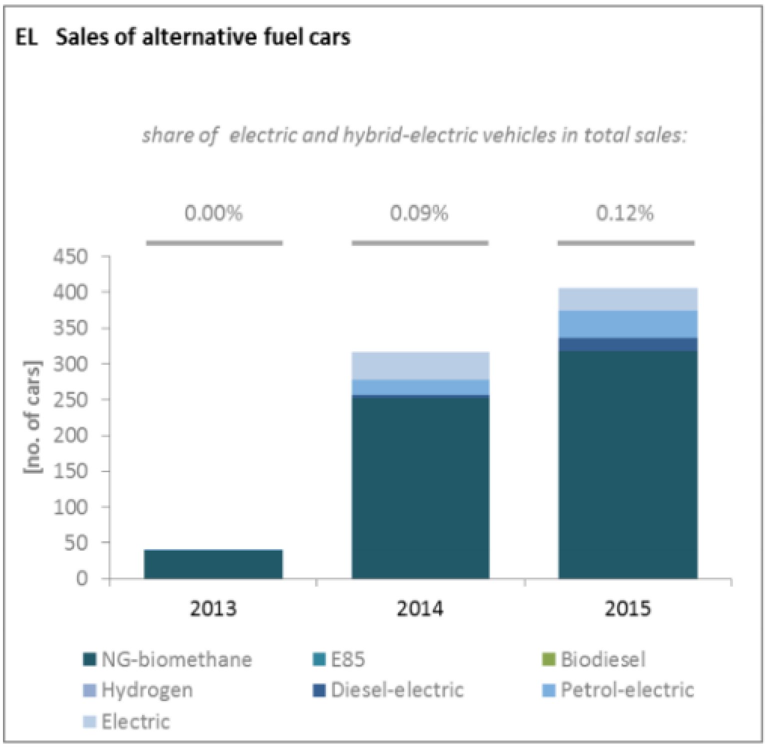
Figure 10: CO_2 Emissions – Road Transport (LHS) and Average CO_2 Emissions of New Cars (RHS) in Greece

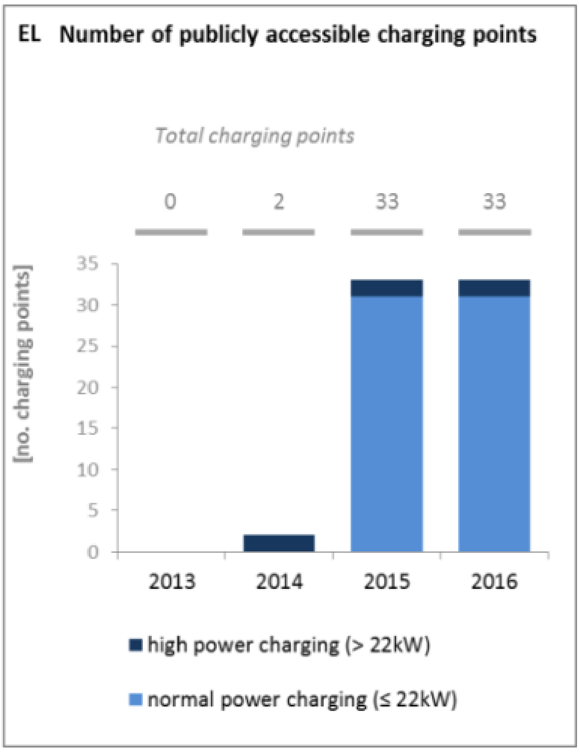


Sources: EEA (2017), European Commission (2017)

The number of electric charging points in Greece remained stable at 33 units over the last years, according to the EAFO observatory.

Figure 11: Sales of Alternative Fuel Cars (LHS) and Number of Publicly Accessible Charging Points (RHS) in Greece





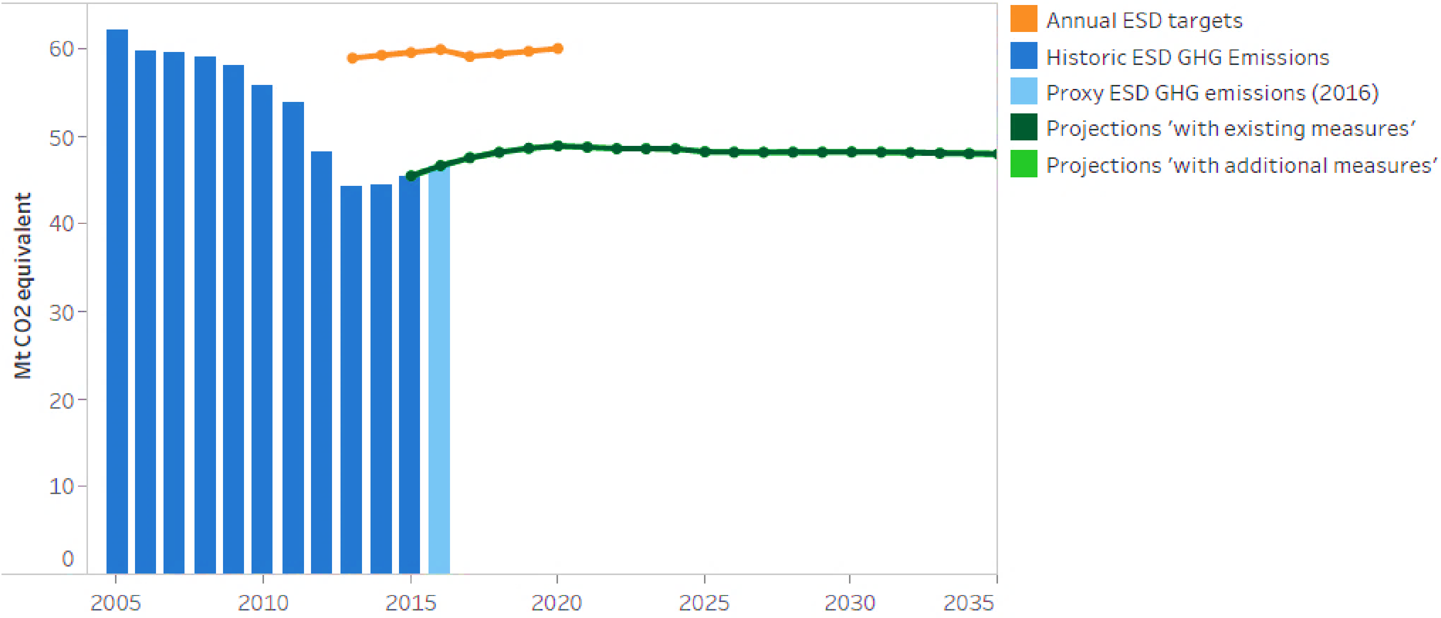
Sources: EEA (2017), European Commission (2017)

National Policy Frameworks under Directive 2014/94/EU on alternative fuels infrastructure have to establish targets, objectives and measures for the development of the market alternative fuels in the transport sector and the deployment of the relevant infrastructure. To this date, no notification has been received from Greece and the Member State has failed to fulfil its obligations under Article 3(7) of Directive 2014/94/EU.

Progress Towards EU Member States' GHG Emission Targets

Each EU Member State shall meet its legally binding targets concerning GHG emissions covered under the Effort Sharing Decision (ESD) for each year of the period from 2013 to 2020. The ESD covers emissions from sectors such as transport, buildings, agriculture and waste that are not covered by the EU Emission Trading Scheme (ETS). Greece has a 2020 GHG emission reduction target of 4% in comparison to 2005 emission level.

