Diffusion of a sustainable EU model to produce 1st generation ethanol from sweet sorghum in decentralised plants

Administrative Manual
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Tel. +39 0481 630750, fax +39 0481 60691

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2. FOREWORD

The bioethanol produced from sweet sorghum is sustainable in terms of environmental remarks and economic viability: the attributed GHGs emissions saving meets the European target to 2018 (i.e. higher than 60%) and the exploitation of by-products guarantees the economic viability also for decentralised small-medium plants (max 15,000 t/y).

In the current situation the EU bioethanol market is controlled by big industrial groups and large agricultural cooperatives of the sugar and alcohol industries and mainly cereals are processed in big plants (100,000-200,000 t/y). This situation is due to some relevant barriers: economical, logistical, ecological, environmental, social and dissemination barriers.

The SWEETHANOL project, supported by the Intelligent Energy program of the European Commission, is aimed to change the current situation concerning the raw material diversification, decentralisation and development of energy chain using sweet sorghum, which can be grown in the southern regions of the EU.

The absence of know-how about the potentialities of sweet sorghum as energy crop, to produce sustainable bioethanol and other energy commodities in decentralised plants, has been overcome through a widespread discussion of the main technical and non-technical aspects with the market players. Furthermore, this pathway is going to be completed through the training of the stakeholders.

This administrative manual completes the “Sweethanol – Technical manual”, where the main details of the chain to process sweet sorghum in bioenergy (i.e. bioethanol, electricity, heat) are explained.

On the contrary, the “Sweethanol – Administrative manual” is especially aimed to provide data and basic information to start up new entrepreneurships in this bioenergy chain for the specific situations of Italy, Greece and Spain: especially the national laws are deepened and also the related incentive systems for the RES, the authorisation processes and the eventual persistent non-technical barriers, which must be overcome. The treatment is integrated with a summary of the EU model to produce bioenergy from sweet sorghum to define briefly the scenario.

The English version can be available for the not-participant countries, where sweet sorghum can be grown (e.g. Romania, Bulgaria, France, Portugal, Croatia, Hungary) in order to increase the transferability of the project’s outcomes in southern EU regions.

The text of the “Sweethanol – Administrative manual” was produced by Michela Pin, Denis Picco and Alessia Vecchiet (CETA – Centre for theoretical and applied ecology, Italy), Oscar León, Paloma González, Roberto Marcos and Anabel Elisa Ruiz (Foundation Cartif – Technological centre, Spain), Kostas Konstantinou, Iakovos Sarigiannis, Irene Tsakiridou and Nikos Remvos (REACM – Regional energy agency of Central Macedonia – Anatoliki S.A., Greece), Luca D’Apote and Luisa Daidone (INIPA – Coldiretti, Italy), Marina Sanz Gallego, Maria Hernandez Sanz and Mª Dolores Curt (ADABE – Association for the diffusion of biomass, Spain), Athanasios Bartsios, Migdalia Prodromos and Tsimpos Ioannis (Agricultural co-operative of Halastra, Greece).

We wish to acknowledge the contributions of all the writers and funding agencies for their co-operation.

31st October 2011

Michela Pin – Project Manager
CETA, Italy

Alessia Vecchiet
CETA, Italy

Denis Picco
CETA, Italy
3. LIST OF ACRONYMS AND ABBREVIATIONS

AENOR Spanish association for normalization and certification

B30 biodiesel 30% v/v blend

Bio-ETBE ethyl-ter-butyl-ether obtained from bioethanol

Bio-SPK bio-derived synthetic paraffinic kerosene

BOD$_5$ biochemical oxygen demand

CCHP combined cooling, heat and power production

CH$_4$ methane

CHP combined heat and power production

CO carbon monoxide

CO$_2$ carbon dioxide

COD chemical oxygen demand

CRES centre for renewable energy sources (Greece)

db dry basis

DDG distillers dried grains

DDGS distillers dried grains with solubles

E10 bioethanol 10% v/v blend

E15 bioethanol 15% v/v blend

E85 bioethanol 85% v/v blend

E90 bioethanol 90% v/v blend

EC European commission

EIA environmental impact assessment

ETEAN national fund for entrepreneurship and development (Greece)

EU European Union

FIT feed in tariff

GDP gross domestic product

GHGs green house gases

H$_2$ molecular hydrogen

H$_2$S sulphidric acid
HRT  hydraulic retention time
HVO  hydro-treated vegetable oil
IEE  intelligent energy europe programme
ILUC indirect land use change
IPPC  integrated pollution prevention and control
LCA  life cycle assessment
LCFS low carbon fuel standard (US, California)
LHV  low heating value
LPG  liquid petroleum gas
LUC  land use change
MATIMT  Italian ministry of the environment, protection of the territory and sea
MIPAAF  Italian ministry of agriculture and forestry
MON  motor octane number
MSE  Italian ministry for economic development
MSW  municipal solid wastes
MTBE methyl-ter-butyl-ether
N₂ molecular nitrogen
N₂O  nitrous oxide
NAP  national action plan
NEC  national energy commission (Spain)
NOₓ nitrogen oxides
NREAP  national renewable energy action plan (Greece)
O₂ molecular oxygen
ORC  organic Rankine cycle
PANER  national action plan of renewable energies in Spain
PER  national plan of renewable energies (Spain)
R.A.E. regulatory authority for energy (Greece)
RED  renewable energy directive, 2009/28/EC
REP  renewable energy plan
RES renewable energy sources
RFS renewable fuel standard (US)
RFS2 renewable fuel standard 2 (US)
RON research octane number
SMEs small medium enterprises
toe tons of oil equivalent
TRPF toothed roller pressure feeder
VOC volatile organic compounds
v/v volume/volume
w/w weight/weight
4. SWEETHANOL PROJECT

SWEETHANOL is a project financed and supported by the European Commission in the ambit of the program IEE-II 2009 (Intelligent Energy Europe), action “ALTENER” – New and Renewable Energies sources.

It is a project related to the diffusion of a sustainable EU model to produce bioethanol and other energy commodities from sweet sorghum in decentralised plants. The project is organised in the following actions:

- know-how refining about the bioethanol production from sweet sorghum. The more interesting data (e.g. investment costs, energy consumption, production costs, bioethanol yield, by-products exploitation) are collected visiting the agricultural research institutes, the plant construction companies and the existing plants;

- sustainable model discussion of the EU model with representatives of each chain player. The chain players (i.e. farmers, agricultural associations, fuel processors, SMEs, seeds and agricultural companies, investors, policy makers and public authorities representatives, energy agencies) are engaged in an EU model discussion through sectorial and intersectorial workshops at national and international level;

- chain actors training through tailor-made courses per categories of chain actor;

- creation and management of the online community (i.e. “Esse community”, link: http://esse-community.eu/), a virtual place where all the chain actors may create the network in order to share and gather information about the sweet sorghum bioethanol chain: articles, info about events, blog, forum, social network, teleconferences and reputation management are performed.

The project covers the following priority activities:

- encouraging market players in the bioethanol supply chain to increase the economic competitiveness and environmental sustainability of the biofuel itself;

- supporting and promoting the application of sustainability criteria for bioethanol;

- addressing the issues under discussion in the current debates on land use and sustainability;

- facilitating and promoting the well-informed debate and the balanced attitude among decision makers and the general public.

The main objectives of the project are:

- know-how diffusion about the sustainable EU model

The sustainable EU model is shared among the chain actors which accept it through the discussion of the technical, logistic, economic, financial, energetic, environmental and administrative aspects and it will be widely spread by each target group. Consequently, as market players, they are encouraged to start up new entrepreneurship to increase the economic competitiveness and at the same time the environmental sustainability of bioethanol. The changes in the bioethanol market are the enhanced raw material diversification, decentralisation of the production and sustainability of bioethanol (mainly as GHGs saving). The proposed wide discussion about the production of bioethanol using sweet sorghum contributes to address the current debates on land use and sustainability and to facilitate and promote a well-informed discussion and a balanced attitude amongst decision makers and the general public.

- daily updating through the network building and the supply chain co-ordination

Through the “Esse Community” the market players are able to count on daily updating of the legislative, administrative and technical aspects related to the bioethanol production and market (in general, and specifically using sweet sorghum). The daily offered updated service simplifies the market analysis necessary for the start up of new entrepreneurship;
consequently the diversification of the bioethanol market is stimulated and the market centralisation among few numbers of chain actors is contrasted. Moreover, the network building contributes to address the issues under discussion in the current debates on land use and sustainability and to facilitate and promote a well-informed debate and a balanced attitude amongst decision makers and the general public.
5. SWEETHANOL PARTNERSHIP

CETA – Centre for theoretical and applied ecology - Italy
CETA was created in 1987 in Gorizia (Italy) and is a non-profit association which carries out research, applied experimentation and innovative technology development in four areas: environment such as sustainable management of environmental and natural resources (water, soil, landscape) and environmental balances and models of environmental accounting; energy such as promotion and diffusion of renewable energy technologies (biomass, biogas, biofuels, solar energy – photovoltaic, geothermal, hydroelectric), energy efficiency, energy planning, analysis and models of territory management, costs-benefits and multi-criteria analyses; territory such as strategic planning and programming, government of the territory (large area and local level), studies of environmental impacts and strategic environmental evaluation, and knowledge such as experimentation of production and innovation models for fuel biomasses and biofuels of 2nd and 3rd generation, research and development of energy crops with low environmental impact for energy production. CETA carries out its own multidisciplinary activities employing high-degree professionals such as engineers, agronomists, biologists, naturalists, economists, architects.

Foundation CARTIF – Technological centre - Spain
CARTIF was created in 1994 as the Automation, Robotics, Information and Manufacturing Technology Centre, a non-profit association focused on applied research and based in Boecillo Technology Park, Valladolid (Spain). From October 2005, CARTIF is legally established as a Foundation keeping its main goals: identifying technology needs and developing R&D-based knowledge, supporting technological innovation in Industry mainly among SMEs and disseminating R&D and innovation results.

REACM– Regional energy agency of Central Macedonia – Anatoliki S.A. - Greece
Region of Central Macedonia and Local Development Agency - Anatoliki S.A. established REACM in 1997, through the European Union’s SAVE programme. The main activities include: data acquisition for energy production and consumption in the region, support to the region’s local authorities in energy policy planning, dissemination activities for RES and RUE technologies, training and education, mobility management on municipal level, promotion of biofuels, support to local industry, SMEs & commercial, pilot application of EMAS in heavy industries in Thessaloniki, training of personnel in industrial sector in ECO-Energy audits, promotion of RES technologies to the agricultural sector, definition of REP, collaboration with neighbouring countries in energy savings, participation in regional planning for development and management of geothermal fields.

INIPA- Coldiretti - Italy
INIPA is the research, training and development National Department for agri-food, environmental and services sectors of Coldiretti (The National Confederation of Farmers - Italy), and it is a legally recognized non-profit organization. It is a unitary structure distributed throughout the country, with associated institutes at regional level and territorial divisions. INIPA promotes, organizes and participates (in partnership with leading agencies at both National and European Community level) in research, scientific information and training for farmers, organizations and territories pointing out the results in favour of the continuous innovation of the agri-food system.

ADABE – Association for the diffusion of biomass - Spain
ADABE is a national association, no-profit, founded in 1986 according to the Directorate General of Domestic Policy of the Ministry of Interior. It is a founding member of AEBIOM
based in Brussels, founded in 1990. It brings together individuals and entities involved in re-
search, technology and/or dissemination of the use of biomass in Spain.

**Agricultural co-operative of Halastra - Greece**
The major activities of the agricultural co-operative of Halastra include: services related to
agricultural products (e.g. rice, corn, cotton, wheat, cereals), collection, drying and storage
of agricultural products, sale of agricultural supplies, sale of agricultural products on behalf
of the members of the association, retail of agricultural goods, rice packaging and trade.
6. GUIDELINES FOR THE EU MODEL TO PROCESS SWEET SORGHUM AS ENERGY CROP

In accordance with the objectives of the SWEETHANOL project, some indications obtained through the discussion with the stakeholders are summarised in the following guidelines, which are the starting point for the technical-economic feasibility studies of each new entrepreneurship.

These guidelines have a value at the EU scale, because they derive from an opened comparison with the contributions of the Italian, Greek and Spanish stakeholders and researchers. In this manual the guidelines are reported in order to define the reference scenario, in which the non-technical data and information must be placed.

Further widening are available in the “Sweethanol – Technical manual”, where these guidelines are applied in some case studies at national scale in Italy, Greece and Spain, in order to complete their treatments also with the economic analyses and the GHGs emissions savings calculation.

6.1 Introduction

Sorghum is a multipurpose crop, because it is able to supply large yields in biomass, sugar and grain depending on the chosen varieties.

At the present time the sweet sorghum varieties supply mainly biomass and sugar, whereas its potentiality as grain crop is not yet expressed.

Many agricultural researches are aimed to overcome this limit, selecting hybrids with high yields in biomass, sugar and grain at the same time. In order to actually express all the potentialities of the crop, other agricultural researches are directed to optimize the harvesting operations, separating all the products, biomass and sugar on one hand, grain on the other hand.

Since these researches are not yet finished, the model to process sweet sorghum foresees the exploitation of sugars and lignocellulosic biomass.

In accordance with scheme reported in Figure 1, the sweet sorghum biomass is crushed and sugar juice is processed in bioethanol.

![Figure 1: scheme of the plant to process sweet sorghum in bioethanol and energy commodities](image-url)
Bagasse, which is the lignocellulosic residue of the crushing unit, is dried and burnt in CHP plant to supply electricity and heat.

Vinasse, which is the residue of the distillation and rectification unit, is a feedstock for the anaerobic digestion using other substrates, such as for example manure, as microbial inoculum, if necessary. The obtained biogas is purified and burnt in CHP plant to supply electricity and heat.

The explained process can be applied in new plants, which are designed on purpose to use only sweet sorghum as feedstock, or can be implemented in pre-existing plants as new production line, which is parallel or complementary to the lines for other feedstock.

**Topic: Sweet Sorghum as Bioenergy Crop**

The species Sorghum has a wide range of genotypes: 4,000 varieties have been identified. The identified varieties can be traced to the following groups:

- **grain sorghum:** usually dwarf varieties (50-80 cm high), which are grown for grain. Grain sorghum is the 4th most important cereal crop in the world after wheat, rice and maize;
- **forage (or fodder) sorghum:** varieties used primarily as silage for livestock due to their high protein and fiber content;
- **fiber sorghum:** tall, fine stemmed and rich in cellulose and hemicellulose varieties;
- **sweet sorghum:** varieties with thick and long stalks and high content of sugars in the stem, mainly sucrose, which are easily fermentable into bioethanol.

