# TRANSPORT BIOFUELS. ENVIRONMENTAL CONCERN IN EU AND THE POTENTIAL OF S. EUROPE FOR SUSTAINABLE AND LOW COST BIOFUELS

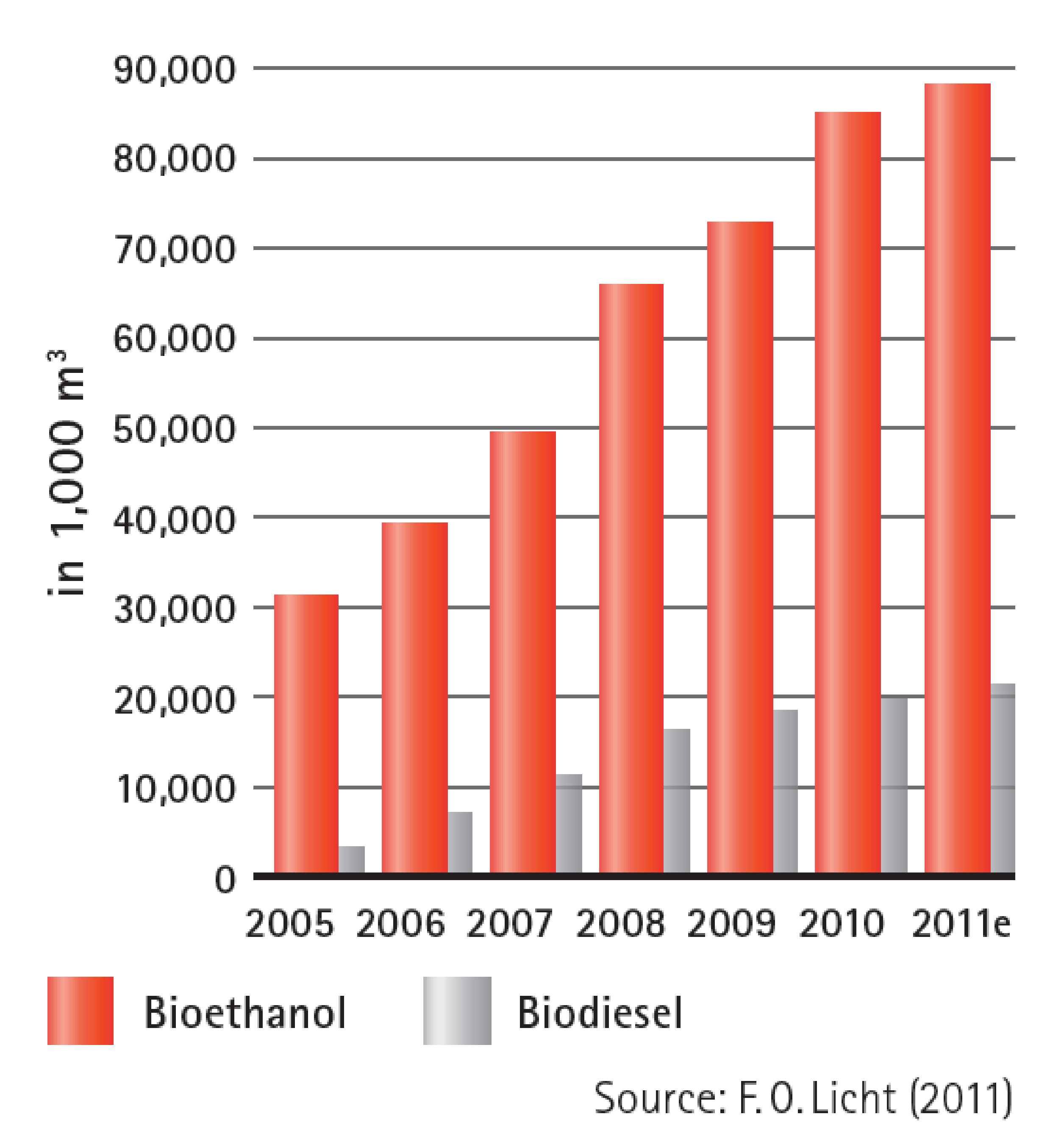

Spyros Kyritsis

President of the Hellenic Agricultural Academy

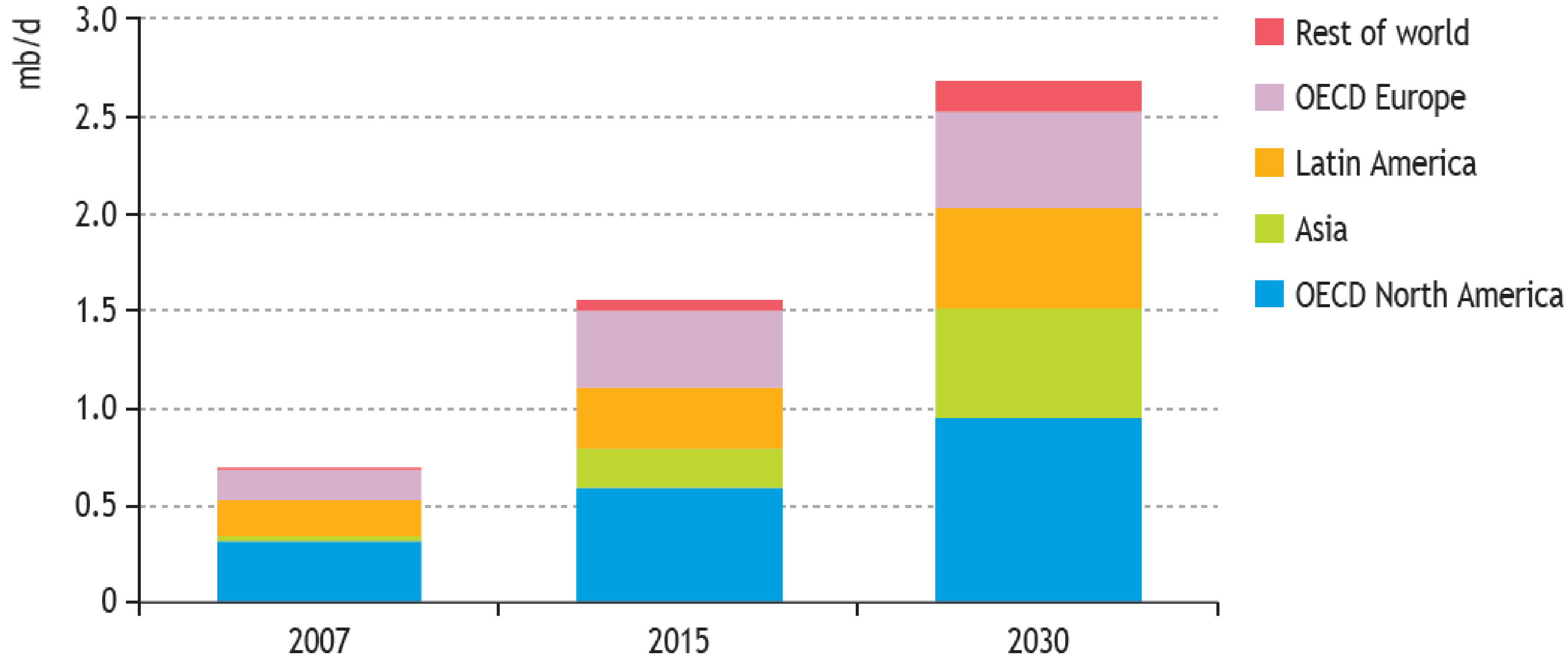

**Invited speaker in " SMART CHP E.C. project" meeting in CERTH/CPERI**

**THESSALONIKI October 2012**

Figure 1: Worldwide biofuels production [16]