Figure 12: GHG Emission Trends and Projections Under the Effort Sharing Decision in Greece



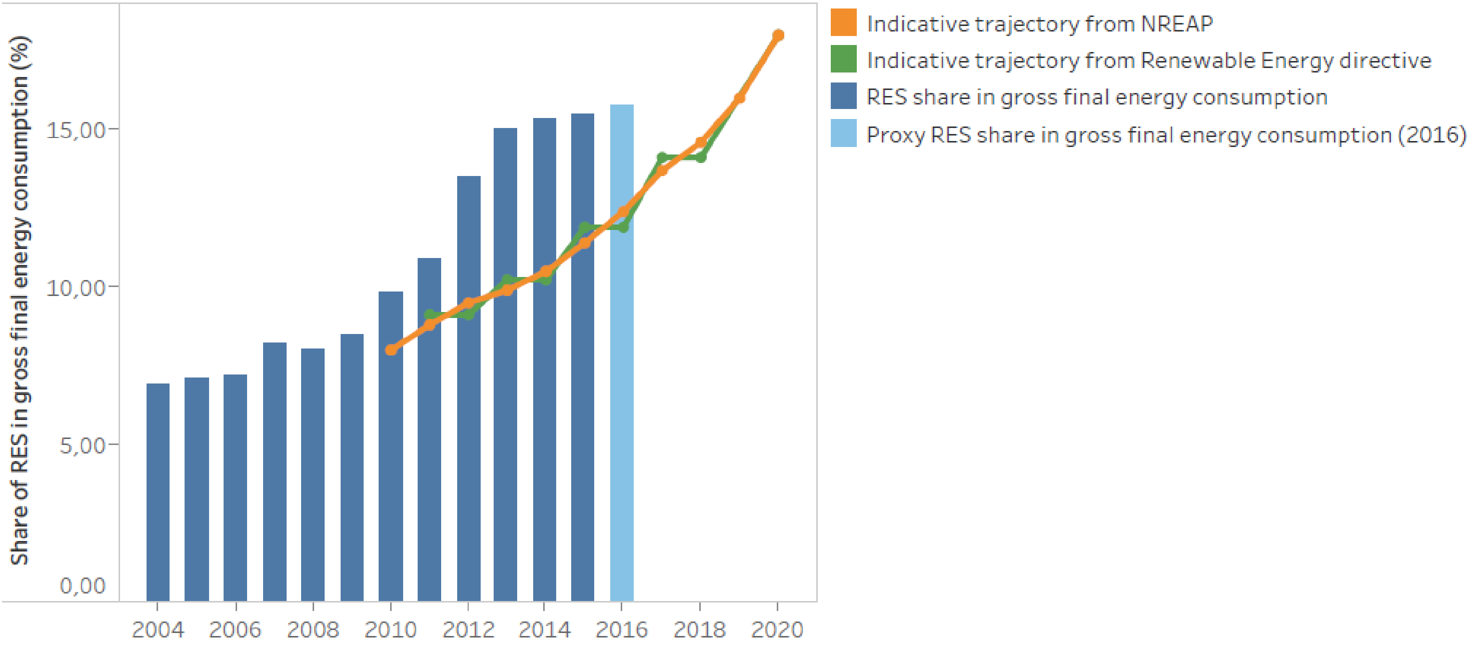
Note: The GHG emission trends represent emissions covered under the Effort Sharing Decision (ESD). For projected emissions, the 'with existing measures' (WEM) scenario reflects existing policies and measures, while the 'with additional measures' (WAM) takes into account the additional effects of planned measures reported by Member States.

Source: EEA (2017)

Progress Towards EU Member States' RES Targets

Each EU Member State shall meet its legally binding targets concerning the 2020 RES share in gross final energy consumption. With a 15.4% RES share in 2015 (against an indicative trajectory of 11.9% for 2015/2016), Greece is on track to meet its 2020 RES target (18%).

Figure 13: Progress Towards Targets Regarding RES Consumption as a Proportion of Greece's Energy Consumption

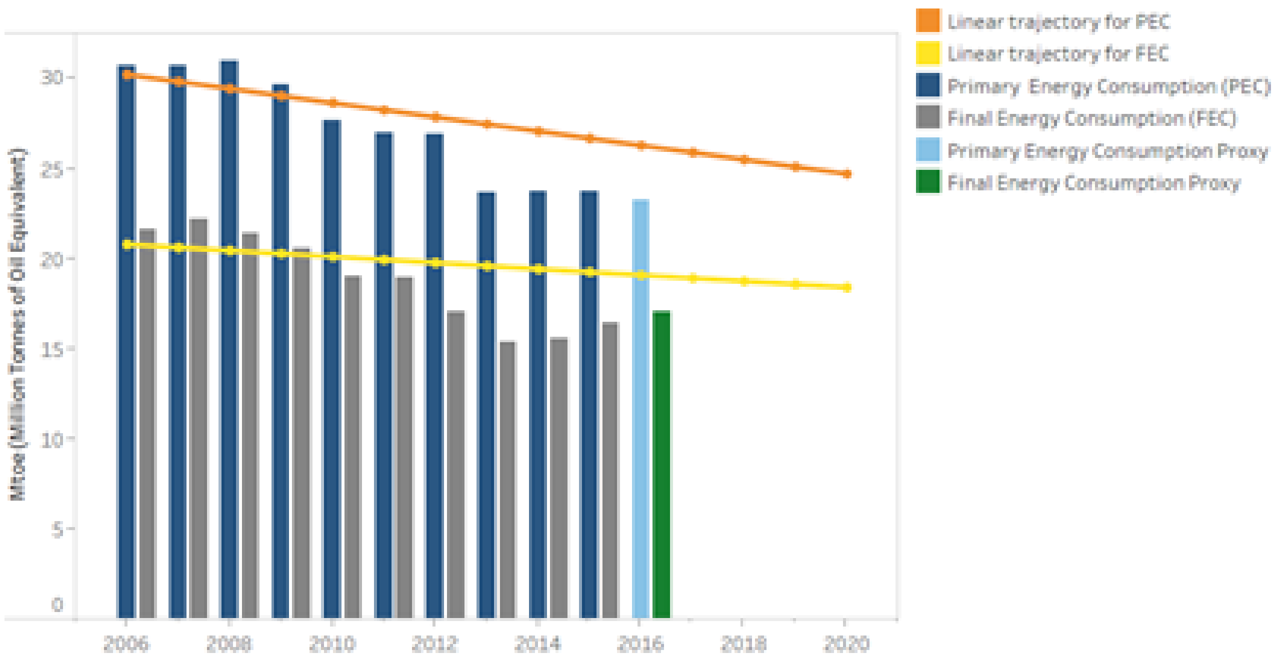


Source: EEA (2017)

Progress Towards EU Member States' Energy Efficiency Targets

Each EU Member State shall meet its non-binding targets for energy consumption for 2020. Between 2005 and 2015, Greece decreased its primary energy consumption by 22.5% to 23.75 Mtoe, based on European Commission's data. Over the same period, final energy consumption also decreased by 21.3% to 16.5 Mtoe in 2015. Despite the fact that Greece has already achieved levels of primary and final energy consumption below the indicative national 2020 targets (24.7 Mtoe in primary energy consumption and 18.4 Mtoe in final energy consumption), it needs to make an effort to keep the primary energy consumption at this level or to minimise its increase when the GDP grows again during the next five-year period (2018-2022).