Sweet sorghum is the most interesting variety for processing in bioenergy, because its yields in biomass, sugars and bioethanol altogether are higher than the yields of the other groups. Sweet sorghum can be grown in a very wide range of soils and climates:

- **soils:** although best yields are obtained from fertile, deep and well drained soils, it could be cultivated in worse soil conditions, shallowness or in soils with low organic matter content. The pH range of soils where sorghum can grow well is also wide (5.0–8.5). Furthermore it has good water stress resistance, it is water-lodging tolerant and shows a good adaptability to saline and alkaline soils. This wide adaptability allows sweet sorghum to be grown where other crops could not be cultivated;
- **climates:** tropical, sub-tropical and temperate regions.

The agricultural requirements of sweet sorghum depend on the soils and climates:

- **water:** under Mediterranean conditions, sweet sorghum needs to be irrigated, but its water use efficiency is very high: the quantity of water is only 1/3 than the amount required by sugarcane, almost 2/3 than sugar beet and 1/2 than maize. In the temperate regions rainfall is usually sufficient to obtain viable yields;
- **fertilisers:** sweet sorghum has relatively lower nitrogen requirements than other crops. In the Mediterranean and temperate climates, where soil fertility ranges from low to moderate, the fertilisation needs are of about: 100-150 kg N, 60-100 kg P₂O₅ and 60-100 kg K₂O per hectare. It is recommended a nitrogen application in two times: before sowing and 20-30 days after the emergence.

Sweet sorghum varieties have different length of the growth cycle:

- **short cycle varieties:** about 70 to 90 days from emergence to flowering in Mediterranean and temperate climates;
- **long cycle varieties:** about 110 days from emergence to flowering.

In the Mediterranean and temperate regions the sowing is from the end of April to the beginning of May. Cultivating varieties with short and long cycles in different fields, the duration of the harvesting period is at maximum 40 days in September-October.

The cultivation of sweet sorghum is mechanised, and the agricultural machinery of maize are utilised.
6.2 Dimensioning of the chain supply

In the creation of the EU model the capacity as anhydrous bioethanol obtained from the processing of sweet sorghum is assumed as criterion for the dimensioning of the chain supplying. Two elements are required in the assessment: the agricultural land cultivated with sweet sorghum and the range of supplying.

Agricultural land requirement

The required agricultural land depends on the yields of biomass and sugars, which are consequent for example to the kind of soil, the water availability, the climate, the grown variety. The main specificities have been traced to some reference scenarios in order to give an indicative value to the stakeholders (Table 1).

Agricultural land requirement

The required agricultural land depends on the yields of biomass and sugars, which are consequent for example to the kind of soil, the water availability, the climate, the grown variety. The main specificities have been traced to some reference scenarios in order to give an indicative value to the stakeholders (Table 1).

The reported ranges for the yields concern some different sweet sorghum varieties, currently available in the EU market.

Two different types of environment are analysed and in each one the conditions to ensure the economic viability are considered.

The cultivation of sweet sorghum in marginal lands is taken into consideration for contexts where the economic viability is guaranteed and the related yields correspond to the lowest values in the reported range for each type of environment.

Especially in the Mediterranean environments (i.e. South Italy, Spain, Greece) the cultivation of sweet sorghum without irrigation is excluded because the biomass yields are too low (2.4-4.6 t/ha db). In the temperate environments (i.e. North Italy) only the eventual emergency irrigation is considered because the rainfall during the growing period is usually sufficient (e.g. 670 mm in May-September 2010).

These data are the input to calculate the hectares which must be cultivated with sweet sorghum in order to supply the plant (whole, or just one production line, as appropriate), basing on its capacity. For each specific situation, the calculated surface could require a larger area, for example if rotations with other crops are proposed in the considered region in order to protect the soil fertility.

Range of supply

Concerning the distance between the plant and the fields, different evaluations must be integrated. The main elements are the impact of transport on the energy balance of the...
chain, the respect of specific limits to access to eventual national aids (e.g. short chain recognised for a maximum range of supply), the logistics consistent with the requirements of the farms (e.g. the necessary number of agricultural machinery, number of driven kilometres) and the plants (e.g. timing of supply during the harvesting) and with the impact of the consequent traffic in the considered area.

In order to give some indications for the range of supply and its repercussions, in Table 2 the details for two simulations are reported.

<table>
<thead>
<tr>
<th>Maximum range</th>
<th>Harvesting in 40 days</th>
<th>Agricultural machineries</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 km</td>
<td>4 parallel yards</td>
<td>4 mower-shredder-charger machines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 farm tractors</td>
</tr>
<tr>
<td>20 km</td>
<td>6 parallel yards</td>
<td>6 mower-shredder-charger machines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24 farms tractors</td>
</tr>
</tbody>
</table>

Table 2: results of two simulations for the supply of a plant with capacity 10,000 t/y as anhydrous bioethanol

In the model creation the dimensioning of the units for the by-products exploitation is based on the amounts of bagasse and vinasse, which are linked to the cultivated agricultural land and then to the assumed capacity as anhydrous bioethanol.

6.3 Processing of the sweet sorghum biomass to bioethanol

The technological sections for the production line of bioethanol are: the crushing unit, the fermentation unit, the distillation and rectification unit and the dehydration unit.

Crushing unit

The extraction of free sugars from the chopped biomass can be carried out through direct pressing using the rolling mills or through a lixiviation system.

In both processes the extraction is made using hot water (75-85 °C) in the ratio between feedstock and hot water of 1:0.1-1:1. The extraction yield is in the range 93-98%.

Comparing these options, the suggested technical solution is the extraction into horizontal or vertical power mills. The extraction principle is the application of high pressure, which is exercised by some couples of rollers (TRPF milling system): 3 couples in the small vertical crushers, up to 9 couples in the big horizontal ones. The speed of the top roller is usually 10-12 rpm in small mills, 6-8 rpm in large mills. In order to improve the extraction efficiency, the optimal addition of hot water is 10% w/w.

The working scheme of the crushing unit is reported in the following figure.

Apart from sugars, sweet sorghum juice contains soluble solids (e.g. anthocyanins and chlorophyll) and insoluble solids (e.g. starch granules). These components must be separated to process the sugar juice to bioethanol. Good quality juice can be obtained after carrying out evaporation with continuous skimming.
**Topic: Production of Bioethanol**

The bioethanol production is based on the alcoholic fermentation carried out by microorganisms in controlled conditions. The correspondent chemical reaction is described as follows:

\[ \text{C}_6\text{H}_{12}\text{O}_6 + \text{H}_2\text{O} \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2 + \text{H}_2\text{O} \]

Although the fermentation is the core of the production, the complete processing depends on the kind of raw material: free sugars are directly fermentable, whereas polysaccharides require a previous hydrolysis.

Furthermore, the complexity of the hydrolytic step depends on the kind of polysaccharides: free sugars can be easily obtained from starch, whereas cellulose and hemicellulose are structural carbohydrates, strongly linked to lignin, and then their hydrolysis is more difficult.

Basing on the converted raw materials and then on the complexity of the implemented technology, bioethanol is considered as a 1\(^{st}\) generation biofuel, a 2\(^{nd}\) generation biofuel or a 3\(^{rd}\) generation biofuel:

1\(^{st}\) generation: converting sugar and starch matters
2\(^{nd}\) generation: converting lignocellulosic crops (e.g. giant reed)
3\(^{rd}\) generation: converting lignocellulosic residues (e.g. straw, MSW).

The kinds of processing are briefly summarised in:

**Sugar matter:**
1. extraction of free sugars from biomass
2. fermentation
3. distillation and rectification
4. dehydration

At the end of the processing 1\(^{st}\) generation anhydrous bioethanol is produced.

**Starch matter:**
1. enzymatic hydrolysis: liquefaction with alpha-amylase and saccharification with glucoamylase
2. fermentation
3. distillation and rectification
4. dehydration

At the end of the processing 1\(^{st}\) generation anhydrous bioethanol is produced.

**Lignocellulosic matter:**
1. pre-treatment to separate lignin from the structural polysaccharides
2. enzymatic hydrolysis: endocellulase, exocellulase, hemicellulase
3. fermentation of C6 sugars (e.g. glucose)
4. fermentation of C5 sugars (e.g. xylose)
5. distillation and rectification
6. dehydration

At the end of the processing 2\(^{nd}\) generation bioethanol is produced, if lignocellulosic crops have been processed, and in alternative 3\(^{rd}\) generation bioethanol is produced, if lignocellulosic residues have been converted.
of coagulated materials, which have risen to the surface. Evaporation should be done with uniform heating. Initially, coagulation starts when juice temperature increases. This scum should be removed during slow heating. Evaporation should not be done fast as scum gathered on the top of the juice may get dissolved during rapid boiling and then floating or settled mass problems may be seen in the syrup.

Fermentation unit
The fermentation is carried out by yeasts (Saccharomyces cerevisiae) at the conditions which favour firstly their quick cell growth and division and afterwards their anaerobic metabolism. Especially the following conditions are required:
- glucose concentration > 9 g/l (in order to benefit from the Crabtree effect and to ensure the alcoholic fermentation instead of the oxidative metabolism);
- pH 4-5;
- temperature in the range 30-35 °C;
- nitrogen concentration 150-180 mg/l (as ammonium).

The fermentation unit has five sections.
1. Pasteurisation of sugar juice: in order to avoid unchecked fermentations by bacteria, sugar juice is sterilised through the pasteurisation at 100 °C for 30 minutes.
2. Preparation of yeasts: yeasts are rehydrated and stabilized in order to obtain the suspension in the mother tank. This step is carried out with a solution rich in glucose, fructose or sucrose, an average temperature of 35 °C and with the addition of bactericide, oxygen and eventually ergosterol. At the beginning of each fermentation reaction, an amount of the mother suspension is flowed as inoculum in the fermentation tank.
3. Fermentation: it can be applied in a in batch process or in a continuous one.
   - In batch fermentation: the fermentation reactions are performed in independent reactors without direct communications among them. The bioethanol yield of this process depends on the tolerance of yeast to the alcoholic concentration in the medium (maximum tolerance 19% v/v for especially selected strains). Although in this process the yield is lower than the yield of the continuous one, the control of contaminations is better and consequently the security is higher because this system allows an easy isolation of the contaminated tank, preventing that it can extend throughout all the unit.
   - Continuous fermentation. The continuous process is set up, flowing the pasteurised sugar juice only to the first tank where yeasts is inoculated. From the first tank the partially fermented juice flows to the following ones; in this transit bioethanol is removed and its concentration in the medium maintains inferior to the inhibition level of yeasts. Then the fermentation by degrees continues until the last tank, where all the free sugars are converted in bioethanol. The yield of this process is higher than the yield of the in batch one, because yeasts are not inhibited. Furthermore, the necessary capacity is less than the volume required by the other one. The main criticism is the contamination risk: in fact, if one of the continuous tanks is contaminated with bacteria, the total system can be contaminated and the decontamination is more difficult.
4. **Recovery of yeasts.** The recovery of yeasts at the end of the fermentation process is a measure to increase the economic viability of the plant. Yeasts are recovered from the fermented medium through centrifugation. If yeasts are yet vital, they are reused in the fermentation process. If yeasts have finished their own lifetime, they are a source of proteins for the preparation of human and/or animal feed.

**Distillation and rectification unit**

The bioethanol concentration in the fermented medium is 9-14% v/v and the objective of this unit is to obtain the azeotropic bioethanol (i.e. 95-96% v/v).

At this aim the fermented medium flows through some distillation columns (i.e. multiple effect distillation) made of bubbling dishes, where water and alcohol are separated basing on their own specific boiling points as they run up the tower. The multiple effect technology allows to reduce the heat consumption of this unit, because the pressure on the column head is lower than the atmospheric value and the boiling point of the components to separate is inferior.

**Dehydration unit**

The dehydration process is necessary to produce anhydrous bioethanol (i.e. 99.7-99.8% w/w). This value of purity is required to produce bio-ETBE or to blend bioethanol directly with petrol. The dehydration unit is based on the molecular sieve technology: zeolite, which is the component of the sieves, retains selectively the residual water molecules, increasing gradually the percentage of bioethanol in the flowing blending.

Anhydrous bioethanol must be stored in tanks with controlled atmosphere (free of air, usually with N₂ or CO₂), in order to avoid the solubilization of water vapour.

The same conditions must be applied in the transport phase.

**6.4 Energetic exploitation of the by-products**

**Bagasse**

Basing on its own characteristics (Table 3), the dried bagasse, residue of the crushing unit, can be burnt in CHP plant to produce electricity and heat.

The size of the CHP plant is correlated to the bagasse availability and then to the agricultural surface cultivated with sweet sorghum and to its biomass yield.

Considering the biomass yields reported in Table 1 and the LHV of Table 3, the reference values in order to design the unit for the combustion of bagasse in CHP plant are reported in Table 4.

As regards with the technical details of the CHP plant, it is kitted out with a biomass burner, suitable to the combustion of herbaceous feedstock, and a turbine, which could be for example a steam turbine based on the Rankine-Hirn cycle, a gas turbine based on the Brayton cycle, or a turbogenerator based on the ORC cycle.

The choice of the technology for the CHP plant depends mainly on the electric power.

<table>
<thead>
<tr>
<th>Bagasse characterisation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture after crushing</td>
<td>30-50%</td>
</tr>
<tr>
<td>Residual sugars</td>
<td>6-7% db</td>
</tr>
<tr>
<td>Cellulose</td>
<td>16-18% db</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>11-13% db</td>
</tr>
<tr>
<td>Lignin</td>
<td>7-9% db</td>
</tr>
<tr>
<td>LHV</td>
<td>17-18 MJ/kg db</td>
</tr>
<tr>
<td></td>
<td>4.7-5.0 kWh/kg db</td>
</tr>
</tbody>
</table>

*Table 3: main characteristics of sweet sorghum bagasse to plan its energetic exploitation*
Figure 3 summarises some situations for the power values in the range interesting for the EU model (0.1-10 MWe) with the related energy efficiency.

The main criticism of sorghum bagasse combustion is the high content in ashes (3-5% db), which are characterised by a low melting point. Consequently, the technology applied in the biomass burner requires an adequate ash removal system and the special extended warranty must be issued by the manufacturer. The management of ashes depends on the law of the specific country.

Vinasse

Vinasse, residue of the distillation and rectification unit, has a chemical composition which is suitable for the production of biogas through anaerobic digestion (Table 5).

The dimensioning of the anaerobic digester is linked to the vinasse availability, to the capacity as anhydrous bioethanol and then to the HRT.