# Figure 2: Worldwide demand for biofuels by Regions [15] (In the reference scenario)

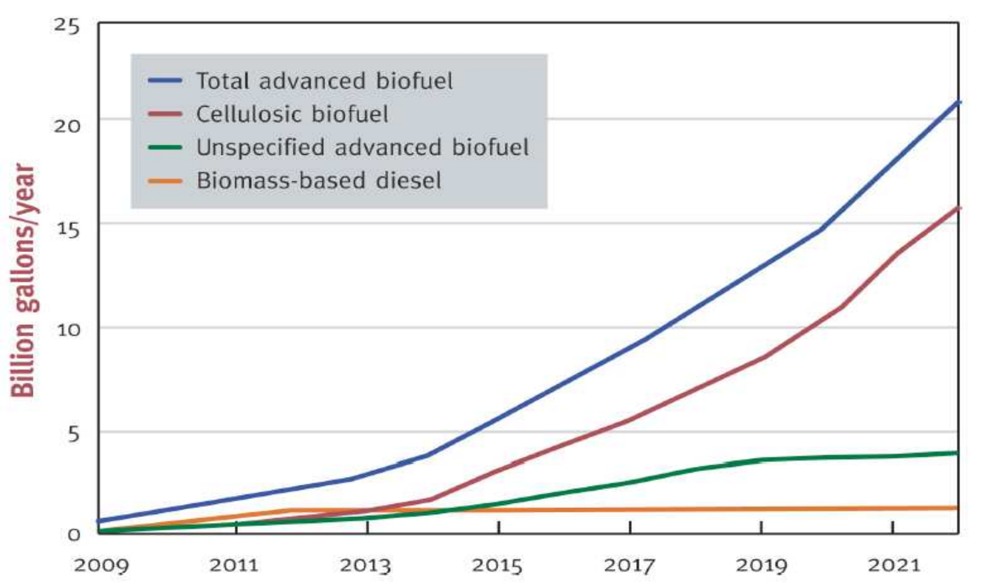



Note: On an energy-equivalent basis.

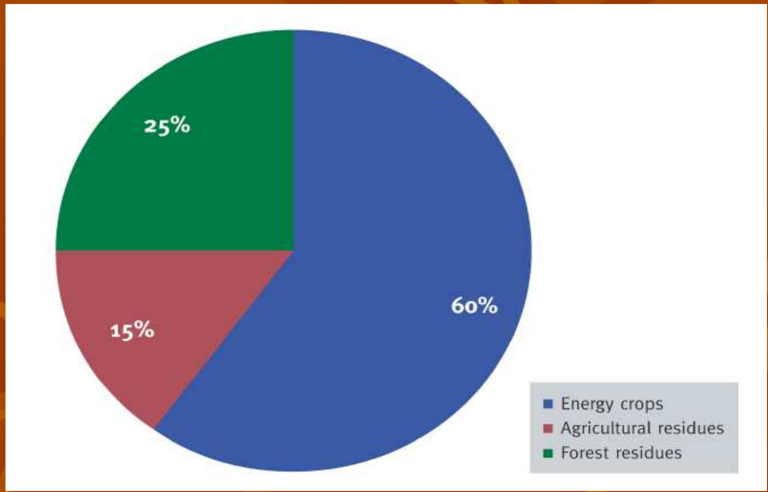
# 1. The US policy on transport biofuels

## National Priorities

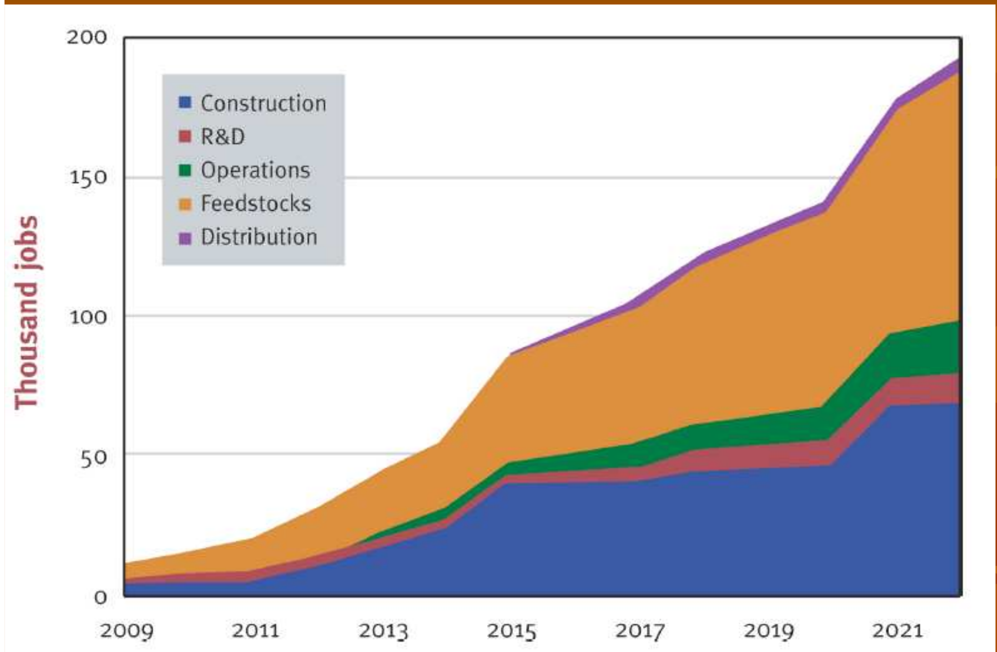
3.1. National security of fuels supply
3.2. Creation of new Jobs
3.3. Support of National Economy




**Picture 3a. Production of advanced bio fuels in USA according the Renewable Fuel Standard .** Targeted Cost: $0.50/lit
*(Source: bio-era Study, 2009)*[17]