Figure 14: Progress Towards Targets Regarding RES Consumption as a Proportion of Greece's Energy Consumption

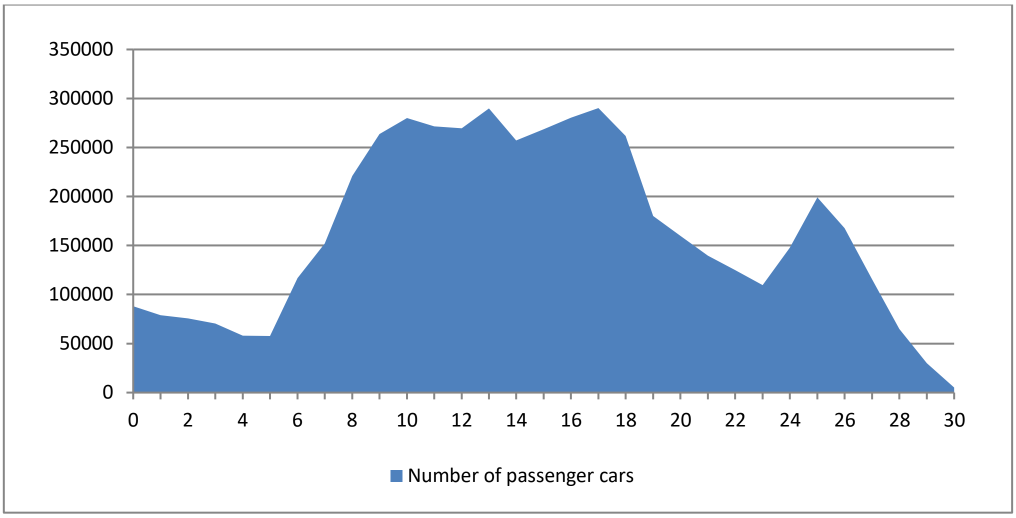


Source: EEA (2017)

7. Current Policy in Greece Regarding the Market Share of Diesel and Gasoline Cars

The passenger car fleet of Greece is one of the oldest in Europe, according to ACEA, numbering more than 3.5 million cars which are more than 10 years in circulation. The average age of Greece's passenger cars was 13.5 years in 2015, while light commercial vehicles and medium - heavy duty vehicles (including buses) accounted for an average of 16.8 and 18.7 years in circulation respectively. Due to stagnation of the local motor vehicle market as a result of the economic crisis, Greek consumers tend to stick to their vehicles for a longer period of time, so in a span of 2 years (2017) the average age of Greece's passenger car fleet is estimated to have risen significantly to 14.7 years.

Figure 15: Age of the Passenger Car Fleet in Greece in 2017



Notes: (a) Data are based on ACEA's report for vehicle age in EU (2016) under the assumption that substitutions made in later years were from the older segment of the car fleet. (b) The number of passenger cars older than 28 years (registered prior to 1990) are estimated to be approximately 100 thousand still in circulation (source ACEA), however the analysis and the allocation of these vehicles to age categories is hypothetical.

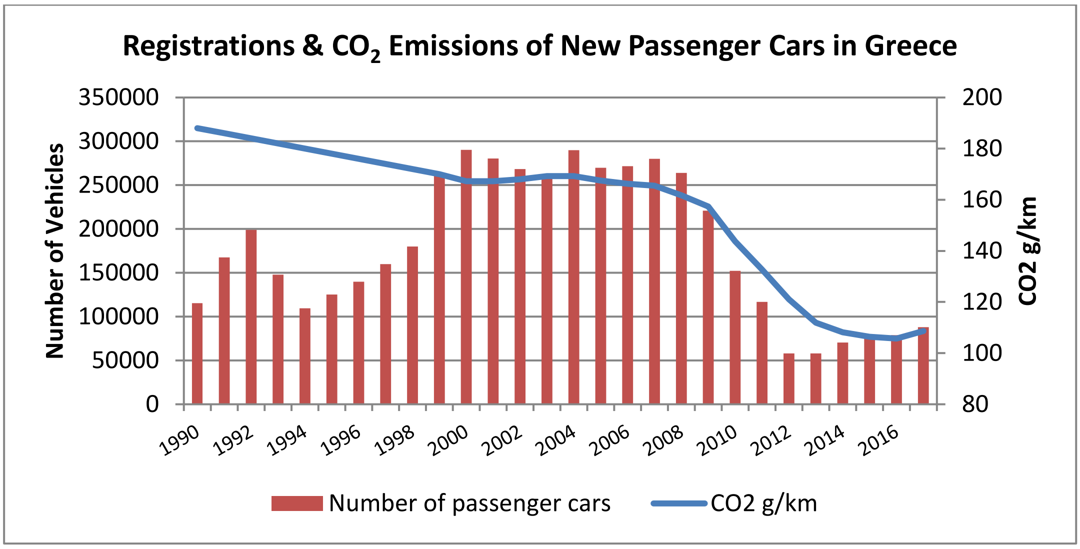
Sources: ACEA (2017), IENE (2018)

As announced on December 2, 2016, at the C40 Mayors Summit in Mexico City, the mayors of Athens, Paris, Madrid and Mexico City said that they will cooperate in order to further incentivise the uptake of alternatively fuelled vehicles and improve infrastructure for walking and cycling. **The leaders of the four major global cities decided to stop the use of all diesel-powered cars and trucks by 2025.**

Figure 16 presents the average CO_2 emissions of the passenger cars registered each year in Greece per km travelled. This data is indicative for the average CO_2 emissions of the total Greek passenger car fleet, which according to IENE's analysis, is approximately 171 grams of CO_2 per km, although the effective value after taking into account the mileage of the fleet should be lower, due to the fact that older more emitting cars are used less than the new ones. Moreover, the use of passenger cars is estimated to emit approximately 8.15 Mt CO_2 equivalent (2015).

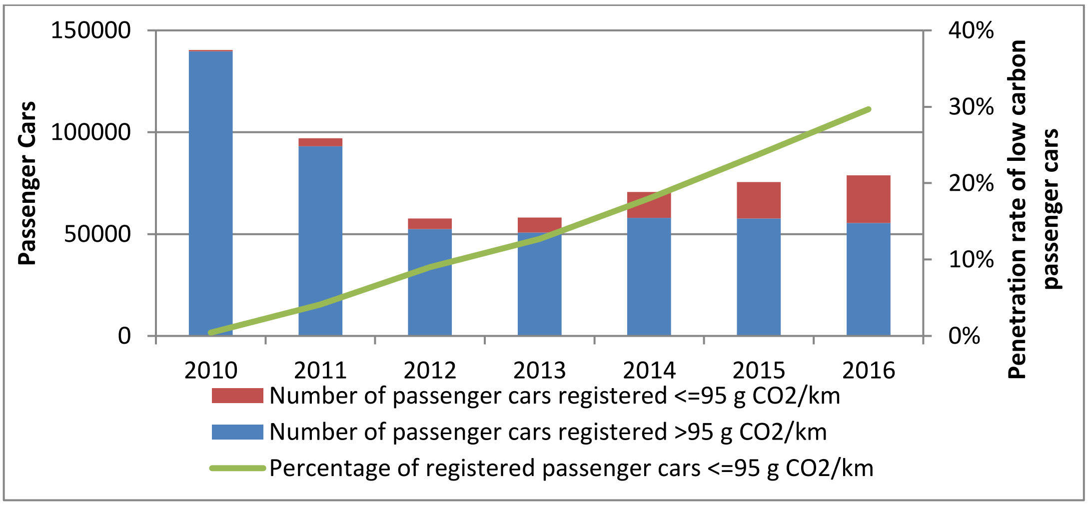
By observation, it is evident that the economic crisis manifested in 2009 affected mainly both the new registrations but also the average CO_2 emissions of new cars due to the turn of the consumers towards smaller vehicles. The trend in the market initiated by the economic crisis still holds to up today with a slow growth initiated in 2014. Furthermore, the financial crisis has put the motor vehicle market in Greece into a recession, where mobility commodities, like light duty passenger vehicles, has been a reluctant purchase. Hence, the remaining consumers have reduced their choices towards smaller efficient vehicles which would primarily satisfy their predicted mobility needs without considering other factors, which prior had been significant in influencing consumer choice in the local motor vehicle market.

