Grant agreement no. IEE/09/902/SI2558298

SWEETHANOL

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

Intelligent Energy – Europe (IEE)

ALTENER

Key action: BIOFUELS

Final Publishable Report

Period covered: from 16th May 2010 to 15th August 2012

Due date: 15th October 2012

Start date of the action: 16th May 2010
End date of the action: 15th August 2012

Duration: 27 months
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1. Final Report Summary

1.1 Sweethanol project

Sweethanol is a project financed and supported by the EC 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.

1.2 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 of Eastern Thessaloniki’s Local Authorities- 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 and sustainable energy actions 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 research, 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.

1.3 Objectives of the action

To reach the specific objective “The know-how diffusion about the sustainable EU model”, the experiences obtained in the visits in India, Peru and Spain were applied in the preparation of the “Sweethanol – Early manual” (D1.2) and were spread through the “Sweethanol – Video” (D2.2), the preliminary EU model was discussed in the participant countries in 15 national workshops (sectorial and intersectorial) and in 1 consortium intersectorial workshop and the shared EU model was described in 4 manuals (i.e. “Sweethanol – Technical manual” – D3.1, “Sweethanol – Administrative manual” – D3.2, “Sweethanol – Intersectorial manual” – D3.3, “Sweethanol – Manual for trainers” – D4.1) while its contents were explained in 92 courses for the stakeholders,
in 3 seminars, in 3 national final conferences, in 1 international final conference, in 28 articles and paper at national and international levels (D6.4, D6.5, D6.6), and in 10 “Sweetanol – Newsletters” (D6.3). All these activities brought sweet sorghum to light for its potentiality as ethanol feedstock, contributing moreover to well-informed debates on land use and sustainability of biofuels among stakeholders, decision makers and general public, engaging actively farmers. In all these activities 2,732 stakeholders were engaged.

To hit the specific objective “The daily updating through the network building and the supply chain coordination”, the Esse Community (D5.1) was created with forum and blog (D5.3, D5.4), teleconferences (D5.5), virtual library (D5.6) and all the main dissemination tools of the project. It is a virtual space, where the stakeholders can meet each other and can obtain daily updating about technical, economic, environmental questions about the EU model and the ethanol market in general. At this aim the Centre of Excellence is and will be available for the next 5 years to give assistance to the market players and its specific role is the coordination of chain initiatives to start up new entrepreneurship. The Esse community has evidenced a high participation (331 members) and vitality (43,731 visits and 314 conversations in forum and through the linked social networks, such as Facebook and Twitter) and it has resulted a flexible and effectiveness tool to create a network among the stakeholders, to simplify the realization of market analyses and feasibility studies, and to give elements for a well-informed debate and a balanced attitude among stakeholders and decision makers.

These elements represent the starting point to achieve the strategic objective, such as “The change in the structure of the EU ethanol market”.

On the contrary, currently in the EU is already increased the awareness about the energetic potentiality of sorghum and consequently the achievement of the strategic objective “The increased awareness about sweet sorghum as ethanol crop” appears very next. It is plausible that the spread discussions, carried out in the framework of the project, could have contributed to this result.
## 1.4 Achieved results and lessons learnt during the action

<table>
<thead>
<tr>
<th>Work performed</th>
<th>Main achieved results</th>
</tr>
</thead>
</table>
| **WP1 - Management** | |}

Identification of project coordinator (CO) (Task 1.1.), administrative contacts (project administrative manager PAM) (Task 1.2.), technical contacts (project manager PM, technical manager TM) (Task 1.3.) and members of the steering committee (SC) (Task 1.4.). The Romanian co-beneficiaries (i.e. BAR and Marex) did not indicate their TMs and members of the SC.

<table>
<thead>
<tr>
<th>WP1 - Management</th>
<th>Main achieved results</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general the partnership has been enforced and the present management of the project is functional.</td>
<td></td>
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</tbody>
</table>

- **On 8th June 2010: Kick Off Meeting (KOM) and first meeting of the SC in Gorizia (Italy).** The Romanian co-beneficiaries did not participate in the KOM without justified reasons (Tasks 1.1., 1.3.).

- **1st amendment to EACI in August 2010** the Romanian co-beneficiaries required the withdrawal. The other beneficiaries accepted the withdrawal. Consequently the diffusion activities in Romania were erased, whereas the communication activities of the project in charge of BAR were taken by REACM. In September 2010 as a consequence of the withdrawal of the Romanian co-beneficiaries, the communication activities of WP6 significantly lagged. The amendment for the withdrawal of BAR and Marex and for the postponement (3 months: duration from 24 to 27 months) was required to EACI (Tasks 1.1., 1.3.).