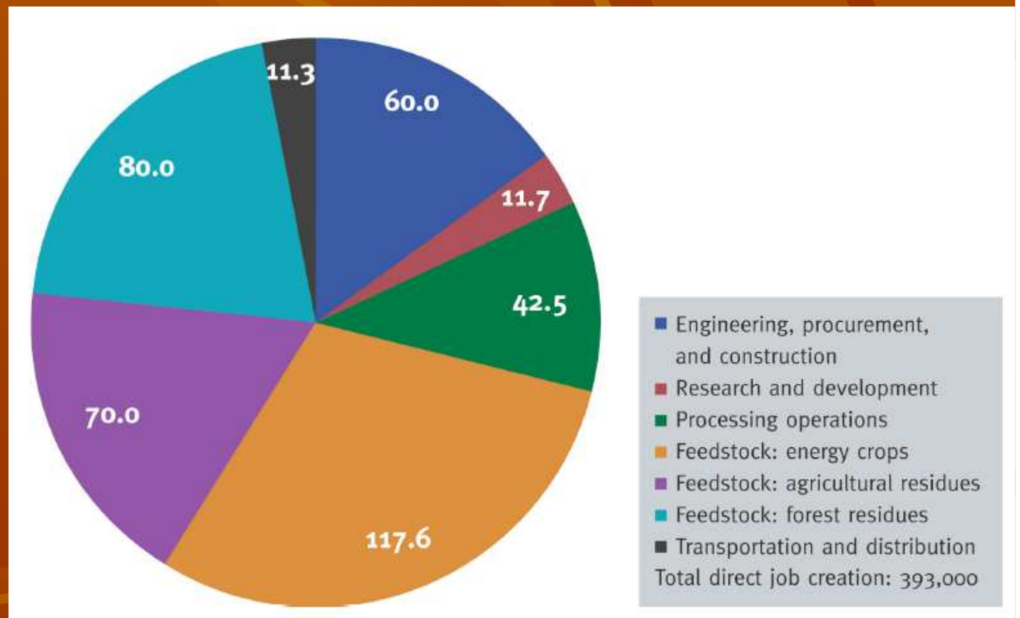



**Picture 3b. The Biomass required the year 2030 for the production of 70 M.m3 advanced bio-fuels is 470 M.t dried Biomass. Source*: bio-era Study, 2009)*** [17].




**Picture 4a. Direct jobs creation from advanced bio-fuels the year 2022.**
*(Source: bio-era study, USA 2009)* [17].

The year 2030 estimations are for 400,000 new direct jobs.




**Picture 4b. Distribution of the direct new jobs (x1000) from advanced bio-fuels the year 2030.**
*(Source: bio-era study, USA 2009)* [17].

Table 1. Indirect (direct x 5) economic results expected in USA from the production of 170 $M.m^3$ advanced bio-fuels the year 2030 *(Source: bio-era Study, USA, 2009)* [17].

| FROM | Billion $ | % |
|---|---|---|
| Constructions and Equipment | 11.5 | 10.2% |
| R&D+royalties | 3.2 | 2.9% |
| Biomass (production, collection, distribution ) | 23.7 | 21.0% |
| Processing –Operation of the Factory | 65.3 | 57.9% |
| Bio-fuels distribution | 9.0 | 8.0% |
| Total direct economic result | 112.6 | |
| Total indirect economic result | 299.6 | |

## 2. EUROPEAN UNION POLICY ON TRANSPORT BIO-FUELS

**EU took measures to:**

**- avoid GHG, as first priority**
**- to create new Jobs,**
**- to support EU-27 economy and**
**- to secure the fuel supply.**

**EU issues(among other more recent relative decisions):**
**- Directive 2009/28/EC, supporting the RES penetration in the EU-27 and**
**- Directive 2009/30/EC, on bio-fuels quality.**

**The EU DIRECTIVE 2009/28/EC FOR THE RENEWABLE ENERGIES [18]**

**This directive could be summarized in the following:**

**20% increase in energy efficiency**
**20% reduction in greenhouse gas (GHG) emissions($CO_2$,$CH_4$,and $N_2O$)**
**20% share of renewables in overall EU energy consumption by 2020**
**10% biofuel component in vehicle fuel by 2020.**

The main elements of these articles are summarized below.

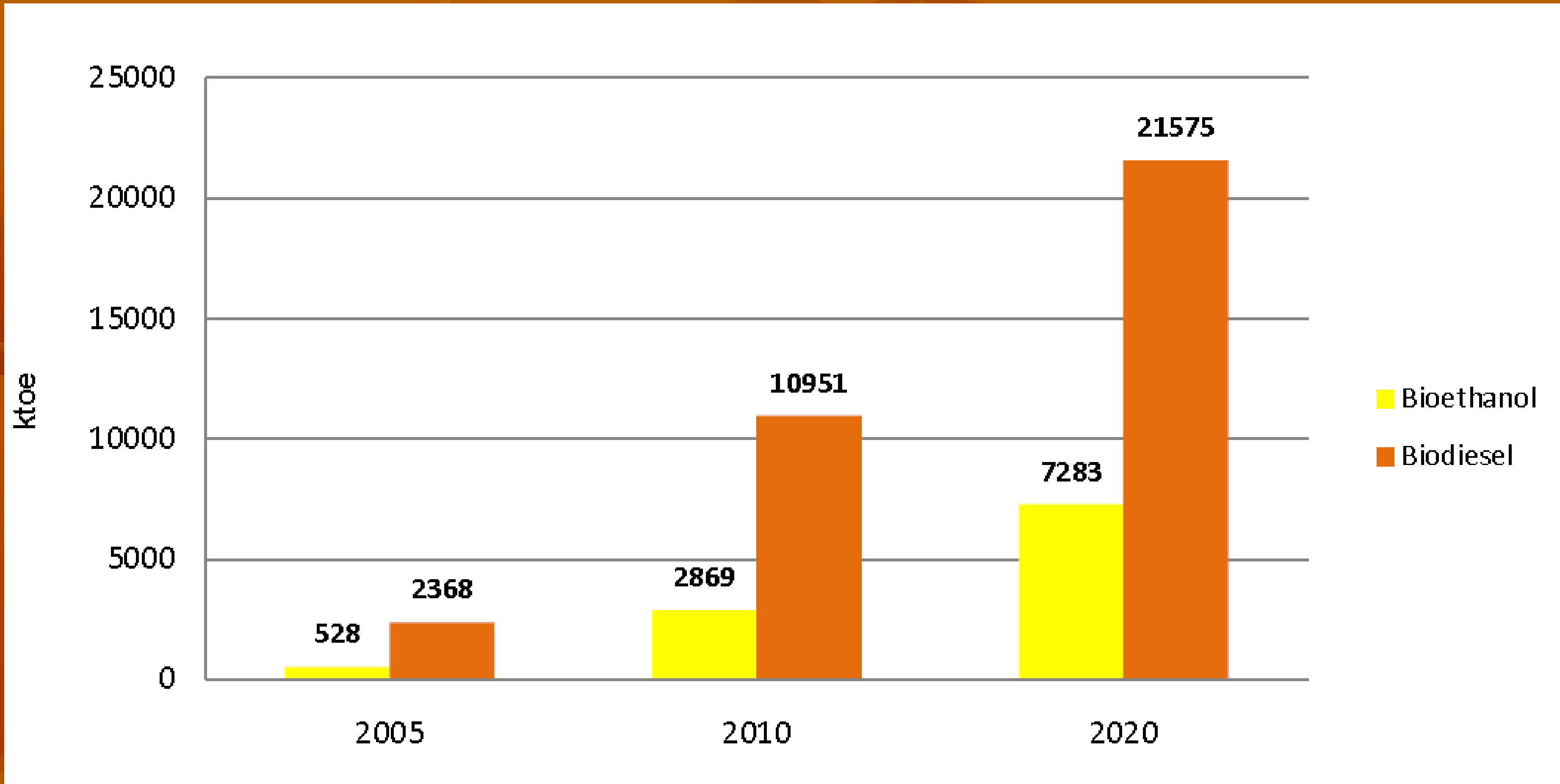
The raw materials coming from inside or outside the territory of the Community, they have to fulfill the following sustainability criteria:

•The GHG emission saving from the use of bio-fuels shall be **at least 35%.**
from 1 January 2017, the GHG emission saving shall be **at least 50%**
from 1 January 2018 that GHG emissions saving shall be **at least 60 %**

•Bio-fuels not be made from raw material obtained from land with **high biodiversity value**
•
•Bio-fuels shall not be made from raw material obtained from land with **high carbon stock (i.e. wetlands, continuously forested areas).**

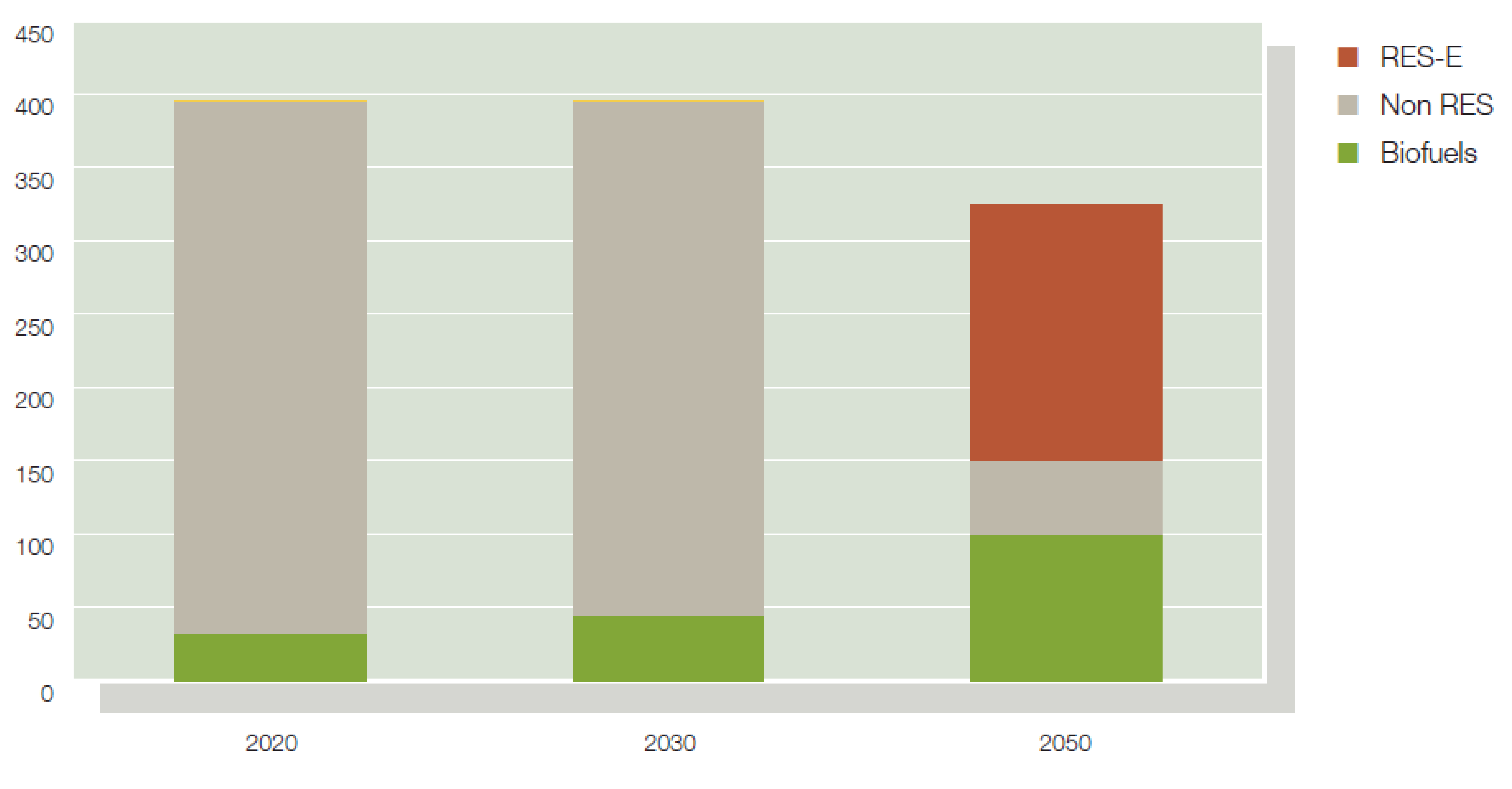
•Bio-fuels shall not be made from raw material obtained from **peatland**.

Note. For more details see the articles of EU Directive 2009/28/EC:
Article 17. Sustainability criteria for biofuels and bioliquids
Article 18. Verification of compliance with the sustainability criteria for biofuels and bioliquids
Article 19. Calculation of the greenhouse gas impact of biofuels and bioliquids
Article 20. Implementing measures Article
21. Specific provisions related to energy from renewable sources in transport