Figure 16: Development of the Average CO_2 Emissions Emitted by the New Passenger Cars in Greece and the Annual Deployment of Passenger Cars



Sources: ACEA (2017), IENE (2018)

Figure 17: Number of Passenger Cars Registered in Greece per Year, which are Compliant with the Emissions Target of 95 CO_2 g/km set by EU for 2021



Sources: ACEA (2017), IENE (2018)

In Greece, the number of light duty passenger vehicles registered, which meet the emissions target of 95g CO_2/km for 2021, has been 71,260 for the period 2010-2016 accounting for 12.3% of the total cars registered in the same period. While the percentage of vehicles sold that are compliant with the emission targets keep increasing steadily. Namely, the share of emission target compliant vehicles accounted for 29.7% of the total sales in 2016, which is significantly higher from 23.8% and 18% which accounted for 2015 and 2014 respectively, generating an incremental trend in adoption of vehicles with low carbon intensity in the country.

Given the fact that the motor vehicle market in Greece is expected to bounce back after the severe recession it experienced up over the last 8 years, it is expected that the rate of substitution of carbon intensive vehicles with new Euro 6 compliant ones will increase significantly in the following years.

Table 7: CO_2 Emissions of Greece's Passenger Car Fleet

	Petrol Passenger Cars	Diesel Passenger Cars	Units
Annual Consumption / vehicle	671.976	498.563 [2]	Liters
Combustion CO_2 Emissions / liter[1]	2.39	2.67	CO_2 kg/l
Annual CO_2 Emissions / vehicle	1606.023	1331.163	CO_2 kg
Total passenger fleet emissions	7.939	0.218	Mt COeq

Notes: (a) CO_2 equivalent emissions per liter of fueled combusted as estimated by US Environmental Protection Agency. (b) The fuel consumption of diesel cars has been calculated based on a ratio of 0.74, which is a market statistics average of consumption ratio of diesel to petrol for the vehicles that have both petrol (gasoline) and diesel version. Here is pointed that driving behavior per vehicle segment is required for more accurate data input.

Sources: ACEA (2017), IENE (2018)

The total emissions resulting from the use of passenger cars are estimated to be 8.16 million tons of CO_2 equivalent, accounting for approximately 48.9% of the total emissions resulting from the activity of Greece's transport sector. By substituting the older segment of the passenger car fleet with EVs, IENE expects the tailpipe emissions of the total country's fleet to reduce radically. Such an introduction leads to 2.3% of tailpipe emission reduction (0.17 $MtCO_2eq$) for substitution of the 100 thousand most carbon intensive cars with EVs, while substituting the 1 million most carbon intensive passenger cars with EVs will result in 21.9%.

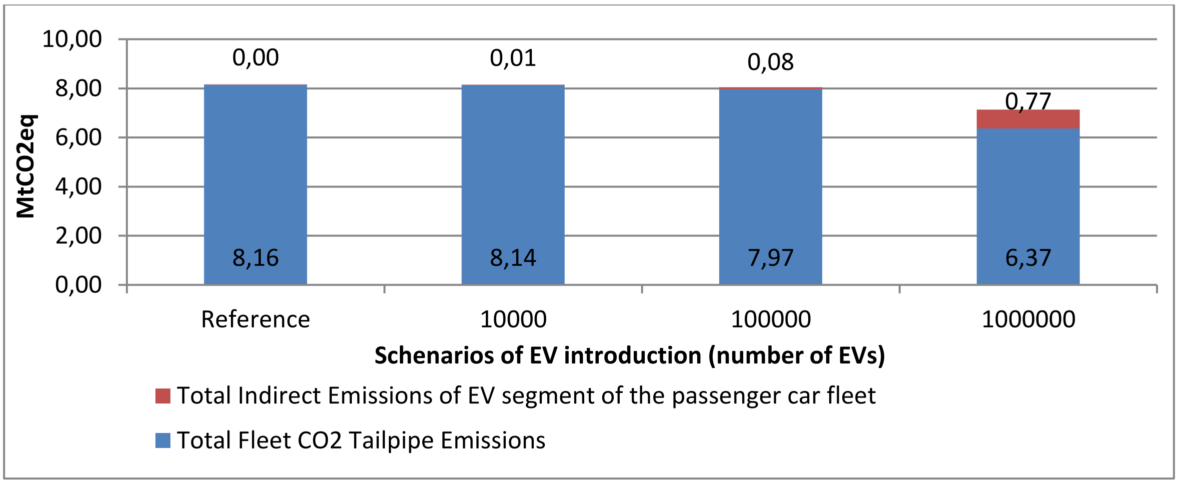
Table 8: Tailpipe and Total Emissions of Greek Passenger Car Fleet in Under Various Scenarios

		Number of EVs introduced			Units
Scenario	Reference	10,000	100,000	1,000,000	EVs
Average CO_2 emissions per km	164.29	163.91	160.56	128.29	CO_2 g / km
Total Fleet Tailpipe CO_2 emissions	8.16	8.14	7.97	6.37	Mt CO_2eq/y
CO_2 Tailpipe Emissions' Reduction (%)	0	0.2%	2.3%	21.9%	%
Total Indirect Emissions of EV segment of the passenger car fleet	0.02	7.70	76.96	769.60	kt CO_2eq/y
Total fleet emissions	8.16	8.15	8.05	7.14	Mt CO_2eq/y
CO_2 Total Emissions' Reduction (%)	0%	0.1%	1.3%	12.5%	%

Notes: (a) The calculation of the tailpipe and indirect emissions CO_2 was based on the average mileage of Greek passenger car fleet measured on the basis of total petrol (gasoline) consumption for 2015, resulting to a total of 9,723 km/year, (b) The reference EV model utilized in the scenario calculations was BMW i3 (2018), (c) Indirect emissions are calculated based on the carbon intensity of the local power sector of 532g CO_2/kWh.