<table>
<thead>
<tr>
<th>WP1 - Management</th>
<th>Main achieved results</th>
</tr>
</thead>
<tbody>
<tr>
<td>In April 2011 this amendment required was accepted by the EACI and sent to the Lead partner, CETA.</td>
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</table>

- **In accordance with the Annex III and the Article I.6.2 of the Grant Agreement at the beginning of January 2011 the Technical Progress Report and the related deliverables were sent to EACI (Tasks 1.1., 1.3.).**

- **On 24th February 2011: the half-year meeting and SC meetings in Rome (Italy) at the offices of INIPA (Task 1.3.).**

- **2nd amendment to EACI: since 15th February 2011 the offices of CETA are located in via Licinio 44, Gorizia (Italy) and since 1st June In December 2011 CETA received the communication about the acceptance of the required amendment.**
2011 Mr. Maurizio Trevisan has taken the place of Mr. Alessandro Bon as CO, because Mr. Alessandro Bon resigned (Tasks 1.1., 1.3.).

On 22nd and 23rd September 2011: the half-year meeting and SC meeting in Gorizia (Italy) (Tasks 1.1., 1.3.).

In accordance with the Annex III and Articles I.5 and I.6 of the Grant Agreement, on 3rd October 2011 the ad interim technical implementation report and ad interim financial statement were delivered to EACI (Tasks 1.1., 1.3.).

On 28th October 2011 CETA, as Lead partner, received an email with the comments of the Financial Officer of the project (FO) about the ad interim financial statement and on 2nd November 2011 CETA, as Lead partner, sent a consolidated answer to the FO (Tasks 1.1., 1.3.).

On 6th December 2011 CETA, as Lead partner, received the comments of the Project Officer (PO) and on 22nd December 2011 CETA, as Lead partner, sent to the PO the consolidated explanations (Tasks 1.1., 1.3.).

CETA collected the explanations of the beneficiaries.

WP2 – Know-how refining

The chain actors to invite to the visits were engaged (Task 2.1.).

10 chain actors were engaged.

The visits of seeds suppliers, technology suppliers and existing plants were carried out outside the EU (i.e. India, Peru) and in the EU (i.e. Spain) (Tasks 2.2., 2.3., 2.4.). 12 visits were performed:

- 4 to agricultural institutes
- 8 to technology suppliers and existing plants.

The “Sweethanol – Early manual” (D2.1) was realised in Italian, Spanish, Greek and English (Task 2.5.).

2,000 copies were printed.
750 CDs rom were prepared.
The deliverable (D2.1) is attached to this report.
The images of the visits in India, Peru and Spain were minutely reported in the “Sweethanol – Video” (D2.2) (Task 2.5.).

WP3 – Sustainable model discussion

623 visualizations during the project lifetime were performed.
The deliverable (D2.2) is attached to this report.

In Italy 1 pilot experience about the use of sweet sorghum as ethanol crop was identified at Bertolino Group (Partinico, Trapani, Sicily Region). The representative participated in NTW2 and NIW in Italy.

In total 655 chain actors: 368 chain actors in the NTW1
123 chain actors in the NTW2
58 chain actors in the NAW
106 chain actors in the NIW.

In Italy in total 216 chain actors:
77 people in NTW1 in Turin, 67 people in NTW1 in Padua, 26 people in NTW2 in Padua, 23 people in NAW in Udine, 23 people in NIW in Padua.

In Greece in total 210 chain actors:
62 people in the NTW1 in Delta, 37 people in the NTW1 in Thermi, 62 people in the NTW2 in Delta, 17 people in the NAW; 32 people in the NIW in Thessaloniki.

In Spain in total 229 chain actors:
51 people in NTW1 in Madrid, 74 people in NTW1 in Boecillo, 35 people in NTW2 in Boecillo, 18 people in NAW in Valladolid, 51 in NIW in Madrid.

In total 1,487 chain actors were trained:

WP4 – Chain actors training

92 courses for the chain actors were conducted.

The following manuals were realised in Italian, Spanish, Greek and English, using the results of the discussion about the EU model (Task 3.3.):

“Sweethanol – Technical manual” (D3.1): 2,400 copies were printed, 900 CDs rom.
“Sweethanol – Administrative manual” (D3.2): 2,400 copies printed, 900 CDs rom prepared.