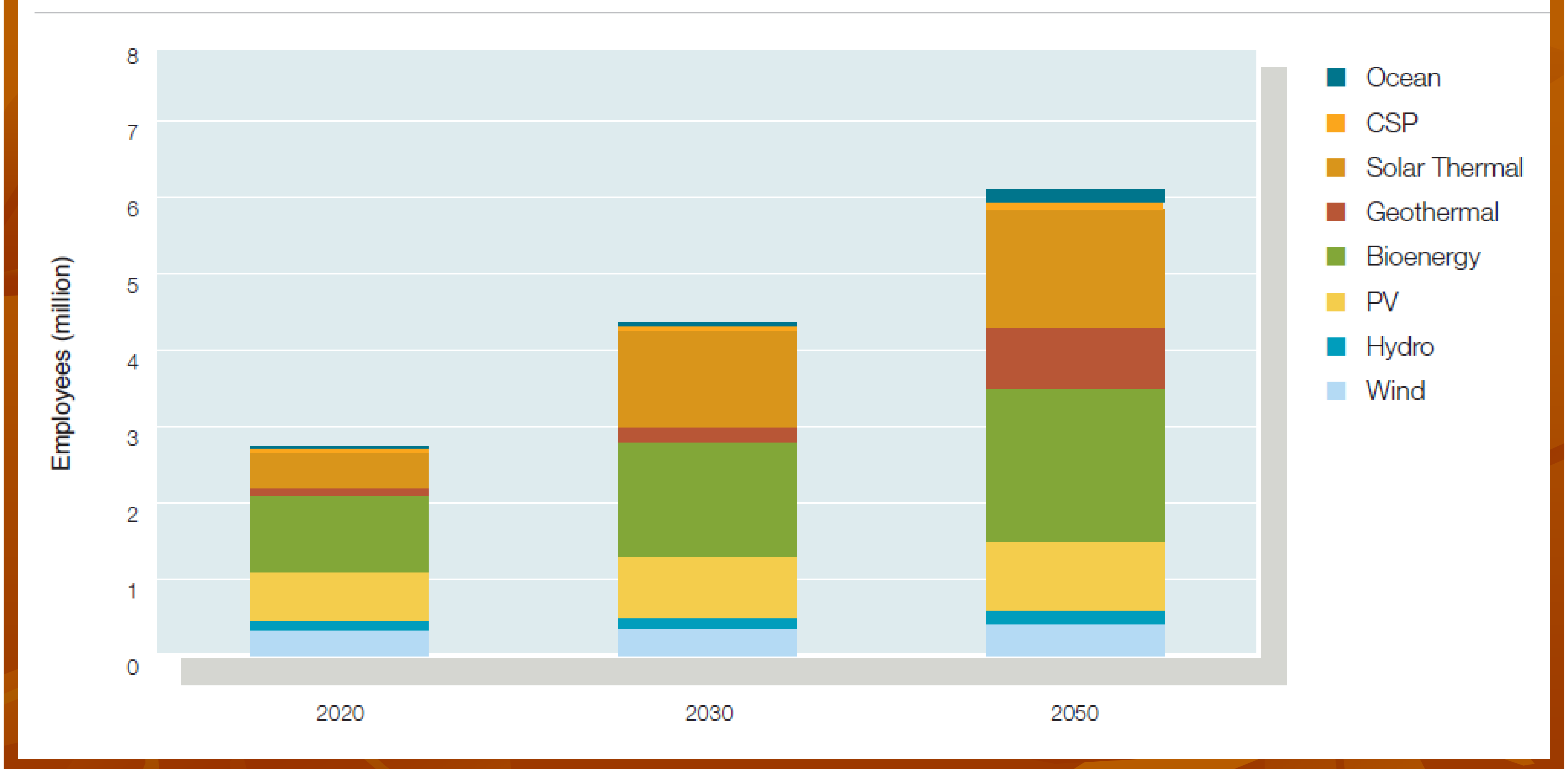



**Picture 5. Contribution of bio-fuels to transportations of the EU-27 (19)**

Fig.6. EREC estimation on biofuels contribution to fuel demand in EU (in M. toe) – Source: EREC [9]



# Fig. 7. Gross employment in the RES sector – Source EREC [9]




From 1 Million the year 2020

To 1.5 Million the year 2030 and

more 2 Million the year 2050

## 3. The dramatic dilemma of EU with regard to Bio-fuels

### 3.1. Sustainability problems

The current European regulation excludes bio-fuels that reduce $CO_2$ emissions by less than 35% from their petroleum equivalent.
So, factoring in ILUC (Indirect Land Use Change) estimates are expected to push several key biodiesel feedstock's **beyond** this threshold (as they are palm oil, soya oil, and rapeseed oil). These feedstock's are the cheapest to produce but are also the least energy-efficient (see Table).

Diesel share in oil product (IEA [(6)] ) will grow from 42% in 2011 to 44% in 2016.
So, biodiesel in EU is expected to meet 2/3 of bio-fuels consumption by 2020, and companies such as Neste, Cargil, Sofiproteol and Abengoa have invested about E 13 billion in EU biodiesel production capacity.

But if biodiesel from feedstock with a high carbon footprint is excluded from EU targets (the reasons of EU encouraging bio-fuel use is purely **environmental and not energy security** like in US, said Mariene Holzner, EC energy spokeswoman),

**much of this investment would be wasted, and increased bio-ethanol production and imports would be unlikely to fully make up the difference**.

**Table 2. ESTIMATED CARBON EMISSIONS FOR DIFFERENT FUEL TYPES**

(Including ILUC)*

| | |
|---|---|
| Tar sands | 107.0 |
| Crude oil | 87.5 |
| Palm oil | 105.0 |
| Soya bean | 103.0 |
| Rapeseed | 95.0 |
| Sunflower | 86.0 |
| Palm oil with methane capture | 83.0 |
| Wheat | 35-64 |
| Corn | 43.0 |
| Sugar | 34-36 |
| 2nd. generation cellulosic ethanol | 9-32 |
| 2nd. generation cellulosic biodiesel | 9-21 |

Source: EC, EurActive(6)

* ILUC=Indirect Land Use Change

## 3.2. Food security problem

Probably EU will eliminate food-crop subsidies for bio-fuels production by 2020 (2) as all of this coming from **food crops**, where it seems there is no much room for growth (2).

In a recent meeting (Oct. 2012 ) of EU bio-energy leaders they proposed "**to limit edible feedstock to just 5%"** (24)

The RCA-methodology (Responsible Cultivation Area) recommends three options to supply the additional feedstock demand for bio-fuels:

*expand energy crop production on "unused land" with low biodiversity and low carbon stocks;

*expand production through yield increases on existing plantations; or

*expand production through integration of energy crop and food-feed production.

Remarque's on RCA-methodology

-**The expansion of energy crop production on "unused land**" it seems to day an acceptable target, if we consider:

A. The algae production where the total global market over the short term future is estimated (1) to have an annual growth of 43% that will lead market volume from $ 271 M. in 2010 to $1.6 billion in 2015.

B. The advanced bio-fuels progress in US and EU. To that direction we face 2 problems:

B1. the **low productivity** of the feedstock, if we consider that:1Ha of corn provides 4.7 $m^3$ of fuel and 3.26 t of animal feed, and 1Ha of non food crop provides 1.12 $m^3$ of fuel and no edible products.

B2. the **high investment** and the final **high cost** of the produced ethanol or wood-diesel.