Sources: ACEA (2017), IENE (2018)

Figure 18: Tailpipe, Indirect and Total Emissions of Greek Passenger Car Fleet in Under the Scenarios Presented in Table 8



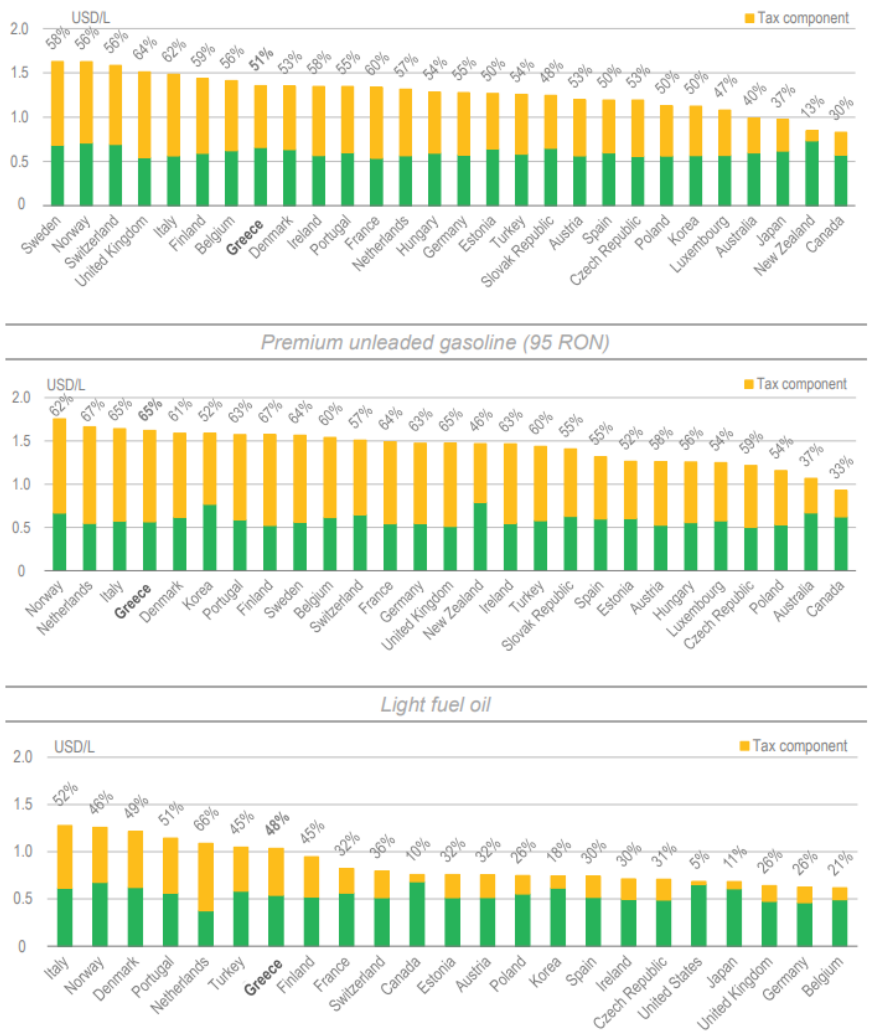
Sources: ACEA (2017), IENE (2018)

Greece's progress in decarbonising transport remains challenging, as is also in other EU Member States. **Greece has a blending requirement for diesel but not for gasoline**. Diesel blending is achieved by using first-generation biofuels, which will become difficult under future EU rules that aim to limit contributions from such unsustainable biofuels. There is almost no deployment of electric or hydrogen vehicles in Greece. Construction of alternative fuel infrastructures is needed to boost the share of alternative fuel vehicles, but the costs appear prohibitive under current economic conditions.

Prices and Taxes

In the first quarter of 2017, Greek consumers paid USD1.36 per litre of automotive diesel, over half of which was taxes, according to IEA's data. Gasoline prices were higher at USD1.62 per litre. Taxes accounted for almost two-thirds of the gasoline price in Greece. Light fuel oil cost Greek consumers USD1.04 per litre, around half of which was taxes. The tax share of the total price has increased for both diesel and gasoline in recent years. Diesel taxes accounted for 48% of the total price and gasoline taxes for 59% in the first quarter of 2011, both below the levels in 2017. Diesel taxes in terms of price per litre decreased by 3%, whereas gasoline taxes increased by 3% from 2011 to 2017. Taxes on fuel oil almost tripled over the same period, and their share of total price for fuel oil increased from 21% in 2011 to 48% in 2017 (see Figure 19).

Figure 19: Fuel Prices in IEA Member Countries, First Quarter of 2017



Source: IEA (2017)

In Greece, dieselisation started only in 2012, when new diesel car models (Euro 5/6 compliant) became widely available. Diesel cars had previously been banned from entering the two largest cities (i.e. Athens and Thessaloniki), representing almost 40% because of dangerous levels of air pollution. Since May 2012, the ban has been lifted, and Greece has seen a dramatic surge in diesel car sales to profit from the huge diesel tax bonus (41% in 2017). In 2012, over 40% of the new cars sold had diesel engines; by 2015, this had risen to 63%, according to Brussels-based Transport & Environment.

As already analysed, Greece has a biodiesel blending mandate, but without new measures, the country cannot increase contributions towards the target for 2020. Notably, a strategy for penetration of biofuels is needed to achieve the 10% target. Greece imports mainly first-generation biodiesels, but this will be a challenge under future EU rules, which aim to limit contributions from such biofuels. No blending mandate is in place for gasoline. The share of renewable energy sources stood at 1.43% in 2015. Blending of bioethanol in gasoline is considered essential to meet the 2020 targets.

8. General Legal and Regulatory Framework about Biofuels in Greece

A. EU Legal Framework

Being a member state of the European Communities (the 3 predecessor international organizations of the European Union) since 1981, Greece has been closely adopting the EU legislation and regulations with limited differentiations where and if it is allowed and requested.

The European Directive (Directive 2003/30/EC) was adopted by amending and supplementing Law 3054/2002 (Organization of the oil market and miscellaneous provisions) with Law 3423/2005 (Introduction of biofuels and other renewable fuels in the Greek market). In 2012, the latest European Directives concerning biofuels, 2009/28/EC and 2009/30/EC, were adopted in Law 4062/2012 in section C and chapters A (Promotion of energy use from renewable sources – integration of European Directive 2009/28/EC) and B (Sustainability criteria of biofuels and bioliquids - integration of European Directive 2009/30/EC), as published on 30 March 3012.

Renewable Energy Directive (2009/28/EC) establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

Biofuels and bioliquids are instrumental in helping EU countries meet their 10% renewables target in transport. The Renewable Energy Directive sets out biofuels sustainability criteria for all biofuels produced or consumed in the EU to ensure that they are produced in a sustainable and environmentally friendly manner.

Companies can show they comply with the sustainability criteria through national systems or so-called voluntary schemes recognized by the European Commission. This framework serves to determine quantity, quality, provenance as well as regulations and targets regarding the biofuel market at the EU and Member States level. These regulations and targets have been adopted by the national regulatory frameworks of Member-States. The aim of this section of the study is to highlight the most prominent EU regulations regarding biofuels and the way that have been transposed and implemented by the Greek legal system.

Certain important details of the RED should be pointed out:

1. **Calculation of the proportion**
   - **(a)** The *numerator* (renewable energy sources) is set to be the sum of all renewable energy types used in all types of transport.
   - **(b)** The *denominator* (total fuel amount) is set to be the sum of all fuels used for all types of transport, road and fixed track, including electricity used in rail transport.