Concerning the vinasse yield, the theoretical correlation coefficient is 7-8 litres of vinasse per litre of bioethanol.

As regards with the HRT to complete the biomethanation, it depends on the chemical composition of the feedstock: as a principle, lignin, cellulose and protein show a slower degradation than fats, starch and sugars. The methanogenesis of vinasse is carried out using also other substrates to start up and/or stabilise the process: for example manure is utilised as microbial inoculum at the beginning.

<table>
<thead>
<tr>
<th>Type of environment</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type MEDITERRANEAN</strong></td>
<td></td>
</tr>
<tr>
<td>Low fertility soils</td>
<td>Bagasse yield: 6-20 t/ha db</td>
</tr>
<tr>
<td>Dry climate</td>
<td>Available energy: 100-130 GJ/ha</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type TEMPERATE</strong></td>
<td></td>
</tr>
<tr>
<td>Medium fertility soils</td>
<td>Bagasse yield: 10-12 t/ha db</td>
</tr>
<tr>
<td>Temperate oceanic climate</td>
<td>Available energy: 190-200 GJ/ha</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bagasse yield: 18-25 t/ha db</td>
</tr>
<tr>
<td></td>
<td>Available energy: 312-442 GJ/ha</td>
</tr>
</tbody>
</table>

Table 4: main elements for dimensioning the unit of bagasse exploitation in some reference type of environments

Figure 3: application fields of the different cogeneration systems

<table>
<thead>
<tr>
<th>Vinasse characterisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
</tr>
<tr>
<td>Volatile matter</td>
</tr>
<tr>
<td>BOD₅</td>
</tr>
<tr>
<td>COD</td>
</tr>
<tr>
<td>Nitrogen</td>
</tr>
<tr>
<td>Phosphorous</td>
</tr>
<tr>
<td>pH</td>
</tr>
</tbody>
</table>

Table 5: main characteristics of vinasse to plan the anaerobic digestion
of the process and lignocellulosic feedstock can be mixed to vinasse to improve the ratio between carbon and nitrogen, if necessary. In this hypothesis the HRT for vinasse is 60 days approximately.

The typical chemical composition of biogas is reported in Table 6.

The theoretical methane yield is 0.395 Nm³ per kilogram of COD, if the content of methane in biogas is 60%.

Assuming the yields in vinasse and methane and the values of Table 5 and Table 6 for COD and LHV respectively, the elements to dimension this unit are summarised in Table 7.

The obtained biogas is burnt in a CHP plant which is based on a Diesel engine or on a gas microturbine.

The utilised Diesel engine requires some modifications in order to work with the Otto cycle in the combustion of methane: it is fitted out especially with a carburettor and the spark plugs. At the present time these modified engines are already available on the market. Heat is recovered through an exchanger from the flue gases and/or from the engine cooling.

The energy efficiency is correlated with the electric power of the CHP plant: in the range considered for the EU model (0.1-5.0 MWe) the electrical efficiency is 30-42%, the thermal efficiency is 45-50%. The highest powers are characterised by the most efficiency above all in the electric conversion.

The digested matter, residue of the biomethanation, is a good fertiliser (nitrogen 800 g/t, mainly as ammonium) and it is applied in the fields in order to compensate the removal of sweet sorghum.
**Topic: Bioethanol and Bio-ETBE**

Bioethanol is ethylic alcohol used as transportation fuel and derived from the alcoholic fermentation of free sugars, such as glucose, sucrose, fructose, or hydrolysed polysaccharides, such as starch, cellulose, hemicellulose, fructans (i.e. inulin).

Basing on its own characteristics bioethanol is suitable to feed the Otto engines instead of petrol:
- the LHV is high: 27 MJ/kg
- the MON and RON values allow an effective combustion control during the compression in the piston: MON 96, RON 130, octane number (i.e. average between MON and RON) 113.

Alternatively bioethanol can be converted in bio-ETBE, which is an antiknock compound usable in the Otto engines instead of MTBE:
- the LHV is high: 35 MJ/kg
- the MON and RON values indicate a good behaviour as antiknock compound: MON 102, RON 118, octane number (i.e. average between MON and RON) 110.

Bioethanol contributes to reduce the GHGs emissions from the transport sector because it derives from biomass and not from fossil sources; consequently the balance between carbon sink and emission is like zero.

Bio-ETBE is considered GHGs neutral only for the fraction of the molecules deriving from biomass: 47% w/w.

The main raw materials converted in bioethanol are:
- sugar matter: sugarcane, sugar beet, sweet sorghum, molasses, marc
- starch matter: grain of cereals, potato, sweet potato, cassava
- lignocellulosic matter: giant reed, straw, maize stalks, organic fraction of the MSW.

Basing on the converted raw materials and then on the complexity of the implemented technology, bioethanol is considered as a 1st generation biofuel, a 2nd generation biofuel or a 3rd generation biofuel:
- 1st generation: converting sugar and starch matters
- 2nd generation: converting lignocellulosic crops (e.g. giant reed)
- 3rd generation: converting lignocellulosic residues (e.g. straw, MSW).
7. THE EU STRATEGIES FOR BIOFUELS AND RES

The interest of the EC in the utilisation of RES in transport, electricity and heat sectors is testified by numerous Directives. For reasons of synthesis, this chapter is aimed to collect only the main documents about the transport sector, because the considered chain is aimed above all to satisfy the increasing demand of biofuels in the EU.

The European biofuels market has enjoyed excellent EC support by way of the Kyoto agreement as well as Directives 2003/30/EC and 2003/96/EC, which are specifically aimed to promote the increased use of biofuels and set indicative targets for their use in the transport industry.

The Directive 2003/30/EC of 8th May 2003 “on the promotion of the use of biofuels or other renewable fuels for transport” laid the foundation for the promotion of alternative fuels in the EU. In particular, it specified that Member States should ensure that a minimum share of biofuels and other renewable fuels is placed on the market and, to that effect, shall set national indicative targets.

Reference values for these targets were given, as calculated on the basis of energy content, namely:
- 2% of all petrol and diesel for transport purposes placed on their markets by 31 December 2005;
- 5.75% of all petrol and diesel for transport purposes placed on their markets by 31st December 2010.

The Directive aimed at increasing the share of renewable energy in the transportation sector (currently dominated almost entirely by fossil fuels) and reducing emissions of CO₂, CO, NOₓ, VOC and other particles harmful to human health and the environment.

In accordance with this Directive, the different types of biofuels are as follows: bioethanol, biodiesel (diesel-quality methyl ester produced from biomass or used vegetable oils and used as biofuel), biogas (fuel gas produced from biomass and/or waste by anaerobic fermentation, purified to natural gas quality), biomethanol, bio-dimethyl-ether, bio-ETBE, bio-MTBE, synthetic biofuels (synthetic hydrocarbons or mixtures of synthetic hydrocarbons produced from biomass), biohydrogen, and oil produced from oil plants by pressing, extraction or comparable procedures, crude or refined but chemically unmodified, when compatible with the type of engines involved and the corresponding emission requirements.

Biofuels may be made available in any of the following forms:
- as pure biofuels or at high concentration in oil derivatives, in accordance with quality standards for transport applications;
- as biofuels blended in mineral oil derivatives, in accordance with the appropriate European norms describing the technical specifications for transport fuels (EN 228 and EN 590);
- as liquids derived from biofuels, such as bio-ETBE where the percentage of biofuel is 47% w/w.

The Directive 2003/96/CE of 27th October 2003 has been focused mainly on the tax applied over the biofuels. This Directive modified the Community Tax for the energetic products and power. In this Directive the following aspects have been established:
- art. 16.1: the Member States can apply the exemption or reduced tax over the biofuels;
- art. 16.3: the exemption or reduction of the tax can be modulated in function of the evolution of the price of the raw materials;
- art.16.5: the application period is of six years, although this period can be prorogued until before 31/12/2012.

This Directive allowed applying the exemption or reduction of the tax since 1st January 2003 (art. 28.2)

The Directive 2009/28/EC of 23rd April 2009 indicates an updated objective for the reduction of the GHGs emissions in the transport sector:
- 10% of the final consumption must be covered with RES within 2020.

Furthermore, the RED introduces for the first time a reduction target for the GHGs emissions from biofuels:
The GHGs emissions saving due to the use of biofuels shall be at least 35%:
- with effect from 1\textsuperscript{st} January 2017, the GHGs emissions saving from the use of biofuels shall be at least 50%:
- from 1\textsuperscript{st} January 2018, the GHGs gas emissions saving shall be at least 60% for biofuels produced in installations in which production started on, or after, 1\textsuperscript{st} January 2017.

These goals have been combined with specific sustainability requirements for biofuels, in response to controversy surrounding their environmental impact, the price of foodstuffs and the loss of biodiversity. All the biofuels that do not offer the minimal GHGs emissions saving (e.g. 35% at the present time), when their whole LCA is considered compared to petrol or diesel will not be included in the goals and will not grant public aid.

Furthermore, the RED takes pains to list the types of land that must not be planted with biofuels crops, namely natural forests, protected areas, wetlands and peat bogs.

The RED includes the “standard default values” for the main biofuels (Annex V, Part A). The calculation includes CO\(_2\), CH\(_4\) and N\(_2\)O, which are both more powerful GHGs than CO\(_2\).

The Member States must notify to the EC of the geographic areas where the mean GHGs emissions savings by biofuel crop type are lower than these standard values.

Besides the RED specifies the method to calculate the GHGs emissions saving in the specific cases, when the standard default values can not be used (Annex V, Part C).

In order to certify the sustainability of biofuels, the introduction of voluntary certification systems could also guarantee data compliance with sustainability criteria. On 27\textsuperscript{th} May 2011 the EC officially recognised the first seven voluntary certification schemes: “Greenenergy Brazilian Bioethanol Verification Program”, “Bonsucro EU”, “Abengoa RED Bioenergy Sustainability”, “Roundtable of Sustainable Biofuels EU RED”, “International Sustainability and Carbon Certification”, “Biomass Biofuels Voluntary Scheme”.

Furthermore the RED indicates that the development of the RES must be united to the increase of the energy efficiency as an aim for reducing the GHGs emissions in the EU. In fact the increase of 20% in the energy efficiency from now to 2020 is another essential objective of the RED.

Further objectives and applications of the RED are the following:
- to establish a common framework for the promotion of the energy obtained by RES;
- to fix the obligated national objectives related to the energy production from RES in the final consumption of the energy and related with the renewable energy for the transport;
- to establish the norms of statistics transference among the Member States, the common projects among the Member States and with outside, the origin guarantees, the administration procedures, information and formation and the access to the power net for the renewable energy.

The Directive 2009/30/EC of 23\textsuperscript{rd} April 2009 aims at improving air quality and reducing GHGs emissions through environmental standards for fuel. It will also facilitate the more widespread blending of biofuels into petrol and diesel and, to avoid negative consequences, set ambitious sustainability criteria for biofuels.

The revised Directive indicates that by 2020 fuel suppliers must decrease by 6% climate-harming emissions over the entire LCA of their products. This can be reached in particular by admixing biofuels to petrol and diesel as well as by improving production technology in refineries. Member States may require an additional 4% reduction from fuel companies, achieved through the supply of energy for electric vehicles or other clean technologies, including carbon credits from third (so-called “Clean Development Mechanism”).

To enable these GHGs emissions cuts, petrol may have higher biofuel content. From 2011, petrol may contain up to 10% (v/v) bioethanol. In order to avoid damage to old cars, however, fuel with 5% (v/v) bioethanol will continue to be available until 2013, with the possibility for Member States to extend that period.
**Topc: The EU Sustainability Criteria for Biofuels in Accordance with the RED**

The sustainability is required equally to biofuels produced in the EU and to the imported ones.

Furthermore, only the sustainable biofuels are counted to reach the target to 2020 and can benefit from eventual national incentives.

The sustainability of biofuels is ensured complying with all of the following criteria:

1. GHGs emissions saving attributed to each biofuel shall be at least 35% since 2012, 50% since 2017, 60% since 2018;

2. biofuels shall not be made from raw materials obtained from land with high biodiversity value, namely land that had one of the following statutes in or after January 2008, whether or not the land continues to have that status:
   - primary forest and other wooded land, named forest and wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed;
   - areas designated:
     - by law or by relevant competent authority for nature protection purposes;
     - for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature, subject to their recognition;
   - unless evidence is provided that the production of that raw material did not interfere with those nature protection purposes;
   - highly biodiverse grassland that is:
     - natural, named grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes;
     - non-natural, named grassland that would cease to be grassland in the absence of human intervention and which is species-rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status;

3. biofuels shall not be made from raw material obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008 and no longer has that status:
   - wetlands, namely land that is covered with or saturated by water permanently or for a significant part of the year;
   - continuously forested areas, namely land spanning more than one hectare with trees higher than five meters and a canopy cover of more than 30%, or trees able to reach those thresholds in situ;
   - land spanning more than one hectare with trees higher than five meters and a canopy cover of between 10% and 30%, or trees able to reach those thresholds in situ;

4. biofuels shall not be made from raw material obtained from land that was peatland in January 2008, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil.
The Directive also incorporates the same environmental and social sustainability criteria for biofuels as in the Directive 2009/28/EC. It imposes limits on the content of sulphur and metallic additives in engine fuel. Finally, the maximum vapour pressure of fuel is also prescribed in order to minimise emissions of volatile air pollutants. The revised environmental quality standards as well as the sustainability criteria for biofuels are applied since 2011.

Member States are required to transpose the Directive into national law by the end of 2010. A recent document of the EC (i.e. Accompanying document to the Communication from the Commission to the European Parliament and the Council {COM(2011)31 final} of 31st January 2011) has assessed the national financing of RES in the Member States and the European strategies to achieve the target to 2020. The situation for the national financing is reported in Table 8.

In the transport sector a mixture of instruments is used to support the development of RES, chiefly biodiesel and bioethanol. Quota systems require the use of biofuels for a given fraction of the road transport fuel mix. The fuels themselves are freely tradable across the EU. The extra cost of the biofuel is then part of the price of petrol or diesel and passed on to consumers. In 17 Member States this quota regime is supplemented by tax credits, whereby expenditure on biofuels is tax deductible. This supplement is therefore additional support funded by taxpayers. The empirical evidence regarding this sector shows that biofuels growth is more effective in those Member States where both instruments are applied.