The “Sweethanol – Intersectorial manual” (D3.3) was realised in Italian, Spanish, Greek and English, using the results of the discussion about the EU model (Task 3.4.):

“Sweethanol – Intersectorial manual”: 2,550 copies printed, 950 CDs rom and 850 USB memories.
performed in the consortium (Tasks 4.1., 4.2., 4.3.): 71 courses for farmers, 3 courses for representatives of seeds companies, 5 course for investors, 3 course for fuel processors and SMEs representatives, 6 course for policy makers, public authorities and energy agencies representatives, 4 for technicians of agricultural associations.

In Italy in total 31 courses were held: 24 for farmers, 1 for representatives of seeds companies, 2 for investors, 1 for fuel processors and SMEs representatives, 2 for policy makers, public authorities and energy agencies representatives, 1 for technicians of agricultural associations.

In Greece in total 24 courses were held: 17 for farmers, 1 for representatives of seeds companies, 1 for investors, 1 for fuel processors and SMEs representatives, 2 for policy makers, public authorities and energy agencies representatives, 2 for technicians of agricultural associations.

In Spain in total 37 courses were held: 30 for farmers, 1 for representatives of seeds companies, 1 for investors, 1 for fuel processors and SMEs representatives, 2 for policy makers, public authorities and energy agencies representatives, 2 for technicians of agricultural associations.

The “Sweethanol – Manual for trainers” (D4.1) was realised in Italian, Spanish, Greek and English (Task 4.2.).

1,242 farmers, 27 representatives of seeds companies, 54 investors, 27 fuel processors and SMEs representatives, 78 policy makers, public authorities and energy agencies representatives, 59 technicians of agricultural associations.

In Italy 515 chain actors: 406 farmers, 5 representatives of seeds companies, 22 investors, 14 fuel processors and SMEs representatives, 45 policy makers, public authorities and energy agencies representatives, 23 technicians of agricultural associations.

In Greece 432 chain actors: 386 farmers, 10 representatives of seeds companies, 2 investors, 2 fuel processors and SMEs representatives, 10 policy maker, public authorities and energy agencies representatives, 22 technicians of agricultural associations.

In Spain 540 chain actors: 450 farmers, 12 representatives of seeds companies, 30 investors, 11 fuel processors and SMEs representatives, 23 policy makers, public authorities and energy agencies representatives, 14 technicians of agricultural associations.

1,750 CDs rom were realised

3 seminars were held in the consortium (Task 4.2.).

39 participants:
14 in Italy, 10 in Greece, 15 in Spain

Assistance during the training courses and beyond their end (Task 4.4.).

The technical manager answered to the questions, required by the stakeholders and the consortium is keeping in touch with them.

WP5 – Online community

The chain actors to invite to the online community (i.e. Esse Community) were identified with the support of the subcontractor InfoFACTORY S.r.l. (Task 5.1.).

Number of members: 331
Number of countries: 42, that are: Italy, Greece, Spain, United States, Indonesia, Mozambique, Colombia, South Africa, Nigeria, Thailand, Australia, Philippines, China, Uganda, Romania, Israel, United Kingdom, Portugal,
France, Dominican Republic, Kenya, Argentina, Germany, Ireland, Uruguay, India, Malta, Peru, Cambodia, Zambia, Poland, Iceland, Mexico, Cyprus, Brazil, Madagascar, Guatemala, Zimbabwe, Denmark, Canada, Ecuador, Finland.
In the EU the most represented countries are Italy, Spain and Greece, respectively. Outside the EU the most interested countries are the US, India, Philippines, Indonesia and Colombia.

| Number of the registered enterprises operating in the ethanol sector: 79 |

The Esse Community (D5.1) and related tools (i.e. web monitoring service – D5.2, forum – D5.3, blog D5.4, logo – D5.7) were created (http://esse-community.eu) by the subcontractor InfoFACTORY S.r.l.. The languages available for the navigation are English, Italian, Spanish, Greek. The Esse Community has accounts on Facebook (https://www.facebook.com/essecommunity) and Twitter (http://twitter.com/#!/essecommunity).

4 teleconferences were performed (Task 5.2.).

The peopling and monitoring of the Esse Community were carried out with the support of the subcontractor InfoFACTORY S.r.l. (Task 5.3.).

The “Sweethanol - Virtual library” was created with the support of the subcontractor InfoFACTORY S.r.l. (Task 5.4.) and the useful documents were uploaded.