2. **Definition of the contribution according to Biofuel Type**

Biofuels made by processing wastes, residues, non-food cellulosic material, and lingo-cellulosic material are considered to contribute *twice* as much as other biofuels.

3. **Sustainability Criteria**

These include the way of calculating biofuel Greenhouse Gas Emissions (GHG) and the setting of its minimum reduction limit, the exclusion of biomass fuels produced in high biodiversity or high soil carbon content areas.

4. Member State Obligations

Each Member State had to submit by June 30, 2010 a National Renewable Energy Action Plan (NREAP) which was to be suitably justified regarding the methodology of reaching the 2020 target by providing a detailed roadmap. The NREAPs submitted by each Member State are expected to reach up to 20.7%, accounting for 0.7% above the 20% pre-set target.

The RED did not address in a concrete way the resolution of the consequences of the increase of GHG emissions due to Indirect Land Use Change (ILUC), the demand fuelled increased allocation of land for bioethanol and biodiesel production.

Its mandate extended only to compiling:

"a concrete methodology to minimize greenhouse gas emissions caused by indirect land-use changes. To this end, the Commission should analyse, on the basis of best available scientific evidence, in particular the inclusion of a factor for indirect land-use changes in the calculation of greenhouse gas emissions and the need to incentivize sustainable biofuels which minimize the impacts of land-use change and improve biofuel sustainability with respect to indirect land-use change."

This was discussed and reformatted for a five-year period to achieve a consensus, including the placing of a 7% cap on conventional crop-based biofuels for the 2020 target and the decision for Member States to pass it by a legislative act by 2017. The European Parliament approved it as a RED reform. It should be noted that ILUC was not addressed directly, relying on the cap imposed to control its expansion, but any changes of land use should be recorded. In relation to ILUC, in 2015 new rules came into force which amend the current legislation on biofuels – specifically the Renewable Energy Directive and the Fuel Quality Directive - to reduce the risk of indirect land use change and to prepare the transition towards advanced biofuels. The amendment:

- limits the share of biofuels from crops grown on agricultural land that can be counted towards the 2020 renewable energy targets to 7%
- sets an indicative 0.5% target for advanced biofuels as a reference for national targets which will be set by EU countries in 2017
- harmonizes the list of feedstocks for biofuels across the EU whose contribution would count double towards the 2020 target of 10% for renewable energy in transport
- requires that biofuels produced in new installations emit at least 60% fewer greenhouse gases than fossil fuels

- introduces stronger incentives for the use of renewable electricity in transport (by counting it more towards the 2020 target of 10% for renewable energy use in transport)
- includes a number of additional reporting obligations for the fuel providers, EU countries and the European Commission

5. The Fuel Quality Directive

The 2009/30/EC Fuel Quality Directive (FQD) complemented and augmented the RED and reformed the Fuel Quality Directive of 1998 (1998/70/EC), particularly in terms of petrol and diesel specification tables.

The combination of these Directives led to:

(i) GHG Intensity and Emissions Regulation: The Directives mandated its reduction regarding transport consumed biofuels and defined the biofuel composition criteria that made this reduction sustainable. GHG biofuel emissions are defined on the basis of default values listed in in RED which are broken down in terms of the cultivation, process, transports steps of biofuel production and consumption. This enables biofuel economic actors to combine actual and default values or use them in a single way, while the life cycle assessment method employed in the actual value calculation is included in the Directives and carbon emissions of any ILUC involved or by-products of the process steps are included in the accounting scheme. Any degraded land employed counts in terms of a GHG bonus scheme.

(ii) Double counting: Directive 2009/28/EC of the European Parliament "the contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels", which is clearly a preferential treatment of the second generation or "advanced" biofuels.

(iii) Sustainability criteria: RED includes definitive sustainability compliance criteria for biofuels consumed in the EU regarding qualification for the RED and FQD targets. Failing this they are not part of the EU renewable energy target and cannot receive any form of subsidy. Also, in "EU Biofuels Annual 2015", RED includes strict definitions for the minimum level of GHG savings, land use rules and adverse effects monitoring protocols.

(iv) Certification systems: The scheme that certifies compliance with both GHG and Sustainability regulations and criteria is based upon "voluntary certification systems", private or state-owned legal entities recognised as valid by the European Commission for a period of five years which may operate at an EU or national level. The only national level system is the Austrian Agricultural Certification Scheme. As of April 2015, nineteen voluntary certification systems have been recognized by the EU **(for further information see Table 9).**

(v) Biomass Sustainability: Despite the fact that the RED demanded from the European Commission to assess whether or not sustainability criteria for solid and gaseous biomass were required, in May 2014 the EC reported that there would be no EU-wide sustainability criteria for biomass before 2020. This decision was based on the assumption that the current national, European and international legislation is sufficient to ensure that the proper and sustainable practices are being used. Nevertheless, it is expected that the EC will develop a biomass policy aimed at maximizing the overall climate and environment benefits of biomass and contributing to significant GHG emission savings for 2020 until 2030.

(vi) Trade Policy: After 2006 trade policy was centred on anti-dumping and tariffs with a methodology of local market protectionism based on the case-by-case imposition of import barriers depending on the country/goods combination. This was not a uniform policy since during the 2006-2012 period, while the EU tariff on undenaturated bioethanol was 88% higher than that on the denatured one, this was followed only by the United Kingdom, the Netherlands, Finland, Denmark, the Czech Republic and Slovakia while the rest of the Members conversely allowed blending only with the undenaturated form. In the exceptional case of the U.S, which is a very big in bioethanol production, an anti-dumping duty of €62.3 per metric ton (MT) was imposed in proportion by weight on agricultural product pure ethyl alcohol content in case of use as a fuel component, exempting all other uses (Council Regulation 157/2013) extending the previously imposed antidumping and countervailing duty (anti-subsidy measure) policy (2009 Regulations 193 and 194) on biodiesel with over 20% biofuel content ("B99" measures). Though the biodiesel measures were to expire by 2014 they were extended for another 5 years in 2015 (Regulations 1518 and 1519). Regulation 490/2013 extended similar measures to encompass Argentina and Indonesia for a limited period which were made permanent by the 2013 by Regulation 1194.

Table 9: The Voluntary Certification Systems Approved by the EU

(1) ISCC (International Sustainability and Carbon Certification)

(2) Bonsucro EU

(3) RTRS EU RED (Round Table on Responsible Soy EU RED)

(4) RSB EU RED (Round Table of Sustainable Biofuels EU RED)

(5) 2BSvs (Biomass & biofuels voluntary scheme)

(6) RBSA (Abengoa RED Bioenergy Sustainability Assurance)

(7) Greenergy (Brazilian bioethanol verification program)

(8) Ensus (Voluntary scheme under RED for Ensus bioethanol production)

(9) Red Tractor (Farm Assurance Combinable Crops & Sugar Beet Scheme)

(10) SQC (Scottish Quality Farm Assured Combinable Crops scheme)

(11) Red Cert

(12) NTA 8080 (The Netherlands)

(13) RSPO RED (Roundtable on Sustainable Palm Oil RED)

(14) Biograce (GHG calculation tool)

(15) HVO Renewable Diesel Scheme

(16) Gafta Trade Assurance Scheme

(17) KZR INIG (Oil and Gas Institute of Poland)

(18) Trade Assurance Scheme for Combinable Crops

(19) Universal Feed Assurance Scheme

B. **Greece**

In the scope of Directive 2009/28/EC, Greece elaborated and submitted its National Renewable Energy Action Plan in June 2010. According to the NREAP, the targeted 20% share of renewable energy in the gross final energy consumption in 2020 will be achieved through the combination of measures for energy efficiency as well as for the enhanced penetration of RES technologies in electricity production, heat supply, and transport. With regards to the pillar of Renewable Energy Sources in Transport, the NREAP states:

"The penetration of biofuels to meet the 20-20-20 target in the transport sector will be achieved through a combination of regulatory actions targeted to promote both the use of more energy-efficient vehicles and the consumption of biofuels in substitution of fossil transport fuels. Emphasis will be put on the domestic production of the required amounts of biodiesel, on the exploitation of the local biomass potential with the cultivation of energy crops for biofuels and on the development of the necessary supply chains in order to assure a significant contribution of the domestic agricultural production."[7]

Through the article 1d Law 3851/2010, the national target for the contribution of renewable energy sources in the final consumption of energy in the transport sector, has been set to reach at least 10% by year 2020.