In the electricity market, 21 Member States now use FIT at least for some technologies and some market segments; 7 Member States use feed in premiums and 6 use quotas. The use of multiple instruments or the adaptation of instruments also reflects the efforts to improve the efficacy of the instrument in a gradual manner without causing too much disruption.
to the market. Changes in recent years have seen a blurring of the traditional dichotomy of tradable certificates (setting quantity not price) and FIT (setting price not quantity). The most part of the Member States have continued to focus on national resources and could achieve their 2020 targets on their own. Historically, Member States have been keen to develop their own resources (contributing to their own emissions reductions, reducing fossil fuel imports and generating jobs) rather than develop the cheapest renewable energy sources. However, as the cheaper renewable energy potentials are exploited and costs start to rise, the need to seek out cheaper RES in other Member States will rise.

In the heating sector in Member States there has been the predominance of investment grants for installation of small solar thermal or solar photovoltaic units. The scope for any large scale heating from RES is only now beginning to be explored in most Member States, partly because it is only now included in the European regulatory framework (i.e. the 20% target). Projects could include developing combined heat and power plants and/or district heating systems based on geothermal, biogas or biomass energy sources.

As regards with the evolution of the electricity market, it will benefit from some cooperation mechanisms introduced by the RED, that allow a cross-financing between Member States for the achievement of the EU target:

- **Statistical transfers:** these are agreements between Member States to transfer a quantity of renewable energy produced in one Member State to another Member State for target compliance purposes. The transfer is purely virtual; there is no accompanying energy flow. This mechanism exists so that Member States with considerable renewable energy sources, or with effective support schemes that help develop such sources cost effectively, can offer any renewable energy production surplus to their requirements (either to their target or trajectory) to other Member States. The other Member States interested in purchasing such transfers would be those with limited domestic renewable energy sources or with inadequate support schemes for developing the available domestic resources. The transfers would normally be for Member States wanting to comply with their targets, or until their own domestic resources can be brought into production at a later stage;

- **Joint projects:** this is a help to build new plants and infrastructure in a Member State, sharing the resulting energy towards two or more Member States’ national targets, in order to reduce the overall cost of reaching the targets. One key difference between joint projects and statistical transfers is the proposed inclusion of “private entities” in joint projects. A private entity such as a power generator, infrastructure company, energy equipment manufacturer, a banking consortium can identify projects in any Member State. Financing such a project could occur under the normal and existing domestic arrangements, but if such arrangements are insufficient, because the support is too low or does not qualify according to domestic priorities, the project would not be built. In such a case, the project developer could broker an agreement whereby another Member State agrees to help finance the project; again, this could be through loans, grants, tenders or access to national support schemes such as FIT or Green Certificate regimes. In exchange for this co-financing, the Member State would receive credit for a share of the renewable energy that was produced as a result of the project.

In addition to the cooperation mechanisms available to Member States, the RED also has created an instrument that would enable third countries to take part in developing renewable energy sources and contributing to the EU target. Accordingly, joint projects between Member States and third countries (similar in structure to the joint projects between Member States) can be established. However, whilst joint projects between Member States can be purely virtual trade arrangements, joint projects with third countries have strict conditions attached to them to ensure that the arrangements generate new renewable energy production of electricity that is actually consumed in the EU. The energy that is produced and exported to the EU under the agreement may not receive
operating support. This rule is applied to reduce the risk of paying double subsidies and over-compensating producers;

- joint support scheme: the Member States may agree to join or coordinate their national support schemes (e.g. a common FIT or Green Certificate/obligation regime). In the event of the joining of schemes, the renewable energy produced under such conditions is considered “pooled” and shared out either as a “statistical transfer” or according to an agreed distribution rule.

It is plausible that with these mechanisms the cost of achieving the targets whilst promoting the growth and future prosperity of the European renewable energy industry can be minimised.

**Topic: The Indirect Land Use Change (ILUC)**

The ILUC is the potential impact due to the expansion of the agricultural lands to cultivate food and animal feed crops, as consequence of the cultivation of biofuels crops in agricultural lands to comply with the sustainability criteria of the RED. This expansion might decrease the lands with high natural carbon stocks being converted for food and animal feed and consequently it might influence the GHGs emissions balance.

Compared to the direct LUC, which occurs when a new activity has settled in an area of land, the ILUC cannot be directly observed and measured.

The EC is assessing the opportunity to consider the ILUC in the sustainability criteria of biofuels. At this aim the EC has launched a public consultation procedure to debate the subject and the models that could be used.

The options considered by the EC are:

- **take no action for the time being, while continuing to monitor**: this option would maintain the RED in its current form but potentially would introduce a means of monitoring the ILUC impacts of biofuels. Taking the decision not to introduce additional policy measures would reduce an area of risk currently facing potential biofuels investors. However, if there is a perceived lack of political agreement on the issue and a risk that, after a period of monitoring, further policy measures could be introduced, then uncertainty will remain. This uncertainty would be likely to prolong the current lack of investor confidence with negative impacts for biofuels investments;

- **raise the minimum GHGs emissions saving threshold for biofuels**: this option would increase the minimum GHGs emission saving threshold that biofuels must pass in order to count towards national target of Member States under the RED. The minimum GHGs emission saving threshold relates only to the direct emissions, so will not necessarily have an impact on the risk of ILUC emissions. Therefore this policy option would not encourage feedstock producers and biofuels manufactures to adopt practices that may mitigate the ILUC risk. Besides there is the risk that a restricted range of biofuel feedstock is available in the market and the costs at the blend points are higher.

- **introduce additional sustainability requirements on certain categories of biofuels**: this option would introduce further requirements in addition to those currently within the RED; the compliance with these new requirements could determine a higher supplying cost and could decrease the number of the market players, selecting the leading organisations which can adsorb the additional cost without adverse impacts on short-term profitability. Consequently the main disadvantage is the decrease of investor confidence;

- **attribute a quantity of GHGs emissions to biofuels reflecting the estimated ILUC impacts**: this option would introduce an ILUC factor that allocates additional GHGs emissions to the calculated direct emissions resulting from ILUC impacts. It is currently applied in the US a federal level (RFS2) and in some case a State level (e.g. in California LCFS). This approach is damaged by the difficulties to quantify the ILUC factor in the
different situations. In fact at the present time the available models use some categorisations (e.g. feedstock, geography) to estimate ILUC emissions, but the specificities are lost and updating and integrations are often required.

Industry representatives are firmly opposed to the introduction of some of these measures, arguing that the models proposed by the EC are scientifically unsound. In fact the modelling studies attempting to quantify the GHGs impact of ILUC at the present time evidence some significant uncertainties, relating for example the by-products contribution (e.g. DDGS and DDG from cereals processing) and the forms of agriculture which increase the carbon stock sequestration (e.g. no till farming, cultivation of perennial crops, that sequester carbon in their roots and trunks).

A report, which has been drafted in October 2011 on behalf on a consortium of industrial and non-governmental organizations, suggests an alternative approach, using a market mechanism to stimulate the ILUC mitigation, such as a carbon credit to the biofuels that meet specified ILUC mitigation criteria (e.g. use of by-products from the biofuel production as animal feed, cultivation of feedstock in abandoned or degraded lands, use of waste as feedstock for biofuels)\(^{11}\).

The EC could take its decisions in coming months. One decision could be to increase the GHGs emissions saving above those of petrol and diesel.

The resolution of the problem is urgent, because the investments in biofuels sector are braked. In fact, uncertainty on how the GHGs emissions of biofuels are calculated makes difficult for investors to determine how the market will value the GHGs emissions performance of a particular biofuel.

7.1 Bioethanol consumption, production and market in the EU

Caused by the target of the RED and likely also caused by the recent increase of the share of bioethanol in blending with petrol (i.e. 10% v/v), the bioethanol consumption in the EU has significantly raised in 2010 compared to 2009: + 26.1% (Table 9).

Taking into consideration this trend it is plausible that the countries that have yet to achieve their biofuels goals will drive the European growth in coming years.

Concerning the European bioethanol production, the amount of bioethanol produced in 2010 has been of 4.3 million tonnes with an increase of 13.3% if compared to the value of 2009 (i.e. 3.8 million tonnes).

The EU bioethanol demand (i.e. 2.93 million toe) exceeds the supply (2.75 million toe) and consequently the importations contribute significantly to the consumed amounts.

As regards with the European bioethanol market, the traditional importing countries are Brazil and the US.

Brazilian imports have almost plummeted to the point of no-return. In fact Brazil is finding it hard to meet the demand of its own domestic FFV market for bioethanol, because the number of these vehicles forms the core of the new registrations and it is rising all the time. Furthermore, in view of the very high world prices, Brazil is encouraging sugarcane exports.

On the contrary, currently the US bioethanol is available for the importation in the EU, because the US supply exceeds the demand. The surplus of bioethanol in the US market constitutes a risk of dumping through the exportation of the blend E90, which benefits from a tax reduction higher than that of the pure bioethanol. This situation is going to change, caused by the forthcoming increase in the share of bioethanol in blending with petrol in accordance with the RFS: at the present time the blend E10 is distributed but in short term the blend E15 will be used in the vehicles put into service since 2001 with a consequent decrease in this surplus of E90.

A significant share of the programmed increase in bioethanol fuel requirements prompted by the RED should revert to European output.
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<thead>
<tr>
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<tbody>
<tr>
<td>Greece</td>
<td>0</td>
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<td>-</td>
</tr>
<tr>
<td>Italy</td>
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<td>139,940</td>
<td>+ 21,926 + 18.6%</td>
</tr>
<tr>
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<td>233,179</td>
<td>+ 80,832 + 53.0%</td>
</tr>
<tr>
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<td>+ 165,089 + 28.4%</td>
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<td>490,112</td>
<td>+ 79,708 + 19.4%</td>
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<td>316,495</td>
<td>+ 155,990 + 97.2%</td>
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<td>63,457</td>
<td>- 1,031 - 1.6%</td>
</tr>
<tr>
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<td>203,943</td>
<td>+ 5,760 + 2.9%</td>
</tr>
<tr>
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<td>134,136</td>
<td>- 3,224 - 2.3%</td>
</tr>
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<td>52,119</td>
<td>+ 9,727 + 22.9%</td>
</tr>
<tr>
<td>Portugal</td>
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<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Romania</td>
<td>53,274</td>
<td>45,142</td>
<td>- 8,132 - 0.15%</td>
</tr>
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<td>61,262</td>
<td>+ 12,936 + 26.8%</td>
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<td>57,615</td>
<td>+ 10,643 + 22.7%</td>
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<td>45,142</td>
<td>+ 5,159 + 12.9%</td>
</tr>
<tr>
<td>Finland</td>
<td>75,451</td>
<td>73,517</td>
<td>- 1,934 - 2.6%</td>
</tr>
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<td>23,241</td>
<td>27,324</td>
<td>+ 4,083 + 17.6%</td>
</tr>
<tr>
<td>Lithuania</td>
<td>14,091</td>
<td>10,412</td>
<td>- 3,679 - 26.1%</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>740</td>
<td>720</td>
<td>- 20 - 2.7%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>1,859</td>
<td>2,904</td>
<td>+ 1,045 + 56.2%</td>
</tr>
<tr>
<td>Cyprus</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Denmark</td>
<td>6,238</td>
<td>34,179</td>
<td>+ 27,941 + 447.9%</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Latvia</td>
<td>1,120</td>
<td>8,419</td>
<td>+ 7,299 + 651.7%</td>
</tr>
<tr>
<td>Malta</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Estonia</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>2,326,675</td>
<td>2,933,977</td>
<td>+ 607,302 + 26.1%</td>
</tr>
</tbody>
</table>

Table 9: consumption of bioethanol in the EU in 2009 and 2010 (in toe)\(^2\)

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of plants</th>
<th>Raw material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>4</td>
<td>Barley, wheat, raw alcohol, maize, lignocellulose</td>
</tr>
<tr>
<td>France</td>
<td>12</td>
<td>Sugar beet, sugar juice, wheat, glucose, raw alcohol</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1</td>
<td>Cereals</td>
</tr>
<tr>
<td>Belgium</td>
<td>2</td>
<td>Cereals</td>
</tr>
<tr>
<td>Germany</td>
<td>3</td>
<td>Cereals, sugar juice</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1</td>
<td>Wheat</td>
</tr>
<tr>
<td>Austria</td>
<td>1</td>
<td>Wheat</td>
</tr>
<tr>
<td>Hungary</td>
<td>1</td>
<td>Maize</td>
</tr>
</tbody>
</table>

Table 10: EU bioethanol plants\(^3\)
8. NATIONAL STRATEGIES AND RELATED SPIN-OFFS FOR THE APPLICATION OF THE MODEL

Basing on the indications of the EU, each Member State has issued laws and decrees in order to make effective at national level these strategies. The treatment of the national legislative instruments is tackled in each country of the consortium in the following paragraphs, where also the national conditions for the viability of the model are explained.

8.1 Italy

Biofuels and RES policy

National Action Plan

In accordance with the indications of the RED, in June 2010 the NAP, where the Italian strategies to achieve the targets to 2020 are planned, has been drawn up.

As regards with the national objective for the share from RES of the total consumption (i.e. 17%) compared to 2005, the NAP has assumed that the total energy consumptions in 2008 and 2020 will be equal approximately caused by the increase in the energy efficiency of the plants and buildings and by the drop in consumptions due to the economic crisis. Then, basing on the total energy consumption of 2008 (i.e. 131 Mtoe), the share from RES of 17% (i.e. 22 Mtoe) has been assigned to the different sectors (i.e. electricity, heat, transport) as reported in Table 11.

The same assumptions have been applied to plan the achievement of the specific target for the transport (i.e. 10%) (Table 12).

The NAP has established in detail the contribution of every RES to the achievement of the total targets. The sharing among the RES is shown in Table 13 for electricity, in Table 14 for heating sector and in Table 15 for the transport one.

As regards with the transport sector, in accordance with the indications of the RED, the 2nd generation biofuels benefit from the double counting and the amount of electricity in the on-road transport is multiplied by the coefficient 2.5 in order to reach the target of 10%.
Analysing the contents of the NAP, the following strategies are evident:

- the promotion to the CHP systems for the burning of biogas and bioliquids;
- the preferential use of wood in the heating sector, instead of in the electricity one;
- the creation of district heating networks fed with RES (e.g. wood, CHP plants using biogas or bioliquids);
- the increasing contribution of the geothermal source in the heating sector;
- the relevance of biofuels to respect the objective to 2020: especially the contribution of biodiesel will cover the 62.3% of the RES and bioethanol the 20.5%;
- the basic role of the importation of biofuels (both biodiesel and bioethanol) to reach the target of 10%.