On 15th August 2012 37 documents are present and downloadable from the registered members.

<table>
<thead>
<tr>
<th>WP6 - Communication</th>
</tr>
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<tbody>
<tr>
<td>The communication was managed by REACM (Task 6.1.)</td>
</tr>
<tr>
<td>The management of the project is functional.</td>
</tr>
<tr>
<td>The domain for the “Sweetanol – Website” was registered in July 2010. The “Sweetanol – Website” (D6.1) is active and it can be utilised in English, Italian, Greek and Spanish (Task 6.2.) (<a href="http://sweethanol.eu">http://sweethanol.eu</a>).</td>
</tr>
<tr>
<td>Since the 4th May 2011 to the 15th August 2012 there were 2,359 visits to the Sweetanol webpage, with 5,905 page views.</td>
</tr>
<tr>
<td>The “Sweetanol – Brochure” (D6.2) were realised and 10 “Sweetanol – Newsletters” were sent to the registered chain actors. They are available in English, Italian, Greek and</td>
</tr>
<tr>
<td>4,700 copies of the “Sweetanol – Brochure” were printed.</td>
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</tbody>
</table>
### Spanish (Task 6.3.)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Participants/Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 national final conference were performed (Task 6.4.)</td>
<td>153 participants:</td>
</tr>
<tr>
<td></td>
<td>21 participants in Italy</td>
</tr>
<tr>
<td></td>
<td>70 participants in Greece</td>
</tr>
<tr>
<td></td>
<td>62 participants in Spain</td>
</tr>
<tr>
<td>1 international final conference was performed in Greece (Task 6.4.)</td>
<td>54 participants</td>
</tr>
<tr>
<td>10 participations to national and international conferences to present the Sweethanol project (Task 6.4.)</td>
<td>-</td>
</tr>
<tr>
<td>28 publications were performed (Task 6.5.):</td>
<td>-</td>
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<tr>
<td>3 scientific papers were published in international review</td>
<td>-</td>
</tr>
<tr>
<td>3 national scientific papers were published in local languages</td>
<td>-</td>
</tr>
<tr>
<td>22 popular and technical articles were published in local languages</td>
<td>-</td>
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</table>

#### WP7 – IEE dissemination activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>The fact-sheets to update the EACI were prepared in June 2010, December 2010, August 2011, August 2012 (D1.3) (Task 7.1.)</td>
<td>-</td>
</tr>
<tr>
<td>The slides for the presentation of the Sweethanol project have been prepared in June 2010 (D7.1) (Task 7.2.).</td>
<td>-</td>
</tr>
<tr>
<td>1 article on local paper has been written in an interview with the IEE-Magazine journalist in December 2010 (Task 7.2.).</td>
<td>-</td>
</tr>
<tr>
<td>The CO presented to the Project Officer the Indicators of the project with the target to 2020 (D7.2).</td>
<td>-</td>
</tr>
<tr>
<td>The CO participated in the “IEE co-coordinators training”, that was carried out in Brussels in 27th-28th May 2010 (Task 7.3.).</td>
<td>-</td>
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</tbody>
</table>

As regards with the **lesson learnt**, the Esse Community is an effective and actual tool to maintain the relationships among the chain actors and it is contributing actively to create and increase a network. The Esse Community will be the point of reference about the topics of the project also in the next years. At the current time the engagement of the agricultural associations represents the main intermediary to involve also farmers in the bioethanol chain. The effectiveness of the
Esse Community has been very useful above all to update the stakeholders, to create new contacts and to answer to their specific questions.

Concerning the applicability of the contents of the project (i.e. the EU model), tested in the dissemination activities of the project, the positions of the consortium countries are different. The Italian energy policy is moving towards the support to sweet sorghum as ethanol crop. In fact at the current time, in accordance with the ministerial decree of 6th July 2012, sweet sorghum is specifically supported when it is used to produce electricity in short chain, because in Italy is considered a non-food crop. The next expected step is the acknowledgment of a specific bonus for the ethanol obtained from this crop, exactly as is the case of other non-food ethanol raw materials (e.g. residues of wine chain), which have the double counting to achieve the target by 2020. The implementation of the EU model in Spain is good and it could be done mainly in Andalusia and Extremadura, although there are other regions where can be implemented this kind of projects, like Castilla la Mancha or Aragon. The Greek farmers have been very interested to know the potentialities of sweet sorghum as ethanol crop and the applicability of the EU model is very promising.