JMD Δ1/Α/10839/2012 (OG1667) provides a list of those feedstocks that are eligible for double counting. These include used cooking oils, animal fats, animal manure, non-food cellulosic and ligno-cellulosic materials (straw, nutshells, etc.), wastes and residues of agriculture, forestry, aquaculture. Double counting, which refers to the contribution of biofuels from non-food crops to the 10% RES in transport target, offers opportunity for development. Biofuels from used cooking oil (UCO) and animal fats as well as advanced biofuels from lignocellulosic materials and innovative fuels created from these feedstocks that enable greater reductions in GHG emissions would count double in the 10% target provided that such a provision is adopted in the local legislation. The biofuel producers questioned have already included used cooking oil and animal fats in their feedstock portfolio; therefore, the implementation of the double counting scheme in Greece would add value to the sector quickly and work in convergence with the applied strategy (in particular, Elin Biofuels S.A. produces biodiesel exclusively from used cooking oil and animal fats, while there is no need for the advanced feedstock to be produced locally).

Laws 4203/2013 and 4414/2016 (active from December 2015) regulate net metering for PV, small wind, biomass/biogas/bioliquids, small hydro, and co-generation plants. **The two laws and a revised ministerial decision issued in 2017 also regulate virtual net metering for public or private legal entities involved in activities of public benefit, in general or for local**

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[7] National Renewable Energy Plan, (2010), Ministry of environment, energy & climate change, Hellenic Republic, p.9, Athens, Greece

purposes, and for farmer and agricultural enterprises. Almost 10 MW of such PV installations have become operational under these programmes.

Penalties

According to decision no. 184182/2016 by the Ministry of Environment and Energy, regulation contraventions are divided in two classes and addressing sustainability criteria in terms of non-submission of pertinent documentation. The first category encompasses infringements concerning cases where economic operators haven't complied with the sustainability criteria imposed by the MD 175700/14420016. For instance, there is a lack of a compliance certificate of sustainability. The second category is related to infringements of provisions and requirements, set by law 4062/2012 which has incorporated the RED and FQD Directive in the Greek legislative framework. The penalties imposed are monetary and begin at €1,000.00 with a limit of €100,000 while repeat offenders could be penalized up to six times the fine for the case of a single offence. Prior to the underlying MD, fines could reach up to €1,000,000.00.

9. Some Thoughts

In terms of EU wide policy directives, the legal framework regarding biofuels leads to a sustainable mechanism which may be involved in fuel market operations contingent upon the existence of subsidies whenever the traditional fossil fuel prices take a dive. The subsidy condition however is untenable in Greece due to the state of the country's economy. Greece is by and large compliant with EU Directives and Regulations, while compliance is actionable in Law in a timely fashion, for biodiesel and bioethanol, as well as other biofuels. In terms of target achieving, biodiesel is on the right path while bioethanol is at the stage where active participation is imminent. However, the resulting legal framework is hampered by an over-multiplicity of laws and statutes which tend to complicate open market operations.

A list of opportunities and threats about Greece's biofuels market is of paramount importance. More specifically:

Opportunities

1. Since biodiesel is currently the only available liquid biofuel in Greece, the further promotion of its penetration by the policy makers looks like an one-way road towards the accomplishment of national targets regarding the renewable energy in transport (10% substitution of energy for transportation by RES and 20% cut in GHG emissions from 1990 levels). Higher blending mandates with diesel could lift off the

market and optimize the operation of existing biodiesel plants. Even after the forthcoming 7% cap on crop-based biofuels is applied, a Greek market of higher biodiesel blending rate (10 or 15%) and with the current supply structure (energy crops mainly) would be within the allowed limits.

2. The import and production of bioethanol is totally a new ground for business. According to the biodiesel producers, a concrete legal and investment framework is of key importance to attract potential entrepreneurs to invest. Provided that the blending of bioethanol with gasoline is imposed as a mandate, similar to biodiesel and relative practices in the EU and globally, a large market would instantly emerge.
3. Apart from the transportation sector that absorbs totally the liquid biofuels in Greece, there could be other appliances as well, including the aviation and marine sectors, which are potential new customers of biofuels with capacity to intake massive quantities of them. However, this is unlikely at least for the short-term or mid-term, as no sign of moving into that direction in Greece has shown up until now. Other potential and more probable appliances, due to the fact that the legal framework is present (L.3468/2006), include the blending of biodiesel with heating gas oil for industrial and residential heating purposes and the usage of blended diesel for power generation[8].
4. The implementation of the double counting scheme in Greece like in other EU countries would add value to the sector quickly and work in convergence with the applied national strategy.

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[8] In Greece, around one-third of diesel oil is currently consumed in the residential sector for heating purposes. Heating gas oil accounts for one-third of the total energy consumption in households. Residential oil consumption was substantially higher before the economic crisis. Residential oil consumption dropped by 62% from 2011 to 2014 owing to a combination of increased heating gas oil prices, reduced household incomes, and the increased penetration of natural gas because of government policy (fuel switching to biomass and natural gas). Consumption increased again in 2015. Some 500,000 households receive a subsidy for heating gas oil that is unrelated to actual consumption, but which is determined based on social criteria. The level of the heating gas oil subsidy for residential consumers depends on income, the number of people in the household, the value of the home, and the climate zone of the household. The subsidy per winter ranges from €37.5 to €625 and is not related to the amount of heating gas oil consumed. Those households that heat their homes with district heating or natural gas do not receive a subsidy, and there is no incentive for households to switch from heating gas oil to cheaper fuels such as natural gas. The relatively high share of oil use in power generation stems from thermal generation on the Greek islands that have no electricity interconnection to the mainland. Greece has a large share of oil consumed in the interconnected power generation. Oil power plants generated 11% of the total electricity generation in 2016 (48.8 TWh). In addition, heat and power generation stood at 13.6% of Greece's total oil consumption (11.2 More in 2016). In addition, there is not a current mass scale production and distribution of such biofuels blending; although such practices might be in place, but there are still undocumented.

5. Marginal lands which in general are of poor quality with regard to agricultural use could possibly be used for biomass production.