<table>
<thead>
<tr>
<th>Power</th>
<th>Production</th>
<th>Share of total RES</th>
<th>Share of the total consumption</th>
<th>Power</th>
<th>Production</th>
<th>Share of total RES</th>
<th>Share of the total consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW</td>
<td>GWh</td>
<td>ktoe</td>
<td></td>
<td>MW</td>
<td>GWh</td>
<td>ktoe</td>
<td></td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>13,890</td>
<td>43,792</td>
<td>3,763</td>
<td>77.65%</td>
<td>12.65%</td>
<td>15,732</td>
<td>52,000</td>
</tr>
<tr>
<td>Geothermal</td>
<td>671</td>
<td>5,324</td>
<td>458</td>
<td>9.45%</td>
<td>1.54%</td>
<td>1,000</td>
<td>7,500</td>
</tr>
<tr>
<td>Solar</td>
<td>34</td>
<td>31</td>
<td>3</td>
<td>0.06%</td>
<td>0.01%</td>
<td>8,500</td>
<td>11,350</td>
</tr>
<tr>
<td>Tides</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Wind</td>
<td>1,635</td>
<td>2,558</td>
<td>220</td>
<td>4.54%</td>
<td>0.74%</td>
<td>16,000</td>
<td>24,095</td>
</tr>
<tr>
<td>Wood</td>
<td>1,700</td>
<td>3,476</td>
<td>299</td>
<td>6.17%</td>
<td>1.00%</td>
<td>3,000</td>
<td>11,500</td>
</tr>
<tr>
<td>Biogas</td>
<td>284</td>
<td>1,198</td>
<td>103</td>
<td>2.13%</td>
<td>0.35%</td>
<td>750</td>
<td>3,200</td>
</tr>
<tr>
<td>Bioliquids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>900</td>
<td>6,300</td>
</tr>
<tr>
<td>Total</td>
<td>18,214</td>
<td>56,349</td>
<td>4,846</td>
<td>100%</td>
<td>16.29%</td>
<td>45,885</td>
<td>115,950</td>
</tr>
</tbody>
</table>

Table 13: contribution of each RES to the electricity production to reach the target to 2020

<table>
<thead>
<tr>
<th>Power</th>
<th>Production</th>
<th>Share of the total RES</th>
<th>Share of the total consumption</th>
<th>Power</th>
<th>Production</th>
<th>Share of the total RES</th>
<th>Share of the total consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geothermal</td>
<td>23</td>
<td>1.19%</td>
<td>0.03%</td>
<td>100</td>
<td>1.05%</td>
<td>0.17%</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>27</td>
<td>1.43%</td>
<td>0.04%</td>
<td>1,400</td>
<td>14.71%</td>
<td>2.33%</td>
<td></td>
</tr>
<tr>
<td>Wood</td>
<td>1,629</td>
<td>84.99%</td>
<td>2.38%</td>
<td>5,185</td>
<td>54.55%</td>
<td>8.62%</td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>26</td>
<td>1.35%</td>
<td>0.04%</td>
<td>141</td>
<td>1.49%</td>
<td>0.24%</td>
<td></td>
</tr>
<tr>
<td>Bioliquids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other heat pumps</td>
<td>*</td>
<td>212</td>
<td>11.04%</td>
<td>0.31%</td>
<td>2,500</td>
<td>26.16%</td>
<td>4.16%</td>
</tr>
<tr>
<td>Total</td>
<td>1,917</td>
<td>100%</td>
<td>2.80%</td>
<td>9,520</td>
<td>100%</td>
<td>15.84%</td>
<td></td>
</tr>
</tbody>
</table>

* with exception of geothermal pumps

Table 14: contribution of each RES to the heat production to reach the target to 2020 (in ktoe)
The NAP indicates the main instruments for adopting these strategies.

Concerning the electricity sector, the rationalisation of the incentive system is necessary. In fact, at the present time the instrument depends on the specific RES. For example for the solar source the FIT is used, whereas for plants supplied with biomass, biogas and bioliquids and power up to 1 MWe two incentives are available: the all-inclusive tariff (with values stable for 15 years) and the Green Certificates multiplied by a specific coefficient. In addition the feedstock supply through the short chain (i.e. maximum distance 70 km) is further rewarded increasing the multiplying coefficient.

As regards with the heating sector, the current White Certificates appear not efficient in rewarding the investments and the NAP suggests to reinforce this instruments for applications with a payback inferior to 10 years and with a significant improvement in the energy saving.

On the contrary currently the main incentive to promote the reduction in use of fossil fuels in this sector is the tax deductibility of part of the costs (i.e. 55%) for interventions aimed to improve the energy efficiency (e.g. condensing boiler, solar thermal plant).

In the transport sector the quota obligation is the system which has been applied in the creation of the biofuels market: in fact, increasing shares of biofuels must be distributed every

<table>
<thead>
<tr>
<th>RES</th>
<th>2005</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES counting for the target 10%</td>
<td>RES counting for the target 10%</td>
<td>Share of the target 10%</td>
</tr>
<tr>
<td>1st generation bioethanol + Bio-ETBE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2nd generation bioethanol + Bio-ETBE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Imported bioethanol + Bio-ETBE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1st generation biodiesel</td>
<td>158</td>
<td>157</td>
</tr>
<tr>
<td>2nd generation biodiesel</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>Imported biodiesel</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electricity in road transport</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Electricity in non-road transport</td>
<td>139</td>
<td>139</td>
</tr>
<tr>
<td>Other biofuels</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>318</td>
<td>338</td>
</tr>
</tbody>
</table>

Table 15: contribution of each RES to the transport sector to reach the target to 2020
year; on the contrary an administrative penalty is applied to the fuels distributors. The shares fixed are: 4% for 2011, 4.5% for 2012.

The Legislative Decree n. 28 of 3rd March 2011 and attached implementing decrees

The Legislative Decree 2011/28 acknowledges in Italy the RED and defines the scenario to implement the strategies of the NAP.

As regards with the biofuels, the decree has introduced two important elements: the share for 2014 has been fixed in 5.0% and the application of the sustainability criteria of the RED will enter into force in Italy since 2012.

In particular, concerning the sustainability of biofuels, the decree has modified the national market, making competitive only the sustainable biofuels because they are the only ones to be counted to reach the target to 2020.

Furthermore, to achieve this objective a special counting system has been foreseen:

• biofuels produced in the EU processing national feedstock are counted with an increased share: +10%, basing on the energy content (i.e. 1 certificate is attributed for 9 Gcal of distributed biofuel);
• biofuels distributed outside the network and mixed with 25% petroleum products are counted with an increased share: +10%, basing on the energy content (i.e. 1 certificate is attributed for 9 Gcal of distributed biofuel);
• biofuels produced from wastes, by-products, no-food feedstocks, included cellulosic and lignocellulosic raw materials and algae, are rewarded with the double counting: + 100%, basing on the energy content.

The modalities to access to the increases foreseen in this decree for the sustainable biofuels will be explained in the attached implementing decree, which is being issued.

The implementing decree will give careful indications about the traceability in the biofuels chains, in order to know in detail all the traders (i.e. fuels distributors, feedstock suppliers) and to provide the instruments to verify compliance with the sustainability criteria until the final trader. Furthermore, the implementing decree will list the by-products, which access to the double counting to reach the target to 2020.

As regards with the electric sector, the decree establishes since 2015 the termination of the Green Certificates and since 2012 the introduction of a new system, where are integrated an all-inclusive tariff and an incentive fixed through an auction.

The value of the all-inclusive tariff is specific for each source and for echelon of power, which in any case can not be less than 5 MWe.

The plants which do not access to the all-inclusive tariff benefit from an incentive, fixed by GSE as the lowest value in Dutch auctions, with a minimum recognized in any case. The auctions are recurrent and special for each source and range of power or for every type of plant. The participation in each auction is subjected to comply with some minimum requirements, such as the financial strength of the proposer and the economic viability of the initiative, and with specific mechanisms to ensure the actual realisation of the plant, such as the deadline for the start date.

Both incentives are combinable with:

• public incentive covering at maximum the share of 40% of the investment costs:
  o for power up to 200 kW for all the RES;
  o for power up to 1 MW for plants installed in farms or managed by farms, cattle farms, farms forestry, food companies, and supplied with biogas, biomass or sustainable bioliquids;
  o for CHP or CCHP plants for solar source or biomass or biogas, which are obtained from agricultural or forest products, manure, included by-products, in the context of specific agree-
ments among the chain actors or through short chain (range of supplying up to 70 km);

- public incentive covering at maximum the share of 30% of the investment costs:
  - for power in the range 200-1,000 kW for all the RES (with the previous exceptions);
- public incentive covering at maximum the share of 20% of the investment costs:
  - for power in the range 1-10 MW for all the RES (with the previous exceptions).

The modalities to access to these incentives will be explained in the attached implementing decree, which is being issued.

In particular the following indications will be detailed: the values of the all-inclusive tariff for each RES and the related range of power, the values for the incentives given through the Dutch auctions (e.g. minimum value recognized in any case), the parameters to grant the proposers to the auctions, the way to pass from the old incentive system to the new one, the calculation to define the production from RES in hybrid power plants.

Concerning the heating sector, two supports are foreseen: for the smaller interventions the contribution pursuant to the tariff for the natural gas, for the bigger ones the issue of White Certificates.

The contribution pursuant to the tariff of the natural gas is aimed to reward the investment costs for the improving of the energy efficiency and for the reduction in the use of fossil fuels. This incentive is suited to the obtained energy saving and its value is constant for all the duration (i.e. maximum 10 years). The applied mechanism suggests that this incentive is similar to the FIT used in the electricity sector.

The White Certificates, foreseen also by the previous incentive system, have been boosted and the procedures have been simplified. In particular their duration and value have been adjusted respectively to the lifetime and the cost of the intervention.

Furthermore a guarantee fund has been established for realising the district heating networks. The modalities to access to these incentives will be explained in the attached implementing decree, which is being issued.

The main indications, which will be given, are: the values and duration of the contribution pursuant to the tariff of the natural gas, the threshold value to distinguish between small interventions and big ones, the minimal technical requirements to access to the incentives (in terms of efficiency, quality of emissions, quality of biomass), the accumulation of different incentives, the values and duration of the White Certificates.

Furthermore, the Legislative Decree 2011/28 contributes to regulate the authorisation procedures for the realisation and the operation of plants supplied with RES.

In accordance with the Directive 2001/77/EC the principle applied in the Italian law foresees the simplification and the acceleration of the authorisation practices related to the plants supplied with RES, in order to promote the development of this sector and to contribute the achievement of the targets to 2020.

The Legislative Decree n. 387 of the 29th December 2003 has acknowledged the Directive 2001/77/EC and the realisation and operation of these are subjected to the “single authorisation”.

In accordance with this decree the competence in granting the “single authorisation” lies with the regional administrations, which can delegate to another institutional body (e.g. Province, Municipality).

In accordance with the Legislative Decrees 2003/387 and 2011/28 the “single authorisation” process has the following steps:

- submission of as “single authorisation” to the regional administration (or delegated institutional body);
- within 30 days: convening of the Conference of the services, in which representatives of all local administrations (e.g. Provinces and Municipalities), Regional Agency for the Envi-
ronmental Protection, electric utilities and local health participate. In the Conference of the services the technical and environmental aspects of the initiative are discussed and eventual information and data are required to the proposers. If the submission of “single authorisation” for many plants in the same region happens, the assessment of each one is carried out considering the cumulative effect of the initiatives;

- within 90 days: granting of the “single authorisation”. In this period is not counted the time for the eventual EIA. The granting of the “single authorisation” allows to start the works to realise the plant and afterwards it allows to start the operation of the plant.

For power inferior to 200 kWe or 250 kWe in case of biogas, the “single authorisation” is not required, but the “authorized simplified procedure” is sufficient. At this aim the application is submitted to the interested Municipality. In accordance with the Legislative Decree 2011/28 the regional and provincial administration can extend this range of power up to 1 MWe.

The Italian law does not require the IPPC for energy plant with power within 50 MWe. The reference law is the Legislative Decree n. 59 of 18th February 2005, which has acknowledged the Directive 1996/91/EC (IPPC Directive).

In the attached implementing decree will be listed the interventions qualified as substantial change of existing plants, which shall be subjected to the single authorisation.

All the implementing decrees, attached to the Legislative Decree 2011/28, are drafted through the cooperation among MSE, MIPAAF and MATTM and they issue within the end of 2011.

The Legislative Decree n. 55 of 31st March 2011

The Legislative Decree 2011/55 increases the amounts of bioethanol in blending with petrol (i.e. 10% v/v, blend E10) and completes the scenario defined by the Legislative Decree 2011/28 about the GHGs emissions saving consequent the utilisation of biofuels.

The decree establishes that at the beginning of every year the fuels distributors shall declare to the MATMM the GHGs emissions and the energy content correspondent to the distributed fuels (fossil fuels and biofuels). In particular, as regards with the biofuels, they shall certify their sustainability in accordance with the RED and Directive 2009/30/EC.

For the calculation of the GHGs emissions saving and related sustainability, the decree acknowledges in Italy the methods for the calculation of the GHGs emissions saving of biofuels, in accordance with the Annex V of the RED.

National conditions for the viability of the model

As regards the viability of the EU model in Italy, basing on the current situation, the following remarks emerge:

- bioethanol produced from sweet sorghum is insufficiently supported by the current incentives (i.e. +10%) and it is not competitive if compared to the 2<sup>nd</sup> generation one (+100%);
- the reward of electricity produced from bagasse of sweet sorghum and from vinasse is promising, because it can benefit from the all-inclusive tariff, which ensures fixed market conditions and reduces the business risk. The values of the all-inclusive tariff for each RES are being determined and they could confirm this remark;
- the reward of heat is promising through the White Certificates, about which the forthcoming decree will determine the values and duration.

Consequently the EU model is consistent with the Italian strategies for using RES in the electricity and heating sector, whereas this statement is not really correct for the 1<sup>st</sup> generation bioethanol. It is important to underline that the current situation is not completely clear, because some important variables persist at the present time: especially the values for the all-inclusive tariff and White Certificates can influence significantly the economic viability of the model. The current situation should be definitively cleared within the end of 2011.
8.2 Greece

Biofuels and RES policy

In 2002 the Greek national law regulating matters relating to Greek oil policy was announced as law n. 2002/3054 “Organization of petroleum products market and other provisions (FEK A' 230/2.10.2002)”. The provision of services and any other activity linked to the refining, marketing, transport and storage of crude oil and mineral oil products is subjected to the provisions of the present law and shall serve the general interest. The exercise of any activity relating to refinement, distribution of biofuels, marketing, retailing, transport of mineral oil products through a pipe and bottling of LPG shall be subject to the granting of a correspondent authorization.