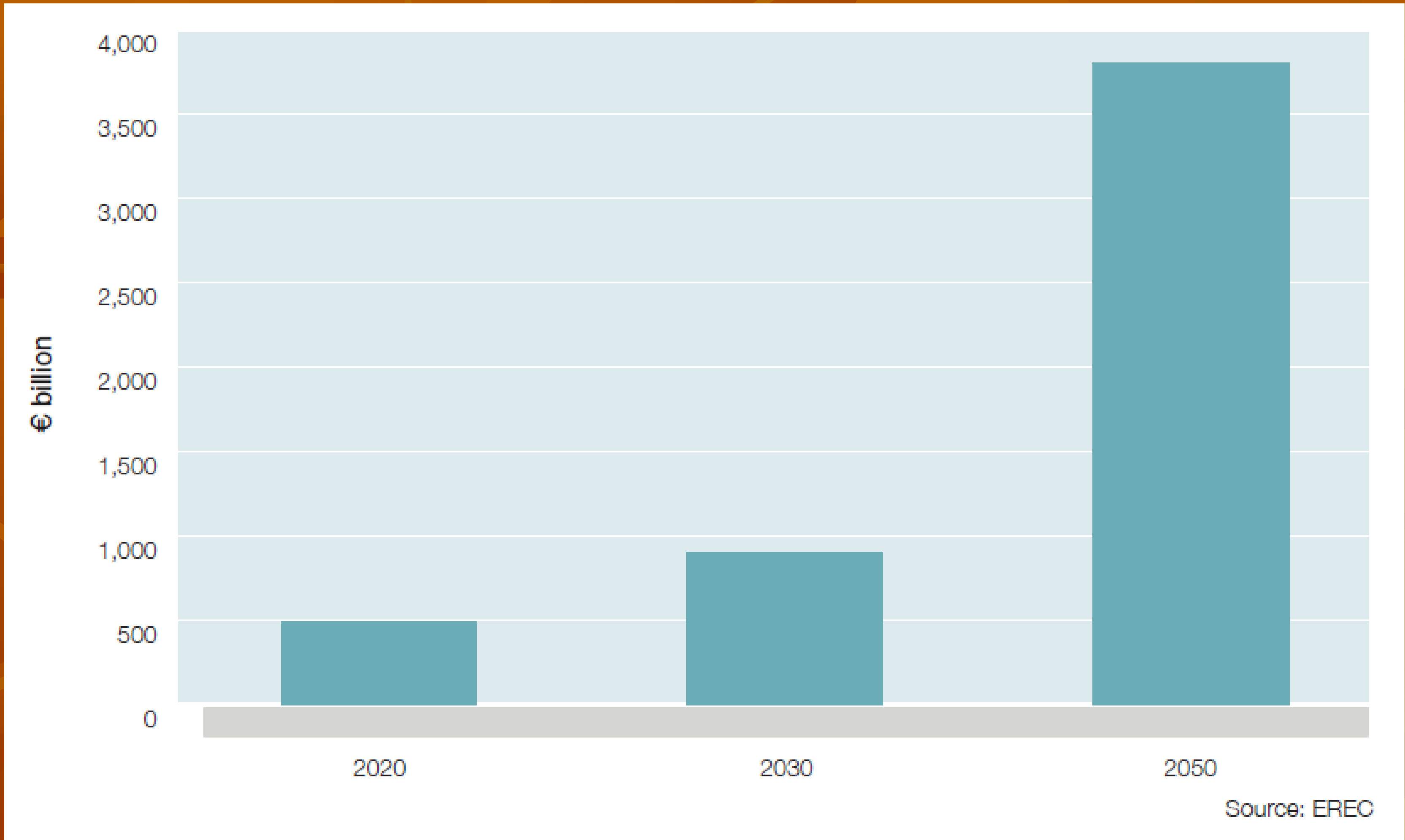
C. The new feedstock under investigation like the Seashore Mallow, Agave, and other, from which we should expect ( limited to my opinion ) solutions.

-**The expansion of the production through yield increase in existing plantations** seems also feasible as they are margins to increase yields further on to a certain point (ex. Hybrid Pennisetum in China, Sweet sorghum Hybrids from Ceres in Brazil [7], Jatropha Hybrids, etc...).But is impossible to solve only this way the huge future demand for bio-fuels in the world.

-**To expand production through integration of energy crop and food-feed production**, that option is feasible also to a certain point.
We have already encouraging results to that direction as they are:
* **the ICRISAT** efforts in India [21] to produce food and feed from Sweet sorghum's seeds and sugar ethanol from the stems,
* **the Nebraska University** [20] research gave good results as they manage to produce by rotation in the same year sugar and seeds ethanol from Sweet Sorghum and Vicia Velosa crop for animal feed and to cover N-fertilizer requirements of Sweet Sorghum plantation.

-We suggest, proposing to the above RCA-recommendations, a fourth option that is **to expand the use of the solid municipal wastes and part of the agricultural residues** for feedstock for advanced bio-fuels.
According to a study from" Bloomberg New Energy Finance" published in January 2012[8], only a small part of the existed agricultural residues in the world, could be enough to cover the world future demand for advanced Bio-ethanol.

Fig.9. $CO_2$ Costs Avoided due to the deployment of RE technologies – Source: EREC [9]




Considering $CO_2$ prices: E 41/t for 2020
E 45/t for 2030
E100/t for 2050

## 4. The potential of South Europe for sustainable and low cost bio-fuels

Given that:

a. The cost of bio-ethanol production in EU (especially in Central and North Europe) is and will remain high in comparison with the international cost (E 450/m3 in EU, compared to E 300 /m3 in US and E 200/m3 in Brazil ), resulting the imports of bio-ethanol mainly from USA and Brazil.

b. The produced bio-ethanol in EU is coming from food-feeds row material, cultivated in agricultural land (cereals, corn, and sugar beets).

c. The cellulosic ethanol and the BtL require huge industrial investments, and their cost will be high compared with the cost of the first generation bio-fuels (at least for the first years of their production).

The researchers are looking for alternative solutions, in parallel to their efforts to cut down the cost of advanced bio-fuels.

The objectives of these researchers are on new species and hybrids and also on new feedstock treatment, with the goal to produce low cost and sustainable transport bio-fuels.

It seems that among the most promising feedstocks are, for the time being, some Sweet sorghum species and hybrids, the Agave species, the hybrid pennisetum, some species of Giant reed and (list not finish) Eucalyptus species.

These feedstocks can give very good results only in some South European regions. Some other feedstocks can be produced also in Central and North Europe, but with much lower productivity in comparison to the same plantations in South Europe ( ex. Willow species and hybrids, Sweet sorghum and other).

As an example one can see the recent results of a comparative research in Germany ( N.52$^{o}$) and in Italy (N.42$^{o}$), with 6 different species of Sweet sorghum (Keller, M81E, Dale, Delta, Bovital and Goliath), where the biomass production and the sugar content were double in South Europe [(11)] .

## 4.1. What South Europe could expect from Sweet sorghum.

- Bio-ethanol production > 6t/ha.

- Co-production of seeds for feed or ethanol.

- Co-production of feed from the rotation in the same year of papilionaceai species *(ex. Vicia Velosa) and from the sub-products from the fermentation (vinasse).*

- Soil enrichment in $N_2$ fertilization able to cover the Sweet sorghun annual needs ( 50 units thanks to azotobacteria).
- Irrigation water needs 50% of corn production needs.

- Cost of bio-ethanol : E 200-250 /$m^3$

- Electricity co-production from the residues ( feed in Tarif for electricity in Greece 150 E/Mwh), or ethanol from cellulose ( 5 t/ha).

## *4.2. Bio-ethanol production from Agave Sp.*

Agave species could be produced ONLY in some regions of South Europe and it could be produced also in marginal land with rain fed irrigation water.

Some Agave species present huge productivity in ethanol production/ ha in non arable land , and can save 2,5 times more $CO_2$ compared with corn savings.