Concerning the management, the main lesson regards the estimation of the working hours. In fact for many activities the working hours, indicated in the Annex II, were underestimated. In particular this happened:

- in the management of the WP1, above all caused by the withdrawal of the Romanian partners, which required many unforeseen working hours; in fact a postponement of three months was required in the 1st amendment. Furthermore, a higher number than that planned was required in the coordination of the consortium to meet deadlines;
- in the visits of the WP2, because they were planned based on the availability of the host organisations (e.g. ICRISAT, TATA Chemicals Ltd), and consequently the travels required times longer than that foreseen;
- in the WP4, because the recruiting of the participants in the training courses required many working hours, because many different channels were tried.

As consequence of this underestimation in July 2012 some beneficiaries (i.e. CETA, INIPA, REACM, Cartif) delivered to EACI the filled templates (i.e. Form A, downloaded from the IEE
website) for the budget shifts between categories of costs (shifts inferior to 20%), in order to correct partially this underestimation.

1.5 Activities and impact after end of the action

The technical assistance to the stakeholders (e.g. feasibility studies, contacts with suppliers), the coordination of the starting chains (i.e. contacts among stakeholders) and the updating about the ethanol market and sweet sorghum processing will continue also beyond the project lifetime through the Esse Community, where the Centre of Excellence has been created at this aim, and through the “Sweethanol – Website”. Both domains will be maintained for 5 years after the end of the project. The agricultural associations, trained through the engagement in courses and discussion activities, will offer technical assistance specifically to farmers, in order to complete the impact of the Esse Community at these chain actors, less accustomed to using web tools.

During the project lifetime an increased awareness about the energetic potentiality of sweet sorghum has been evidenced. In Italy sorghum has been included in the list of energy crops, which are specifically supported in the framework of the ministerial decree of 6th July 2012 (annex I, table 1- B). This inclusion has a direct benefit on the viability of the model in Italy, because the payment of the electricity produced from bagasse of sweet sorghum is significantly increased (specific bonus of 30 €/MWh for this feedstock is foreseen since January 2013). This decision might be correlated with the project activities, because the representative of the Ministry of the Economic Development was engaged in the discussion workshops of the WP3 (i.e. NAW and NIW), in order to awake the policy makers about the potentiality of sweet sorghum. In 2011 in Spain the Ministry of industry, tourism and trade has just released a document on the “Assessment of the balance of GHGs emission from biofuels production”, in which the production of bioethanol from sweet sorghum in Andalusia (South Spain) is evaluated.

Apart from this document, has been published in Spain the results of the evaluation GHGs emissions of sweet sorghum for bioethanol production, obtaining one of the best results comparing with other raw materials, like cereals, sugar beet or Jerusalem artichoke. Although the overprice on the electricity rates for biomass has been temporally eliminated, there is a great interest on the investment in this kind of production, mainly in Extremadura, Andalusia and Aragon, where the sweet sorghum production is very high. For that reason, at this moment, one
industrial project is been developed following the Spanish model (scale, type of production and so on).

The sustainability and profitability of the EU model discussed and diffused through the project are confirmed by the technical assistance, required to the Centre of Excellence. Currently 8 technical advices are being: 1 in Romania, 5 in the US, 1 in Indonesia, 1 in Cyprus.

1.6 Possible cooperation with other projects/programmes

- SWEETFUEL project, financed by 7th FP and aimed to select and test new sweet sorghum varieties suitable to produce ethanol. The beneficiaries were engaged in the SWEETHANOL activities and *vice versa*; furthermore they are members of the Esse Community. Ms. Federica Zanetti (University of Bologna) participated in the final national conference in Italy, explaining the available agricultural results. This contribution is shortly reported in the 7th “Sweethanol – Newsletter”. Mr. Eugenio Macchia, member of the SC, participated in the conference of the SWEETFUEL project on 18th April 2012, carried out in Bologna (Italy), explaining the contents of the EU model.

- CROP2INDUSTRY project, financed by 7th FP and aimed to test innovative energy crops. On 31st January 2012 Ms. Alessia Vecchiet participated in the final international conference of this project, carried out in Bologna (Italy), explaining the EU model applied in Italy.

- BIOGRACE, financed by the IEE program and aimed to harmonize the calculation of the greenhouse gases (GHGs) emissions saving due to biofuels. Contacts with the beneficiaries were useful to apply their public tool to calculate the GHGs emission saving of ethanol obtained from sweet sorghum in the EU model.