The Directive 2003/30/EC was adopted by the Hellenic legislative framework on December 13th 2005 by putting into force law n. 2005/3423 “Introduction onto the Greek market of biofuels and other renewable fuels” as it was amended by law n. 2008/3653 (Article 55)”. These specific laws defined the Greek national strategy for biofuels aimed to bring the share of biofuels and other renewable fuels in the Greek market to 5.75% of the total petrol and diesel consumed in the transport sector by December 2010. According to law n. 2008/3653 (Article 56) the introduction of bioethanol into the market is envisaged for the period 2010-2016. The use of direct bioethanol into gasoline is not considered suitable for Greek climate therefore its conversion to bio-ETBE is proposed.

The law n. 2005/3423 completes the law n. 2002/3054 and sets the base for the disposal of biofuels through a system for allocating quantities of biodiesel. By joint decision of the Ministers of finance, development, rural development and food it was established a program of distribution of biodiesel in quantities. In particular, Article 15A of this law and the law n. 2009/3769 with Articles 21 and 22 provide the tools for the strategic development of energy crops in Greece, establishing the distribution system of biodiesel among the potential producers.

The Greek law n. 2010/3851 (OG A/85/4th June 2010) “Accelerating the development of RES to deal with climate change and other regulations in topics under the authority of the Greek Ministry of environment, energy and climate change” sets the Greek REP in the scope of the RED. Specifically, the law n. 2010/3851 sets specific targets for RES electricity share (40%), RES heating and cooling share (20%), and RES transport share (10%), in order to achieve the national target of 20% contribution of the energy produced from RES to the gross final energy consumption.

After 8 years of European Directive implementation, bioethanol plants are yet to be installed. 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 and Xanthi to bioethanol production plants, along with simultaneous production of high nutritive quality fodder, electricity and heat, with annual capacity of 150,000 m³ bioethanol each. The raw materials would be beet, grain and corn crops, which are already common in Greece and production could be initiated within 18-24 months after the beginning of works, eventually starting by the end of 2009 or the beginning of 2010. The Greek Sugar Company launched a competition to attract a strategic investor in 2007. In 2008, two offers from two different investors, Motor Oil Hellas and Cal West Ethanol & Renew Energy EU LLC, were announced. The international competition was however cancelled in November 2010 without being completed.

Annual biomass production from agricultural residue in Greece is estimated at 5 million tons of dry biomass per year, a production that equals to 2 million tons of oil equivalent. According to data from the Oil Policy Directorate of the Ministry of Development the annual demand for domestic fuel, oil has surpassed 4 million tons. Proper utilization of the produced
biomass can cover up to 60% of domestic fuel annual demands, the percentage covered is nevertheless only 3% of the annual energy demands15.

Currently is under development the harmonization of the Greek institutional framework, and more specifically of the law n. 2002/3054, to the Directives 2009/28/EC and 2009/30/EC. On July 2011 the Ministry for environment, energy and climate change established a working group to draft implementing regulations on the introduction and promotion of bioethanol as a fuel in the Greek territory under the provisions of Article 15A (10) of the law n. 2002/3054 (GG 230 A) as applicable. The working group is constituted of 24 members, representatives of various public and private parties such as:

- Ministry of environment, energy and climate change
  - Directorate of Oil Policy, General Secretariat for Energy and Climate Change
  - Directorate of Supervision and Management of Oil Products
  - Directorate of Oil Products Facilities
  - Investors Service for RES projects
  - Ministry of finance
  - Directorate of Excise duties
  - D29 Directorate of Alcohol, alcoholic, beverages, wine, beer
  - D28 Directorate of Petrochemicals
- Ministry of infrastructure, transport and networks
  - Directorate of Vehicle Technology
  - Ministry of rural development
  - Directorate of Tobacco, Aromatic and Medicinal Plants
- Ministry of development, competitiveness and shipping
  - Directorate of Development and Coordination
- Centre for renewable energy and saving
  - Biomass Department
  - Environmental & Transport Department
- Hellenic Petroleum S.A.
- Motor oil Hellas-Corinth Refineries S.A.
- National Technical University, School of Chemical Engineering
  - Laboratory of Fuels and Lubricants Technology
  - Biotechnology Laboratory
- Agricultural University of Athens
- Hellenic Petroleum Marketing Companies Association
- Greek Union of Petroleum Marketing Company
- Hellenic Association of Biofuel Producers
- Hellenic Association of Biodiesel Industries
- National Centre for Environment & Sustainable Development
- Regulatory Authority for Energy.

The objective of the working group is to introduce the promotion of bioethanol as fuel in the Greek territory in a mixture with petrol or through conversion into petrol components. More specifically, the group will investigate a complexity of issues relating to: the importation, supply, production, sale, distribution, the minimum of blending, technical specifications, taxation and monitoring of the tax base, and will recommend specific institutional interventions in order bioethanol to be entered in the Greek market in accordance with the provisions of Article 15A, (10) of the law n. 2002/3054 (GG 230 A) as amended and in effect to Article 22 of the law n. 2009/376 (Official Gazette A 105) and accordance with the objectives of the RED. The working group is going to complete its work within four months of its establishment.

Milestones to be set for the introduction and promotion of bioethanol as fuel in the country

I. Utilization of domestic resources (raw material producers of energy crops or biomass) from domestic units with multiple benefits for the national economy and security of supply.
II. Energy production from local or regional small and medium-sized businesses, as they have a positive impact on social cohesion, on export prospects, on job opportunities and opportunities for regional and local development.

III. Use of technological advances to ensure the reduction of production costs and incense-ment of energy efficiency. These objectives can be served by measures of internal policy, that may correspond to the respective applicable for biodiesel such as:

I. indirect support of the production within the Greek territory from domestic or foreign investors who will use the raw materials produced by Greek farmers, appropriate energy crops (e.g. sweet sorghum, maize);

II. support (indirect subsidy) of contracted agriculture (with long or short term contracts aside) to provide the raw material exclusively by Greek farmers;

III. financing of investment for production of bioethanol including to either the expansion

<table>
<thead>
<tr>
<th>Allocation of biodiesel to the plants</th>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Contracts for biodiesel production with farmers that cultivate energy crops within the Greek territory</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>b) Purchase invoices and/or accounting data supply cottonseed and/or cotton</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>c) Invoices for supply of raw materials derived from used vegetable oils and animal fats with Greek origin, suitable for producing biodiesel</td>
<td>7.5%</td>
<td></td>
</tr>
<tr>
<td>d) Capacity of biodiesel plant established in a Member State of the EU or import contracts intact biodiesel established in another Member State of the EU</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>e) A certificate issued or the contract award to obtain ISO 9000 series on production and/or full text available biodiesel</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>f) The offered by the applicant company, a maximum premium</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>g) Existing cooperation agreements with research institutions and organizations or contracts to participate in research projects within the EU on issues related to biofuels and biomass</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>h) All the supplies of biodiesel in kiloliters, on allocations of the previous two years</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>i) The index of consistency of supplies of, on the breakdown of last year, the refineries</td>
<td>7.5%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Table 16: allocation of biodiesel quantities to the biodiesel plants
of units already operating as biodiesel production plants or establishing new plants from domestic or foreign investors;

IV. development of small and medium-sized bioethanol plants located near the centers of feedstock production and port facilities;

V. establishing a minimum percentage of bioethanol blending in transportation fuels;

VI. establishing the obligation of the refineries to absorb the bioethanol produced;

VII. introduction of tax incentives for bioethanol producers.

Example of indirect support for the development of energy crops in country’s system for the production and distribution of biodiesel (a) & (b)

As regards with the authorisation process, terms and formalities concerning the production, distribution, blending and release for consumption of biodiesel have been issued with a Joint Ministerial Gazette No. 2006/1757. The respective conditions for bioethanol have not been published yet.

Excluded from the obligation to obtain a license to produce electrical energy or any other certification decision are physical or legal persons, who produce electrical energy is biofuel stations with installed electrical capacity smaller than or equal to 1 MW.

Exempt from the obligation of publication of the “Approval of Environmental Conditions” decision are the stations producing electrical energy from RES installed in field courts, as long as their installed electrical capacity does not exceed 0.5 MW for stations producing electricity using biofuels.

National Renewable Energy Action Plan (NREAP)\textsuperscript{16}

In the scope of Directive 2009/28/EC, in July 2010 has been drawn up the NREAP; this report has been compiled under the supervision of the National Committee for Meeting 20-20-20 Targets and Other Requirements (20-20-20 Committee).

The following table of NREAP presents the estimation of total contribution expected from each renewable energy technology in Greece to meet the binding 2020 targets and the indicative interim trajectory for the shares of energy from renewable resources in the transport sector 2010-2020.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioethanol/Bio-ETBE</td>
<td>-</td>
<td>43</td>
<td>142</td>
<td>171</td>
<td>198</td>
<td>226</td>
<td>256</td>
<td>287</td>
<td>316</td>
<td>346</td>
<td>376</td>
<td>414</td>
</tr>
<tr>
<td>Of which imported</td>
<td>-</td>
<td>43</td>
<td>142</td>
<td>171</td>
<td>198</td>
<td>226</td>
<td>256</td>
<td>287</td>
<td>316</td>
<td>346</td>
<td>376</td>
<td>414</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>1.2</td>
<td>64</td>
<td>69</td>
<td>83</td>
<td>97</td>
<td>113</td>
<td>130</td>
<td>146</td>
<td>161</td>
<td>175</td>
<td>190</td>
<td>203</td>
</tr>
<tr>
<td>Renewable electricity</td>
<td>-</td>
<td>2.4</td>
<td>3.3</td>
<td>4.4</td>
<td>5.4</td>
<td>6.2</td>
<td>7.2</td>
<td>8.3</td>
<td>9.4</td>
<td>12.1</td>
<td>14.5</td>
<td>16.5</td>
</tr>
<tr>
<td>Of which road transport</td>
<td>-</td>
<td>0.7</td>
<td>0.7</td>
<td>0.8</td>
<td>1.0</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.6</td>
<td>3.3</td>
<td>4.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Of which non-road transport</td>
<td>-</td>
<td>1.7</td>
<td>2.6</td>
<td>3.2</td>
<td>4.1</td>
<td>5.0</td>
<td>5.9</td>
<td>6.9</td>
<td>7.8</td>
<td>8.8</td>
<td>10.0</td>
<td>11.4</td>
</tr>
</tbody>
</table>

**Figure 4:** estimation of total contribution expected from each renewable energy technology in Greece (35biofuels that are included in Article 21(2) of Directive 2009/28/EC; 36from the whole amount of bioethanol/ bio-ETBE; 37from the whole amount of biodiesel)

The comparison of the basic results for the final energy consumption, the RES contribution and the amount of RES installations required is given in more detail in the following Table.

**Sustainability criteria for biofuels and bioliquids implemented at national level (indicated in the NREAP)**

There is no specific legislation for the implementation of sustainability criteria for biofuels and bioliquids presently under consideration. The introduction of sustainability criteria at national level is planned to be carried out through legislative alternatives that include:
<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity production [TWh]</td>
<td>58.86</td>
<td>58.86</td>
<td>58.86</td>
<td>64.13</td>
<td>61.47</td>
<td>62.09</td>
<td>72.18</td>
<td>68.46</td>
<td>72.48</td>
</tr>
<tr>
<td>Total RES electricity [GWh]</td>
<td>7.84</td>
<td>7.84</td>
<td>7.84</td>
<td>14.16</td>
<td>16.97</td>
<td>18.26</td>
<td>20.23</td>
<td>27.27</td>
<td>29.74</td>
</tr>
<tr>
<td>% RES electricity production</td>
<td>13%</td>
<td>13%</td>
<td>13%</td>
<td>22%</td>
<td>28%</td>
<td>29%</td>
<td>28%</td>
<td>40%</td>
<td>41%</td>
</tr>
<tr>
<td>Of which biomass/biogas</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.12</td>
<td>0.12</td>
<td>0.05</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Of which hydro (excluding pumping)</td>
<td>2.54</td>
<td>2.54</td>
<td>2.54</td>
<td>2.89</td>
<td>2.92</td>
<td>2.91</td>
<td>2.91</td>
<td>2.95</td>
<td>2.95</td>
</tr>
<tr>
<td>Of which wind</td>
<td>1.33</td>
<td>1.33</td>
<td>1.33</td>
<td>3.78</td>
<td>4.30</td>
<td>4.74</td>
<td>6.25</td>
<td>7.50</td>
<td>8.25</td>
</tr>
<tr>
<td>Of which solar photovoltaic</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.41</td>
<td>1.27</td>
<td>1.51</td>
<td>0.70</td>
<td>2.20</td>
<td>2.90</td>
</tr>
<tr>
<td>Of which CSP</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
<td>0.03</td>
<td>0.00</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Of which geothermal</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.02</td>
<td>0.01</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td>Of which biomass/biogas</td>
<td>1.01</td>
<td>1.01</td>
<td>1.01</td>
<td>0.88</td>
<td>1.13</td>
<td>1.13</td>
<td>0.93</td>
<td>1.22</td>
<td>1.29</td>
</tr>
<tr>
<td>Of which solar heat</td>
<td>0.22</td>
<td>0.22</td>
<td>0.22</td>
<td>0.24</td>
<td>0.27</td>
<td>0.22</td>
<td>0.27</td>
<td>0.36</td>
<td>0.41</td>
</tr>
<tr>
<td>Of which geothermal</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.00</td>
<td>0.02</td>
<td>0.03</td>
<td>0.00</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Of which ambient heat</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.12</td>
<td>0.13</td>
<td>0.21</td>
<td>0.19</td>
<td>0.28</td>
<td>0.36</td>
</tr>
<tr>
<td>Of which biofuels in transport</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
<td>0.28</td>
<td>0.39</td>
<td>0.39</td>
<td>0.41</td>
<td>0.62</td>
<td>0.69</td>
</tr>
<tr>
<td>% RES in gross final energy consumption</td>
<td>9%</td>
<td>9%</td>
<td>9%</td>
<td>12%</td>
<td>15%</td>
<td>16%</td>
<td>14%</td>
<td>20%</td>
<td>21%</td>
</tr>
</tbody>
</table>

**Figure 5: summary of results for energy consumption and RES utilization for the three basic scenarios examined for the compilation of the Greek NREAP**

- additions amending law L3769/2009, so that all quantities of biofuels placed on the domestic market meet the sustainability criteria of Directive 2009/28/EC;
- use of the invitations to participate in the quota allocation of pure biodiesel – terms and conditions for the verification of compliance with sustainability criteria. Note that under Article 15A (10) to (11) of L3769/2009, the supply of bioethanol and other biofuels in the Greek market is determined by JMDs which may cover sustainability criteria;
- issuance of a JMD as specified in Article 15A par. 12 of L3054/2002.