Threats

1. Given the absence of established bioethanol blending in Greece, the achievement of national targets until the very close horizon of 2020 remains doubtful.
2. While achieving the 2020 targets seems dubious, there has been no sign of updated national planning beyond 2020 until nowadays. The lack of such strategic plan will be deferring the potential development of the local biofuels' market, depriving it of competitiveness against markets of other countries more advanced in terms of organization and planning.
3. High relative costs limit the sustainability and question the viability of the industry. The relatively high cost of feedstock in Greece is considered to be the most material factor for the high price of the final product. If it were not for the biodiesel allocation program that regulates in total the produced and traded quantities and thus, the prices, giving by far priority to domestic production (for instance in 2015, 93% domestic and 7% imports), there is a possibility that extensive low-cost imports would have flooded the market. In addition, the fact that the Biofuel Producers pay for value added tax (VAT) with their purchases but do not collect VAT[9] from their sales since they sell untaxed product, creates a significant working capital restraint, which is amplified due to the delays at the return of VAT from the Greek State.

Table of Regulatory Framework

EU level

- Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC, published on the Official Journal of the European Communities (1998) L 305/58
- Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, published on the Official Journal of the European Union (2013) L 140/16

[9] VAT is imposed on the sum of commodity cost and excise duty.

- Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending (i) Directive 98/70/EC, as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and (ii) Directive1999/32/EC, as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EC, published on the Official Journal of the European Union (2013) L 140/88
- Directive 2015/1513 of the European Parliament and of the Council of 9 September 2015 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels and amending Directive 2009/28/EC on the promotion of the use of energy from renewable sources, published on the Official Journal of the European Union (2015) L239/1
- Commission Regulation (EC) No 193/2009 of 11 March 2009 imposing a provisional anti-dumping duty on imports of biodiesel originating in the United States of America, published on the Official Journal of the European Union (2009) L 67/22
- Commission Regulation (EC) No 194/2009 of 11 March 2009 imposing a provisional countervailing duty on imports of biodiesel originating in the United States of America, published on the Official Journal of the European Union (2009) L 67/50
- Commission Regulation (EU) No 157/2013 of 18 February 2013 imposing a definitive anti-dumping duty on imports of bioethanol originating in the United States of America, published on the Official Journal of the European Union (2013) L 49/10
- Commission Regulation (EU) No 490/2013 of 27 May 2013 imposing a provisional anti-dumping duty on imports of biodiesel originating in Argentina and Indonesia, published on the Official Journal of the European Union (2013) L 141/6

Greece

- Law 2969/2001 for the Production and use of Ethyl Alcohol and Alcoholic Products, published on the Government's Gazette A 281/18.12.2001
- Law 3054/2002 for the Organization of the Petroleum Market and other Provisions, published on the Government's Gazette A 230/2.10.2002
- Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport, published on the Official Journal of the European Union (2003) L 123/42
- Law 3423/2005 for the Introduction of Biofuels and Other Renewable Fuels to the Greek Market, published on the Government's Gazette 304/A'/13.12.2005

- Law 3468/2006 for the Generation of Electricity using Renewable Energy Sources and High-Efficiency Cogeneration of Electricity and Heat and Miscellaneous Provisions, published on the Official Gazette A 129/27.06.2006
- Law 3653/2008 for the Institutional Framework of Research and Technology and other Provisions, published on the Official Gazette 49/A/21-3-2008
- Law 3769/2009 for the Implementation of Equal Treatment for Men and Women regarding Access to and Supply of Goods and Services and other Provisions, published on the Official Gazette 105/A'/1.7.2009
- Law 3851/2010 accelerating the Development of Renewable Energy Sources to address Climate Change and other provisions in matters of competence of the Ministry of Environment, Energy and Climate Change, published on the Official Gazette 89/A/2010
- Law 4062/2012 for the Promotion of the Use of Energy from Renewable Sources (Integration of Directive 2009/28 / EC) - Sustainability Criteria for Biofuels (incorporation of Directive 2009/30 / EC), published on the Official Gazette 70/A/30.03.2012
- Joint Ministerial Decision 316/24.02.2012 adapting the National Legislation to the Directive 2009/30/EC in respect of the quality of Diesel and Petrol, published on Government's Gazette Issue B-501
- Ministerial Decision 184182/2016 for the Classification of Violations and Determination of a procedure for imposing final charges on compliance with Sustainability Criteria for Biofuels and Bioliquids and the Readjustment of the cap, published on Government's Gazette Issue 3278/B/12-10-2016
- Joint Ministerial Decision 175700/1442001 regarding the Sustainability System of Biofuels and Bioliquids, published on Government's Gazette Issue 1212/B/26-4-2016
- Ministerial Decision D3/A/152225/7.8.2013 by which a Technical Regulation was approved named as "Technical guidelines for the storage and distribution of biofuels in refineries and petroleum storage and distribution facilities", published on Government's Gazette Issue B 2055/23.8.2013

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APPENDIX 1

Table: Biofuels by Generation

Fuel	Feedstock	Energy Density (MJ/kg)	GHG CO_2 (kg/kg)	Notes
		First Generation		
Bioalcohol: -Ethanol -Propanol -Butanol	Starches from wheat, corn, sugar cane, molasses, potatoes, other fruits	**By Type:** 30 34 36.6	**By Type:** 1.91 N/A 2.37	
Biodiesel	Oils and fats including animal fats, vegetable oils, nut oils, hemp, and algae mixed with diesel	37.8	2.85	
Green Diesel	Made from hydrocracking oil and fat feedstock	48.1	3.4	Chemically identical to fossil fuel diesel
Vegetable Oil: -Castor Oil -Olive Oil -Fat -Sunflower Oil	Unmodified or slightly modified	**By Type:** 39.5 39 32 40	**By Type:** 2.7 2.8 N/A 2.8	
Bioethers	Dehydration of alcohols	N/A	N/A	These are additives to other fuels that increase performance and decrease emissions, particularly ozone
Biogas	Methane made from waste crop material through anaerobic digestion or bacteria	55	2.74 (does not take into account the direct effect of methane, which is 23X more effective as a GHG than CO_2)	Same properties as methane from fossil fuels
Solid Biofuels: -Wood -Dried plants -Bagasse -Manure -Seeds	Everything from wood and sawdust to garbage, agricultural waste, manure	**By Type:** 16-21 10-16 10 10-15 15	**By Type:** 1.9 1.8 1.3 N/A N/A	This category includes a very wide variety of materials. Manure has low CO_2, but high nitrate emissions.
		Second Generation		
Cellulosic ethanol	Usually made from wood, grass, or inedible parts of plants			
Algae – based	Multiple different fuels made from algae	Can be used to produce any of the fuels above,	See specific fuels above	More expensive, but may yield 10-100X more fuel

Biofuels		as well as jet fuel		per unit area than other biofuels
Biohydrogen	Made from algae breaking down water.	Hydrogen compressed to 700 times atmospheric pressure has energy density of 123	Does not have any greenhouse effect.	Used in place of the hydrogen produced from fossil fuels
Methanol	Inedible plant matter	19.7	1.37	More toxic and less energy dense than ethanol
Dimethylfuran	Made from fructose found in fruits and some vegetables	**33.7**		Energy density close to that of gasoline. Toxic to respiratory tract and nervous system
Fischer-Tropsch Biodiesel	Waste from paper and pulp manufacturing	37.8	2.85	Process is just an elaborate chemical reaction that makes hydrocarbon from carbon monoxide and hydrogen

Sources: http://biofuel.org.uk/what-are-biofuels.html and Polemis (2016)