- SORGOSWEEET financed by the Ministry of Science and Innovation of Spain in the special call “PLAN E” between 01/01/2010 to 31/12/2011. Some of the beneficiaries of the project were engage in the SWEETHANOL activities, some of them are members of the Esse Community and participated in some national workshops in Spain.

1.7 Maintenance of the “Sweethanol – Website” beyond the project lifetime

REACM, as WP6 leader, will maintain the “Sweethanol – Website” for 5 years after the end of the project. CETA will cover the expenses to maintain the domain for 5 years.
2. Achievements of the action

The Sweethanol project foresaw 7 work packages and in the following figure the flow chart is schematised.

![Flow chart of the Sweethanol project](image)

**Figure 1: flow chart of the Sweethanol project**

### 2.1 Achieved results per work package against initial objectives

**Management (WP1)**

The activities were performed in accordance with the Annex I, achieving the expected outputs (1 KOM, 4 half-year technical meetings, 4 SC meetings, 15 technical contact points), registering a good daily communication within the partnership through the “Sweethanol – Basecamp” (instead of teleconferencing), and preparing the planned deliverables (9 agendas and minutes of the meetings, 2 annual reports of the SC, 4 half-year analysis for outside communication on work progress, 1 final publishable report). The CO, PAM and PM of CETA coordinated the activities.
and the co-beneficiaries cooperated ever actively in all the tasks. The SC supervised the achievement of the results. In the SC a representative of the market players was invited, the Vice-president of Green Engineering S.r.l.. He participated in 2 meetings, contributing to organize and perform the discussion of the EU model. The withdrawal of BAR and Marex and the related 1st amendment were effectively managed, shifting the dissemination activities to REACM and erasing the activities in Romania. During the implementation of the project the partnership cooperated to catch up.

**Know-how refining (WP2)**

The activities were performed in accordance with the Annex I, achieving the expected outputs and deliverables.

As regards with the outputs, in the period October-November 2010 **4 agricultural institutes** were visited (Task 2.2) and on the whole **8 visits** were organized in total at **technology suppliers and existing ethanol plants** (Tasks 2.3. and 2.4.). The travels to visit seed suppliers, technology suppliers and existing plants of ethanol production were organised, in order to maximize the benefits of each travel. The organisation of the travels was focused to study the reality of 3 different societies and different forms of producing ethanol: Asia (India), Latin America (Peru) and Europe (Spain).

**Visits to agricultural institutes (Task 2.2.):**

- **India:** International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), that has its headquartered in Hyderabad (Andhra Pradesh) and has long experiences on sorghum cultivation in India. ICRISAT has been researching sorghum suitability, along other species, as a crop and as a human food for more than 30 years. Although the main researching line for sorghum has been for food, ICRISAT is also studying the possibility of producing ethanol from sweet sorghum, because of the regulatory frame: it is mandatory in India to blend petrol with ethanol to comply Government policies. Most experiences developed by ICRISAT on sweet sorghum have been done focusing on linking food production from sorghum grains with ethanol production from sugar stalks, trying to make the most of sweet sorghum and producing at the same time food and energy. Main research lines on sweet sorghum are developing improved hybrid parents and varieties, seed production, cropping systems analysis, crop management and mechanisation improvement, post-harvesting operations and
facilitating incubation of sweet sorghum-based ethanol production technology by entrepreneurs’ perspective;

- **Spain**: the University Polytechnic of Madrid, Agro-Energy Section, where varietal experiments of sweet sorghum are carrying out, and the Centre for Plant Genetic Resources of Spain (CRF), located at the city of Alcala de Henares (Madrid) were visited. The CRF is a public research organism belonging to the National Institute of Agriculture Research and Technology (INIA) of the Ministry of Science and Innovation of Spain. The Centre was created in 1993 in order to contribute to avoid losing genetic diversity in autochthonous plant species, varieties and ecotypes and no longer used landraces, whose genetic potential can be used in agriculture and food, within the national and international field. The Centre keeps 34 collections with a total of 67,606 accessions of different types. Vegetable accessions are the most numerous; they amount to 15,333 seed accessions. Following in the rank list are the grain legumes with 14,022 accessions and winter cereals with 9,025. On the whole the Centre gathers 3,745 species in 990 genera coming from about 138 countries;