A final decision on the instrument that will implement such sustainability criteria for the biofuels and the bioliquids is not taken yet.

**National conditions for the viability of the model**

Greece has enforced the Directive 2003/30/EC by passing the national law 3423/2005, which enables the production, import and trading of biofuels. Up to date Greece does not produce bioethanol; in the country there are thirteen industrial plants and three enterprises that produce and import respectively biodiesel. Greece has managed to reach the EU target and substitute the 5.75% of diesel with biodiesel but still lags in the production of bioethanol to substitute the same percentage of petrol/gasoline consumption, which in 2009 was 4,376,240 toe.
The RES play a major role in the country’s evolving energy make-up. Biomass and biofuels have been identified as strong market components with high growth potential. Three main success factors that may affect the profitability of a bioethanol chain are:

- the government legal framework and supporting policies
- the sustainability of the feedstock supply
- the availability of the latest technology.

To ensure the financial viability of the bioethanol plants, incentives by the government should be provided. The major costs in biofuel production are the fuel taxes imposed by the governments, which in case of Greece correspond to the amounts given in Table 17.

In addition to the incentive provided by the exemption of the taxes on biofuels, all the legal issues shall be addressed in such a way that in order for new investors to be motivated to proceed with the plants, they must be able to deal with less bureaucracy issues. Unfortunately, many cases are known regarding investments in the field of RES exploitation for the production of either electricity or thermal energy that have not been realized due to bureaucracy problems.

For the sustainability of the feedstock the following issues should be addressed. First, the farmers should be assured via contract agreements that they will sell their entire crop at a fixed price which will ensure their profit. Research has shown that sweet sorghum has low needs in water and fertilizers and farmers have a higher economic initiative in cultivating this energy crop since the sugar content per hectare of sweet sorghum cultivation is higher in comparison to other crops. Still many organizations/institutions are working in the improvement of the sweet sorghum productivity and tests of new varieties and hybrids are currently under way.

Another issue is the location of the plant. It is said that for the sustainability of the biomass, the collection centers should not be placed further than 30 km from the plants. There are different arrangements that may take place between the plant owners and the farmers, apart from the known one which is the sale of the crop (stalks and grains) to a plant. Independent farmers and/or farmer associations may proceed to the extraction of the juice and sell only the juice to the plant and as the extracted juice should be fermented immediately after the extraction the distance of the plant from the juice extraction unit should not be far. Another arrangement is that farmer associations ferment also the extracted juice and sell it to a distillation plant.

Examining the profitability of the EU model for the bioethanol production using sweet sorghum, labour costs should be also taken into consideration, as in non EU countries (e.g. India) where such kind of plants exist labour costs are much lower. On the other hand, investors should be assured that the fuel distilleries will buy all their bioethanol production at an advantageous price. If all the above aspects could be defined and the latest technology was available in each country, the bioethanol market could be enhanced and the defined EU targets could be reached. By using the latest technology it is possible to improve the ethanol yield and reduce costs.

It is estimated by the World Bank that investment of more than 30 billion euro will be required by 2020 in the upgrade and building of power plants, in transmission and distribution, and the RES. In Greece, the agricultural sector accounts for more than 5% of GDP, more than three times the EU average of 1.8%. Companies involved in biomass and biofuels will therefore find abundant sources of raw materials. In addition, the binding commitments of the Greek gov-

<table>
<thead>
<tr>
<th>Type of Fuel</th>
<th>Taxes (€/liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol with lead</td>
<td>0.621</td>
</tr>
<tr>
<td>Petrol unleaded</td>
<td>0.610</td>
</tr>
<tr>
<td>Petrol for airplanes</td>
<td>0.637</td>
</tr>
<tr>
<td>Diesel for vehicles</td>
<td>0.382</td>
</tr>
<tr>
<td>Diesel as heating fuel</td>
<td>0.382</td>
</tr>
<tr>
<td>Kerosene</td>
<td>0.410</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>0.382</td>
</tr>
</tbody>
</table>

Table 17: taxes on fuels

It is estimated by the World Bank that investment of more than 30 billion euro will be required by 2020 in the upgrade and building of power plants, in transmission and distribution, and the RES. In Greece, the agricultural sector accounts for more than 5% of GDP, more than three times the EU average of 1.8%. Companies involved in biomass and biofuels will therefore find abundant sources of raw materials. In addition, the binding commitments of the Greek gov-
ernment to replace 10% of current transport fuels with biofuels by 2020 translates into measurable opportunities within the next decade.

The main advantages of investing in biomass and biofuels in Greece are:

- abundant raw materials
- agricultural sector equals 5.2% of GDP vs 1.8% (i.e. EU average)
- high FIT for biomass, whose values guaranteed for 20 years are:
  - 200 €/MWh for power inferior to 1 MW
  - 175 €/MWh for power from 1 MW to 5 MW
  - 150 €/MWh for power higher than 5 MW;
- binding national commitments in biofuel use
- favorable, long-term legislative framework, ensuring investment reliability.

Provisions regarding wholesale prices of petroleum products

According to law 2010/3851 the prices of petroleum products available in the national market are set freely throughout the entire state by those who practice the trade of these products.

For reasons of competition protection, the owners of a Refining License and a License for Distribution of Biofuels are obligated to inform the Minister of economic development, competitiveness and shipping as well as the R.A.E. the manner by which the ex factory prices of petroleum products are established.

The companies trading petroleum products are under the same obligation for what concerns the real prices (including possible discounts and other arrangements) at which they sell their petroleum products to the petrol stations in each area.

Investment law 2011/3908

The submission of investment plans is done in two time periods per year (April and October).

The main contents of the law are:

- the defined annual budget, making clear the allocation of financial resources so investors may plan accordingly;
- the guidelines for all sectors of the economy, except for those expressly provided for in Article 2 of the law;
- specified and fixed application deadlines (April and October).

Furthermore this law:

- is mindful of scarce public funds by providing incentives primarily through tax exemptions: for each euro of subsidy provided, three euros of tax exemptions are provided;
- provides for binding schedules, electronic submission, investment monitoring and new Investor Service Offices that assist investors;
- introduces a new evaluation process by establishing the National Register of Evaluators and Auditors;
- focuses on sustainable investment projects that are environmentally friends, promotes innovation, regional cohesion, youth entrepreneurship and create jobs.

Investment categories:

1. General Entrepreneurship
   Target Group: all enterprises irrespective of sector.
   Provides: tax breaks of up to 100% of the maximum allowable amount of aid.
2. Regional Cohesion
   Target Group: investors with projects that address local needs or capitalize on local competitive advantages.
   Provides: all forms of aid. The subsidy rate and leasing subsidy may reach up to 70% of the maximum allowable amount of aid. For new enterprises this percentage is increased by 10 percentage points.

3. Technological Development
   Target Group: enterprises that invest in innovation and want to upgrade their technology infrastructure.
   Provides: all forms of aid. The rate of subsidy and leasing subsidy may reach up to 80% of the maximum allowable amount of aid.

4. Youth Entrepreneurship
   Target Group: investors from 20-years to 40-years old.
   Provides: aid for virtually all costs (including operational) for five years from the start of the business. Total aid may reach up to 1,000,000 €.

5. Large Investment Plans
   Target Group: investments with a budget of at least 50,000,000€.
   Provides: all forms of aid, either in one form or a combination of forms. The level of aid decreases as the amount of investment increases. The percentage of the subsidy may not exceed 60% of total aid.

6. Integrated, Multi-Annual Business Plans
   Target Group: companies legally formed at least five years previous to application, to implement integrated multi-annual (2-5 years) business plans with a budget of at least 2,000,000 € in total.
   Promotes: technological, administrative, organizational and business modernization. 100% of the maximum regional aid applicable shall be granted.

7. Partnerships and Networking
   Target Group: partnerships and networking configurations or clusters. These clusters shall be comprised of at least ten enterprises in the Region of Attica and the Thessaloniki Prefecture and of at least five enterprises in other prefectures, operating in the form of a consortium.
   Provides: for any form of aid.

Types of aid:
A. Tax relief: tax relief comprising exemption from payment of income tax on pre-tax profits which result, according to tax law, from any and all of the enterprises activities.
B. Subsidy: gratis payment by the State of a sum of money to cover part of the subsidized expenditure of the investment.
C. Leasing subsidy: includes payment by the State of a portion of the installments paid under a leasing agreement executed to acquire new machinery and/or other equipment.
D. Soft loans by ETEAN: the amount to be covered by a bank loan may be funded by soft loans from credit institutions that cooperate with ETEAN enterprises.

The aid referred to above shall be aggregated for the purpose of determining the total amount of aid allocated to the investment project. In this case the benefit of the funding above is included in total aid, which may not exceed the limits delineated on the Regional State Aid Map (Table 18).
<table>
<thead>
<tr>
<th>Region</th>
<th>Prefecture Zone</th>
<th>Percentage of aid</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Aegean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyclades</td>
<td>C</td>
<td>15%</td>
</tr>
<tr>
<td>Dodecanese</td>
<td>C</td>
<td>15%</td>
</tr>
<tr>
<td>Sterea Ellada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fthiotida</td>
<td>B</td>
<td>15%</td>
</tr>
<tr>
<td>Fokida</td>
<td>B</td>
<td>20%</td>
</tr>
<tr>
<td>Evia</td>
<td>B</td>
<td>15%</td>
</tr>
<tr>
<td>Viotia</td>
<td>A</td>
<td>15%</td>
</tr>
<tr>
<td>Euritania</td>
<td>C</td>
<td>20%</td>
</tr>
<tr>
<td>Thessaloniki</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Halkidiki</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Kilkis</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Pella</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Imathia</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Pieria</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Serres</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Grevena</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Kozani</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Florina</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Kastoria</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Attica</td>
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<td></td>
</tr>
<tr>
<td>Attica</td>
<td>A</td>
<td>15%</td>
</tr>
<tr>
<td>Thessalia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larissa</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Magnissia</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Karditsa</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Trikala</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Corfu</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Lefkada</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Kefallinia</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Zakynthos</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Heraklion</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Hania</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Lassithi</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Rethymnon</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Lakonia</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Messinia</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Korinthia</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Arkadia</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Argolida</td>
<td>B</td>
<td>30%</td>
</tr>
<tr>
<td>Mytilene</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Chios</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Samos</td>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>Kavala</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Xanthe</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Rodopi</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Drama</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Evros</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Ioannina</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Arta</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Preveza</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Threspotia</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Achaea</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Etolo-Akarnania</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Iliea</td>
<td>C</td>
<td>40%</td>
</tr>
<tr>
<td>Table 18: regional state aid map and aid rates for each prefecture</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
An Independent Service for RES is introduced by the Ministry of environment, energy, and climate change which will act as an “one-stop shop” and will be responsible for providing information to all potential investors who are interested in RES.

8.3 Spain

Biofuels and RES policy

National Action Plan

According with the European Directives referred to the promotion of renewable energies, Spanish Government developed the National Action Plan of Renewable Energies of Spain (PANER), published on 30th June of 2010. This PANER has been based on the European Directive 2009/28/CE, fixing Spanish objective on 20% of energy consumed from renewable energies in 2020 with a contribution of 10% from renewable energies in the transport sector. The development of the regulation of the energetic activity promoted by the Directive has been described by the RD661/2007, where is included the writing of the National Plan of Renewables Energies (PER).

Although the PANER and PER include all the renewable energies and the reduction on the energy consumption, there is a specific part for the promotion and regulation of the biofuels production and consumption.

The National Action Plan for the biofuels promotions is based in the evolution of the production and consumption of biofuels until 2009 in Spain. The evolution of the production capacity in Spain has been increased in the last years until 4 million of tonnes of oil equivalent. Although this increasing on the production capacity, the consumption has not increased in the same form. In fact, the motivation of this consumption has been promoting through the Ministerial Order ITC/2877/2008 of 9th October, where is described the promotion of the biofuels use in the transport sector.

Considering this aspect on the production and consumption of biofuels in the transport sector, there are other tools to ensure the Spanish objective for 2020. The energetic efficiency has become very important, translating this importance in specific actions. On the transport sector, considering the impact of the actions over the quality of the air in cities and the social pressure, the impact on the consumption of energy has been fixed on 40%.

Apart from this, there are specific actions to make more efficient the transport, mainly with a modification on the taxation for the transport, including an environmental part on it, or new energetic labelled, to try to promote the use of more efficient elements.

Apart from the last indications, there are other laws that have influence over the promotion or development of this sector, through environmental regulation, for example, as it is described on the Directive 2008/50/CE, where is indicated the air quality on the cities. Indirectly, this Directive is going to have an influence over the efficiency on the transport.

Other regulation made by Spanish Government to reduce the impact of the transport and ensure the objectives for 2020 is the bylaw 443/2009, that has fixed the emissions of CO₂ on the road transport on 95 gCO₂/km for 2020. The objective marked wants to be achieved including the promotion of electric cars and hybrids plugged until 10% of the total park of cars.

Figure 6: evolution of biofuels in Spain (consumption and production capacity)
All the laws, bylaws, orders and so on, have been developed to achieve the global objectives for the renewable energy in Spain, fixed on the Directive 2009/28/CE, and assumed by the Spanish Government. These objectives are shown in Table 19 and they include all the uses for the renewable energies.

Although the targets indicated before are calculated for all the renewable energies in Spain, there is a specific calculation for the energy in the transport sector, including power consumption in the transport, biofuels and so on. This calculation is shown in the Table 20.

In this document, the calculation of RES consumption has been done, but this calculation is not going to be achieved if there are no actions to promote the consumption and production in Spain.