**Fig. 10. Energy production characteristics of Agave tequilana [12]**

**Agave tequilana weber**

Our enhanced cultivar produces:

- 3X more sugars than sugarcane, up to 42° Brix
- 8X more cellulose than the fastest-growing tree
  - 64.9% of its dry biomass is cellulose
- 4X more dry biomass than the GMO poplar tree, or the switchgrass
- 2X more fructose syrup than corn (pound for pound)
- 2X more inulin than licorice (pound for pound)
- Captures 4X more CO2 than any tree
- Other agave species can even double these numbers

## *5. A new model for sustainable and low cost bio-ethanol production developed in the South of USA.*

**A. Classical model for advanced bio-ethanol production in large industries.**

* Usual total cost for the industry installation: **$ 2.64/lit**

* High transportation cost for feedstock from the production place to the industry.

**B. The new model for the row material production and the processing for ethanol in the farm.**

* Investment cost for ethanol processing**: $ 0.264/lit**

* Ethanol processing in favor of the farmer's family income.

***** **2,3** times more jobs creation, besides the jobs for feedstock production.

**In USA this new model for ethanol production is supported by:**

1. The National Sorghum Producers (NSP)
2. The Sweet Sorghum Ethanol Association (SSEA)

**and the actual production of ethanol from Sweet sorghum > 8 b.lit/ year[13]**

# The new model for integrated production of ethanol

- The new Model for integrated ethanol production in the farm is also known in USA under the name SORGANOL, from McClune Industries. This company succeed a high productivity of Sweet sorghum >9m3/ha.
  They use also a special harvesting machinery called "Sor-Cane Harvester", that it collects Juice and filters it during harvesting

- The production cost of ethanol is: $ **0.132/lit**.

- The cost for the Sweet sorghum plantation is around the 1/4-1/3, compared with the cost of corn plantation.

- The duration of the plantation is 100-120 days for the 1$^{st}$ harvest and 60 days for the 2$^{nd}$ harvest (in southern regions).

## Comparison of SORGANOL with Corn Ethanol [14]

- Gains from bio-ethanol production/ha:

  -Corn ethanol: (10,000 kg/ha x \$0.189/kg=\$1,900/ha – production cost \$1,400/ha) =**<u>\$ 494/ha</u>**

  -SORGANOL: (7,496 lit/ha x \$0.63/lit=\$4,750/ha - \$790,7/ha production cost) =**<u>\$ 3,959/ha</u>**

- Gains from $CO_2$ emissions/ha:

-SORGANOL: 8.4 times less emissions $CO_2$ in comparison to corn ethanol.

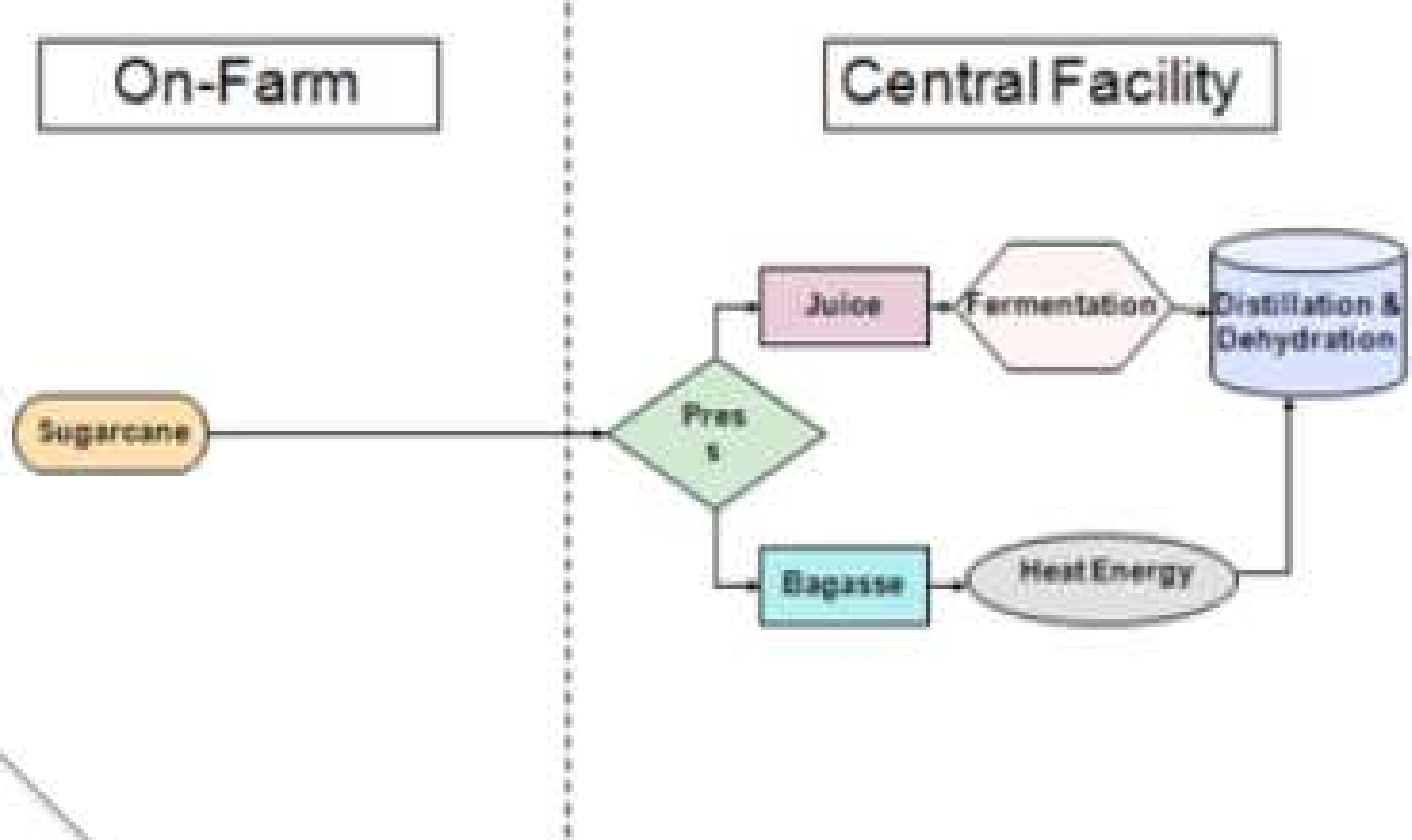
## 5.1. Advantages for South Europe and EU from the use of the new model for ethanol production from Sweet sorghum and Agave sp.

Sustainable and lower cost bio-ethanol production in comparison to ethanol produced and imported from USA or produced in the rest of EU, both not sustainable.