- **Peru**: Maple Energy Inc. in Sullana (Piura region) was visited in order to understand the practices applied in the arid regions to produce biomass for the ethanol chain. In Peru at the moment sugarcane is cultivated and processed to ethanol, but the sweet sorghum utilisation is taken into account as alternative to the sugarcane, where this crop has low yield (i.e. semi-desert areas). Peru is a country in which the incipient development of ethanol production and use is having a particular impact on industrial, agronomic and social development. Its history in the biofuel sector began few years ago, following the footsteps of other nearby countries such as Brazil, Colombia or the US. In this case, the development of ethanol production in Peru has had an economic and environmental justification. This last justification is due to the high level of pollution that can be found in cities like Lima, mainly due to the traffic. The use of sugarcane for ethanol production in Peru has been made considering the social and the environmental aspects. This aim has taken into account the development of desert and semi-desert areas as a priority. This development fits well with the sustainability required for the production of ethanol by the Directive 2009/28/EC, as it allows the transformation of desert areas without any kind of productivity into productive areas with similar yields of high quality areas.
Visits to technology suppliers and existing plants (Tasks 2.3. and 2.4.):

- **India**: Tata Chemicals Ltd in Nanded (Maharashtra) (technology supply and existing ethanol plant, Tasks 2.3. and 2.4.): plant for the processing of sweet sorghum to ethanol, based on the technology supplier Praj Industrie Ltd. The plant has a capacity of 30,000 litres of ethanol per day and uses also sweet sorghum bagasse as fuel for power generation; M/s. Rusni Distilleries Ltd in Hyderabad (Andhra Pradesh) (existing ethanol plant, Task 2.4.): plant for the processing of sweet sorghum, connected to ICRISAT as example of decentralised model for the ethanol production. In the decentralised model, developed by ICRISAT in cooperation with M/s. Rusni Distilleries Ltd, a part of the processing of sweet sorghum is carried out in decentralised crushing units (DCU). A DCU is a place where the sugar juice is extracted from the sweet sorghum stalks. Each DCU can manage 70 hectares of sweet sorghum. The plant of M/s. Rusni Distilleries Ltd is a mid-sized plant with a capacity of 40,000 litres of ethanol per day (in full operation). Rusni has 30 crushing units of 1 t/h capacity each, and 6 tanks for the fermentation phase and the syrup production. Rusni, apart from the sweet sorghum syrup supplied by the cluster centre (DCU) buys sweet sorghum stalk for 9-10 € per ton from other farmers near the area. The cost of the plant was about 7 million €;

- **Spain**: ACOR agricultural cooperative in Olmedo (Castilla and León region) that was selected as example of model with the direct engagement of farmers in the biofuels chain. The cooperative has 8,000 farmers, who supply sunflower seeds to produce biodiesel and sugar beet to obtain sugar. The cooperative approach applied in ACOR gave important suggestions to optimize the model under study which uses sweet sorghum, in particular as regards the remuneration of the biomass suppliers (i.e. through the selling of the biomass and the sharing of the profits). Ethanol plant Abengoa Bioenergy Biofuels Castilla y León in Babilafuente (Castilla and León region), where cereals, especially wheat and barley, are the selected raw materials for the ethanol production. This plant has been planned to produce ethanol for the internal market (i.e. blending in petrol or conversion in bioETBE) and it is located near a temporary storage area of petrol. This strategy facilitates the blending or direct mixing, during loading of tankers, for subsequent distribution to the national stations;
- **Peru**: Ethanol plant *Caña Brava* in Sullana (Piura region), where sugarcane is cultivated in arid areas and biomass is processed to produce 350,000 litres of ethanol per day; **Sugar factory Agro Industrial Paramonga S.A.A.** in Paramonga, where 10,000 hectares are cultivated with sugarcane to produce sugar, ethanol, molasses, bagasse and other derivates. **University of Piura, Engineering faculty, Energy section**, in Piura, where the technological plants to process algae in biofuels were visited. **University of Lima, Engineering faculty**, where the research in technology to convert different residual cellulosic materials in ethanol is active.

During the visits the know-how about the processing of sweet sorghum into ethanol was deepened. The visits at the agricultural institutes contributed in particular concerning the current results of the selection of hybrids of sweet sorghum as multipurpose crop, about the mechanisation of the agricultural practices, about the agricultural requirements and practices and about the sugar profile of the selected hybrids. The visits at the technology suppliers and existing ethanol plants allowed to increase the knowledge about the technological details (i.e. typology of crusher, concentration units as strategy to preserve sugars, dehydration and related management of waste water, safety measures), economic viability (i.e. investment cost, operative costs, impact of the ordinary and extraordinary maintenance, advised hours of works/year), energy balance (i.e. impact of use of by-products in favour of the sustainability of obtained ethanol), technology scalability (i.e. estimation of the minimum size for decentralised plants), logistics (e.g. distance of the farms from the plant, timing of supplying), and contract farming.