In biofuels sector, there are specific actions to promote the consumption and production. These specific actions are shown in Table 21.
<table>
<thead>
<tr>
<th>Denomination of the action</th>
<th>Type of action</th>
<th>Expected result</th>
<th>Group and/or activity to which the action is intended</th>
<th>Existing or under project</th>
<th>Date for beginning and end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of the technical specification for B30 and E85, and their inclusion on the biofuels quality legislation in Spain</td>
<td>Regulatory</td>
<td>Improve the biofuels quality control and increase the confidence on this sector</td>
<td>Industrial, petroleum and logistic sectors</td>
<td>Project</td>
<td>2010-2012</td>
</tr>
<tr>
<td>Design and implantation of AENOR system to ensure the quality on the biofuels production process</td>
<td>Regulatory</td>
<td>Improve the biofuels quality control and increase the confidence on this sector</td>
<td>Industrial, petroleum and logistic sectors</td>
<td>Project</td>
<td>2010-2012</td>
</tr>
<tr>
<td>Design and implantation of a control system of sustainability in all the production chain of the biofuels commercialized in Spain, according with requirements of the Directive 2009/28/CE of 23rd of April.</td>
<td>Regulatory</td>
<td>Enhance the sustainability analysis</td>
<td>Agricultural, industrial, petroleum and logistic sectors</td>
<td>Project</td>
<td>2010-2012</td>
</tr>
<tr>
<td>Maintenance and adaptation of the scheme of the obligatory use of biofuels in the transport faraway from 2010. At this moment until 2010 there is the Order ITC/2877/2008</td>
<td>Regulatory</td>
<td>Increase the biofuels demand</td>
<td>Agricultural, industrial, petroleum and logistic sectors</td>
<td>Existing Project</td>
<td>From 2008 2010-2020</td>
</tr>
<tr>
<td>Modification of the legislation over the special taxations that allows the use of biogas as biofuel in transport at similar conditions than bioethanol and biodiesel.</td>
<td>Regulatory</td>
<td>Diversification of the biofuels offer</td>
<td>Industrial, petroleum and logistic sectors</td>
<td>Project</td>
<td>2010-2011</td>
</tr>
<tr>
<td>National Program to support the technological development in the biofuel sector: 2G and bio-refinery.</td>
<td>Regulatory-Financial</td>
<td>Improve the technological development</td>
<td>Industrial, petroleum and logistic sectors</td>
<td>Project</td>
<td>2011-2020</td>
</tr>
<tr>
<td>Actuation of the Administrations through the promotion of buying cars with guarantee to use of mixing of fuels with biofuels.</td>
<td>Regulatory-Financial</td>
<td>Increase the demand of biofuels</td>
<td>Administrations and automotive sector</td>
<td>Project</td>
<td>2011-2020</td>
</tr>
</tbody>
</table>

Table 21: specific actions on the biofuels sector
In this document, the calculation of RES consumption has been done, but this calculation is not going to be achieved if there are no actions to promote the consumption and production in Spain.

In biofuels sector, there are specific actions to promote the consumption and production. These specific actions are shown in Table 21.

Apart from the last actions, there are other specific actions to ensure compliance of the requirements of articles 17 and 21 of the Directive 2009/28/CE. Specifically, the biofuels must meet sustainability criteria. The Ministerial Order ITC/2877/2008 develops a mechanism to promote the biofuels use for the transport sector, indicating the minimum amount obliged and how to measure the amount sold and consumed. The article 7 of this Order describes the requirements to accredit the biofuels sold and consumed in Spain.

The sustainability of the biofuels must be accredited, considering the quality, origin of the raw materials, and the environmental evaluation of the crops.

The circular 2/2009, 26th of February, from the National Commission of Energy, is going to regulate the promotion of the biofuels use in transport, indicating in its article 7 the system to present the applications of certification for the biofuels sold or consumed. In this Circular is indicated that the certification of sustainability for the biofuels will be required.

According to this circular, there will be described the traceability needed in the production chain of biofuels, from the crop to the sale of the biofuel, taking special attention to the inputs and outputs of the production, including: internal registers of input or output for each step of the chain; documents of certification along the chain; minimal period of time to maintain these registers.

In this Order ITC/2877/2008, in the article 6, is designing to the National Commission of Energy as the administration responsible to expedite of the certificates for the biofuels, management of the certification mechanism, and supervision and control of the obligation for commercialising the biofuels.

On the other hand, in Spain, the law 42/2007, of 13th December, of the Natural Heritage and the Biodiversity, is indicating what is the biodiversity and how to conserve this biodiversity, as is indicated on the Directive 2009/28/CE.

Promotion of the use of renewable energy in transport: Support Systems

In Spain there are several laws that promote the biofuels use. For example, the law 34/1998 indicates the annual aims of biofuels in the transport. These aims are mandatory since 2009, focusing the 5.83% in 2010.

To ensure these aims, the Order ITC/2877/2007 establishes the promotion mechanism for the use of these biofuels in the transport sector, fixing minimum aims per product under the global aims indicated in the law 34/1998. Apart from this, this Order makes flexible the accounting of the amount of biofuels sold or consumed and this Order develops a certification system and payments that will be managed by the National Energy Commission. This promotion action allows ensuring in 2011 a 7% of biofuels in fuels and diesel.

The overall aims for the biofuels are 3.40% in 2009 and 5.83% in 2010. Apart from these aims, there are specific aims per product as shown in Table 22.

At this moment, in the Order ITC/2877/2008 there is no specific promotion per technology or product, and there is no specific promotion of the biofuels under article 21, paragraph 2 of the Directive 2009/28/CE.

Considering that this Order has designed to the National Energy Commission (NEC) to manage the issuance of

<table>
<thead>
<tr>
<th>Aims for biofuels in diesel</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5%</td>
<td>3.9%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Aims for biofuels in petrol</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5%</td>
<td>3.9%</td>
<td></td>
</tr>
</tbody>
</table>

Table 22: aims for biofuels in Spain
Certificates, management and control of the obligatory of biofuels commercialization, the NEC published the Circular 2/2009 where is established the mechanisms to promote the biofuels consumption, normative to control this production and consumption, and so on. This Circular indicates that the NEC is authorised to make inspections to control the obligatory indicated in the Order reported before.

Other alternative in Spain to promote the use of biofuels in the transport is the regulation of the biofuels use in vehicles of the Administration. The Council of Ministers developed in 22nd of May 2006, an Inter-Ministerial Commission to include environmental aspects in the public procurements. This objective is fixed on the Order PRE/116/2008, where is approved a Plan for the Green Public Procurement from the State General Administration.

With the application of this Order, the objective is to achieve in 2012 the 38% of biofuels in the total consumption of fuels by the Mobil Park of the State.

In Spain, apart from the obligations, there are other actions to promote the production and consumption of biofuels, mainly through financial help and public funding. The specific legislation that controls this financial help is the following:

- Law 38/1992 of 28th of December of Special Tax
- Royal Decree 1165/1995 which approved the bylaw of Special Tax
- Law 53/2002 of Fiscal actions, Administrative and the Social Order
- Royal Decree 1739/2003 that modifies the by law of Special Tax approved on the Royal Decree 1165/1995 and in the Royal Decree 3485/2000
- Law 22/2005 that include on the Spanish Ordering Legal the Communitarian Directives related to the taxation of the energy products and power
- Royal Decree 191/2010 that modifies the Special Tax Bylaw, approved by Royal Decree 1165/1995.

In all these laws and Royal Decrees, there are specific considerations for the tax applied to the biofuels. These are specific forms to promote the production of the biofuels in Spain. For example, the Special Tax Law for biofuels indicate that, until 31st of December 2012, shall apply to biofuels a special type of zero euros per 1,000 liters on the hydrocarbons’ tax. The special type shall be used only on the volume of biofuel used even when it is mixed with other products.

Whenever the comparative evolution of the production costs of petroleum products and biofuels will be recommended, the Laws of the State Budget may replace the zero by a tax rate of positive amount, not exceeding the amount of type tax applicable to the equivalent conventional fuel. It is a statutory scheme administered by the Department of Customs and Excise Tax Agency.

On the other hand, eligibility within this support system is not related to the size of the agent that commercializes the biofuel.

Tax exemption for biofuels pilot projects

The Special Tax Law provides that the production or import of biofuels which are intended for using as fuel will be exempted of special hydrocarbon’s tax, either directly or mixed with conventional fuels in the field of pilot projects for the technological development of less pollutants products.

Pilot projects shall be considered for the technological development of less pollutant products or the pilot projects limited in time focused on the production or use of the products to demonstrate the technical viability of their production or use, further excluding the industrial exploitation of the results thereof.

This is a voluntary scheme managed by the Department of Customs and Excise of Tax Agen-
cy. The Special Tax Bylaw indicates that, once approved the exemption request, the man-
agement center issues the recognition agreement with the effect the waiver requested by
stakeholders and not exceeding five years.

There is a maximum size established in the Bylaw on Special Taxes related to the accredita-
tion of the pilot project and it is limited to demonstrate the technical feasibility of their pro-
duction or use. This condition is considered proven when the amount of biofuel produced
does not exceed 5,000 liters per year.

**Evolution of the biofuels area in Spain**

The hypotheses to explain the expected development in the production and use of biofuels
in Spain during the period 2011-2020 are the following:

- **Bioethanol and Bio-ETBE.** Consumption is expected to be nearly double, from 232 ktoe in
  2011 to 400 ktoe in 2020. A major jump in consumption will occur around 2013, with the
  likely demise of the protective gasoline and the generalization of the specification of pet-
  rol like E10. On the other hand, it is estimated that the important contribution of imports
  of ETBE to the domestic ethanol consumption observed in 2010 will be reduced in subse-
quent years until it disappears. This aspect will be ensured with the widespread incorpora-
tion in petrol of a direct blending of bioethanol and ETBE. Regarding the consumption of
bioethanol and bio-ETBE indicated in the Article 21.2, the information shown displays the
expectation that at the end of the period 2011-2020 any projects of bioethanol produc-
tion come to be commercial projects in Spain for the production of bioethanol from ligno-
cellulosic materials or waste.

- **Biodiesel.** Also the biodiesel consumption is estimated to double in the time period cor-
  responding to PANER passing from 1,471 ktoe in 2011 to 3,100 ktoe in 2020. However, the
  growth rate is not expected uniform, until 2013 will be very small, and from there it will ac-
celerate the development due to the specifications for mixtures labeled along with the
  expected success of the normalization of the B10. As for imports, which in 2010 is expected
  to represent more than 60% of domestic consumption, is expected a gradual decline over
  the next few years, before stabilizing at around 10% of total consumption during the sec-
ond half of the period 2011-2020. Finally, regarding the consumption of biodiesel in Article
  21.2, the table displays the expectation exists that at the end of the period 2011-2020 will
  reach a level of use of used vegetable oils close to two thirds of the potential use of them.

- **Others.** The evolution of consumption of biofuels between 2011 and 2020, according to
  estimates made for the preparation of this Plan also includes a small contribution of bio-
fuels different than ethanol and biodiesel, to be considered during the second half of the
period. Among these, those who are more likely to build an autonomous development
on the future would be the biogas for transport, the HVO and the Bio-SPK for the aviation
market, all of these technologies are in a very preliminary stage of development today.
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bioethanol / Bio-ETBE</strong></td>
<td>113</td>
<td>232</td>
<td>232</td>
<td>281</td>
<td>281</td>
<td>290</td>
<td>301</td>
<td>300</td>
<td>325</td>
<td>350</td>
<td>375</td>
<td>400</td>
</tr>
<tr>
<td><strong>Biofuels of the article 21.2 (2009/28/CE)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>52</td>
<td>52</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td><strong>Biofuels imported</strong></td>
<td>0</td>
<td>25</td>
<td>15</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Biodiesel</strong></td>
<td>145</td>
<td>1,471</td>
<td>1,471</td>
<td>1,493</td>
<td>1,493</td>
<td>1,990</td>
<td>2,169</td>
<td>2,450</td>
<td>2,600</td>
<td>2,750</td>
<td>2,900</td>
<td>3,100</td>
</tr>
<tr>
<td><strong>Biofuels of the article 21.2 (2009/28/CE)</strong></td>
<td>0</td>
<td>50</td>
<td>55</td>
<td>55</td>
<td>60</td>
<td>65</td>
<td>161</td>
<td>170</td>
<td>175</td>
<td>180</td>
<td>190</td>
<td>200</td>
</tr>
<tr>
<td><strong>Biofuels imported</strong></td>
<td>0</td>
<td>910</td>
<td>515</td>
<td>373</td>
<td>299</td>
<td>299</td>
<td>325</td>
<td>245</td>
<td>260</td>
<td>275</td>
<td>290</td>
<td>310</td>
</tr>
<tr>
<td><strong>Hydrogen from renewable resources</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Power from renewable resources</strong></td>
<td>107.9</td>
<td>99.1</td>
<td>130.5</td>
<td>152.9</td>
<td>175.8</td>
<td>195.5</td>
<td>223.6</td>
<td>252.4</td>
<td>282.3</td>
<td>312.6</td>
<td>346.3</td>
<td>381.2</td>
</tr>
<tr>
<td>For transport by road</td>
<td>0.0</td>
<td>0.1</td>
<td>0.9</td>
<td>3.1</td>
<td>6.8</td>
<td>12.3</td>
<td>30.6</td>
<td>48.3</td>
<td>66.5</td>
<td>84.6</td>
<td>103.6</td>
<td>122.9</td>
</tr>
<tr>
<td>For transport different from a road</td>
<td>108</td>
<td>99</td>
<td>130</td>
<td>150</td>
<td>169</td>
<td>183</td>
<td>193</td>
<td>204</td>
<td>216</td>
<td>228</td>
<td>243</td>
<td>258</td>
</tr>
<tr>
<td><strong>Others like vegetable oils, biogas and others</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Biofuels of the article 21.2 (2009/28/CE)</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>366</td>
<td>1,802</td>
<td>1,833</td>
<td>1,927</td>
<td>1,950</td>
<td>2,477</td>
<td>2,695</td>
<td>3,004</td>
<td>3,209</td>
<td>3,416</td>
<td>3,624</td>
<td>3,885</td>
</tr>
</tbody>
</table>

Table 23: estimation of the total contribution expected of each renewable energy technology in Spain aimed at meeting the binding targets for 2020 and the indicative interim trajectory for the shares of energy from renewable resources in the transport sector 2013.
9. LIBRARY AND SOURCES

1. CETA


8. A.A.V.V. 2006 “Energia dalle biomasse. Le tecnologie, i vantaggi per i processi produttivi, i valori economici e ambientali”, Progetto Novimpresa


11. “Biofuels and in direct land use change”, October 2011


15 CRES – Centre for Renewable Energy Sources and Saving (http://www.cres.gr)
16 http://www.ypeka.gr/LinkClick.aspx?fileticket=CEYdUkQ719k%3D&tabid=37
17 http://www.gsis.gr/teloneia/xrisimes_plirofories_teloneia/efk/efk2.htm
18 http://www.investingreece.gov.gr
20 MITyC / IDAE
21 PANER 2011-2020
This administrative handbook contains the guidelines to start up in the EU the chain to produce energy (i.e. bioethanol, electricity and heat) from sweet sorghum and furthermore it completes the technical description of the EU model with the treatment of the current politico-economical conditions, that favour or not the start up of these entrepreneurship in the countries of the consortium (i.e. Italy, Greece, Spain).

The handbook is mainly target at investors, policy makers and representatives of public authorities and energy agencies.