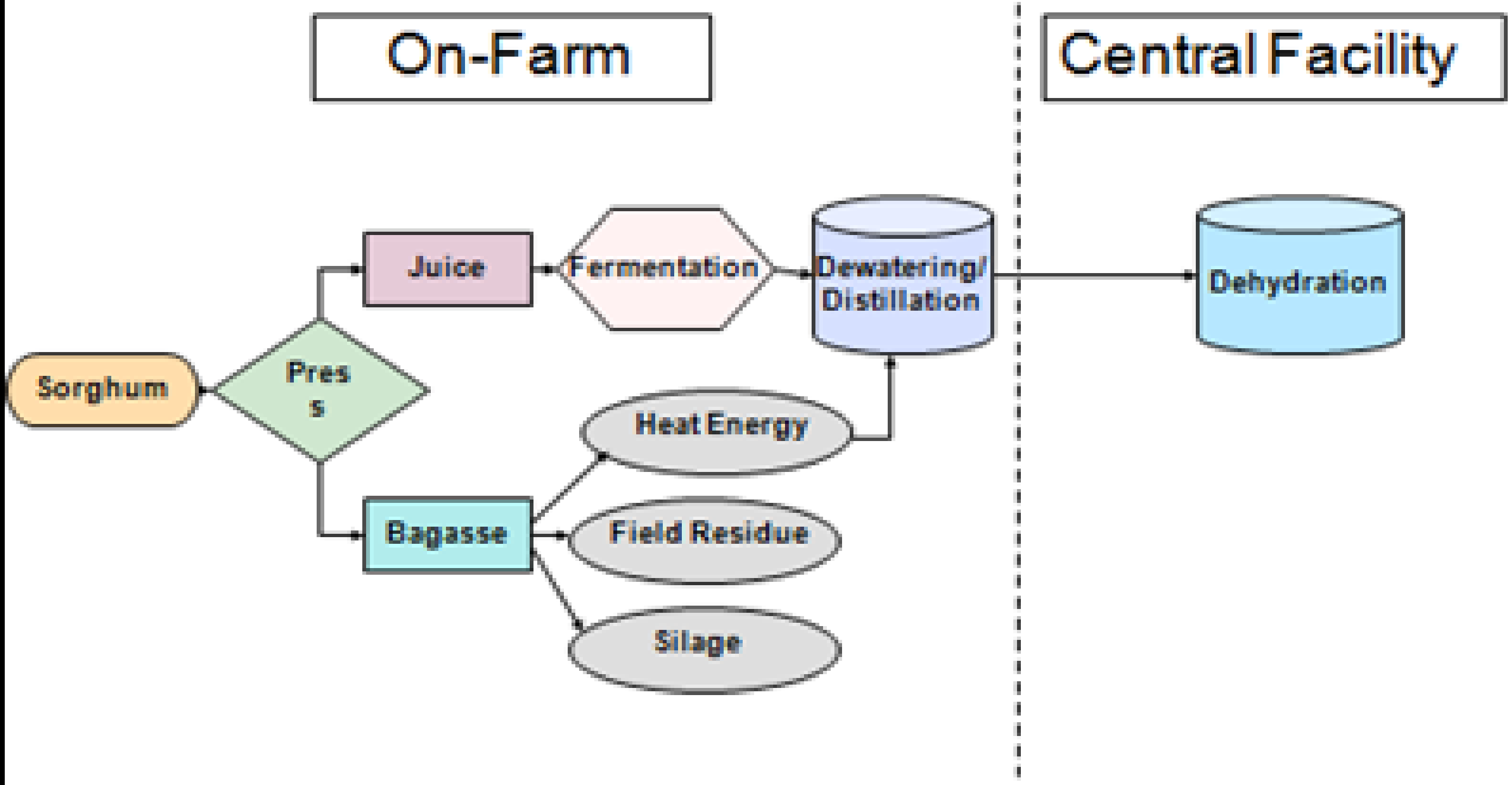
EU can produce bio-ethanol in competition in the world bio-ethanol market, and securing its fuels supply, gaining also economic advantages.

South Europe will create new direct and indirect jobs that is very important, especially today.

# Traditional Sugar Processing



# Potential In-Field Processing



# Fermentation

1.SBI Bulletin. 006/2012. “Algal Biofuels Technologies- Global Market and Product Trends”. www.sbireports.com
2.Jim Lane.09/2012. “Is the EU Abandoning Biofuels ?” Renewable Energy World. Com.10/2012
3. World of Bioenergy.com. 10/2012. “Thedemand for biofuels is expected to grow approximately 7% a year in the EU and to reach 10% the year 2020 in EU”
4. World of Bioenergy.com. 10/2012. “More bioenergy than oil inSweeden”.
5. Imke Luebbeke . 01/2011. “Closing the Sustainability Gap to ensure a sustainable future for biofuels”. WorldofRenewables.com/renewablesnews/bioenergy/closingthe sustainability 01/2011.
6. Jeremy Bowden. 08/2012. “Bioethanol vs Biodiesel. Europe hesitates over indirect impact of green fuel”. Renewable Energy World, 08/2012. www.renewableEnergyworld.com.
7. Ceres, Inc. 08/2010. “ Ceres opensBrazil Subsidiary to support Sweet sorghum Busines”. www.ceressementes.com.br.
8. Bloomberg. 2012. “ Moving Towards a next-generation ethanol economy”. Bloomberg New Energy Finance 2012.
9. Zervos A., Lins C., Muth J., 04/2010. “RE-thinking 2050. A 100% Renewable Energy Vision for the European Union”. EREC 2010.
10. Taylor p., 2008. “Scenarios and Strategies to 2050’. Energy Technology Perspectives 2008. IEA/OECD.
11. Ruggeri R.,Rossini F., Provenzano M.E., Del Puglia I.L.M. 2012. “Sweet sorghum Potentials as biofuel feedstock in two European growing areas”. 20th. European Biomass Conference, Milano 2012.
12. http//www.greenoptimistic.com/2011/08/09/agave.
13. www.surganol.com/ , www. Sorghumgrowers.com.
14. McClune Industries presents Sor-cane Harvester and SORGANOL Biofuel Innovations. LLC; 7 Potterville Main st. Reynolds, GA 31076D/B/A/ McCLUNE Industries.
15. IEA, 2009. “Biofuels outlook”. World Energy Outlook. IEA 2009, p.88
16. Bioethanol Report, 05/2011. “The fuel of the future”. www.Crop-energies.com.
17. Bio Economic Research Associates,2009. “US Economic Impact of Advanced Biofuels Production: Perspectives to 2030”.
18. EU Directive 2009/28/EC.
19. AEBIOM, 2011. “Annual Statistical Report”. 2011.
20. University of Nebraska, 2008. “Sweet Sorghum Research “. http://www.agronomy.unl.edu/newsfacultystaff/research/sweetsorghum.html.
21. Belan VS bReddy, Ramesh S., et all, 2009. “Sweet Sorghum, food, Feed, Folder and Fuel crop”.ICRISAT 2009. www.icrisat.org(Biopower)Index.html.
22. IEA. ”Biofuels road map”. 23. F.O.Licht’s, 2011. ”World Ethanol and Biofuels Report”. 24. M. Chaplin, 10/2012.”EU new plans..” renewableenergyworld.com, 17/10/2012. 26. Bellmer D,Huhnke R. 2010, ”In field Fermentation Issues”. www.bioenergycenter.okstate.edu

Thank you for your attention

skir@aua.gr