As regards with the deliverables, the **“Sweethanol – Early manual” (D2.1)** (2,000 printed copies and 750 CDs rom, downloadable from the “Sweethanol – Website” and Esse Community) and the **“Sweethanol – Video” (D2.2)** (electronic, divided in 6 files, published in YouTube© with specific links in the Esse Community and in the “Sweethanol – Website”) were realised in accordance with the Annex I (Task 2.5.). On 15th August 2012 623 visualisations of the “Sweethanol – Video” were performed, as sum of the different files.

The WP leader, Cartif, organized the visits in the framework of the Tasks 2.2., 2.3. and 2.4.. The organisation of the Indian travel was done by Cartif staff with the collaboration of an external consultant, which prepared the previous contacts with the ICRISAT and TATA; the other
beneficiaries participated in the travels. The other travels were organized completely by the staff of Cartif.

For the realisation of the “Sweethanol – Video” the subcontractor was selected following the provisions of Article II.9 of the Grant Agreement. The company subcontracted was Soluciones4Web, expert on the development of marketing, web design and promotional videos edition.

The working hours of the staff of some beneficiaries were higher that the values indicated in the Annex II. This gap was due to organizational problems: in fact in order to reconcile in the same travel the visits to seeds and technology suppliers and existing plants (of strategic interest) and to reduce the impact of the flight cost, the duration of the travels increased and other visits were added during the stay.

Concerning the engagement of the chain actors, in accordance with the Task 2.1., all the beneficiaries were involved in this activity. In total **10 chain actors were engaged**, whereas the target of success of the Annex I (i.e. 18 participants) was not achieved. The main reason is the co-financing, which was necessary by the participants. In fact the proposed contribution covered the cost for the flight tickets and the chain actors were not able to co-finance the costs for the travel, which were long to reconcile all the visits (i.e. hotel for 8 nights in India, 9 nights in Peru and 4 nights in Spain and relative provisions).

All the participants in the visits participated actively to the discussions of the model in the events of the WP3. Besides, the identified chain actors who did not participate in the travels have been involved in the Esse Community life and they are active members.

Chain actors of other countries, not included in the consortium, did not participate in the visits.

In the preparation of the “Sweethanol – Early manual” (D2.1), CETA coordinated the drafting, which was performed by all the beneficiaries, basing on their proper skills. CETA completed the version in English with the contributions of the other co-beneficiaries and translated it in Italian, whereas REACM translated it in Greek and Cartif translated it in Spanish.

**Sustainable model discussion (WP3)**

The activities were performed in accordance with the Annex I, achieving the expected outputs and realising the planned deliverables. In the following scheme the activities of the WP3 are shown.
Figure 2: schemes of the discussion workshops of the WP3
As regards with the outputs related to the Task 3.1.:

**9 national technical workshops** (NTW) were carried out:

- **3 NTW in Italy**: 1 NTW1 in with **77 chain actors**, and 1 NTW1 in Padua (21\textsuperscript{st} June 2011) with **67 chain actors**; 1 NTW2 in Padua (22\textsuperscript{nd} June 2011) with **26 chain actors**. In total **170 participants** with heterogeneous profiles: farmers and their representatives (agronomist, agricultural association most of all Coldiretti, Consorzi Agrari d’Italia S.p.A.), representatives of seeds suppliers (Sivam, Assosementi, KWS), SMEs representative (Green Engineering S.r.l., Chimitrade S.r.l., PAB S.r.l.), fuel processors (M&G, Chemtex Italia, Moncada Energy, Gruppo Bertolino), fuel distributors (Lyondell Basell Italia), professionals (professional association of engineers of Florence), industrial associations (Assocostieri), researchers (ENEA, universities of Padua, Milan and Turin, CRA-ING), Custom Agency, representatives of public authorities (Regione Piemonte, Regione Lombardia, Regione Autonoma Friuli Venezia Giulia);

- **3 NTW in Greece**: 1 NTW1 in the Municipality of Delta with **62 chain actors**, and 1 NTW1 in the Municipality of Thermi (12\textsuperscript{nd} July 2011) with **37 chain actors**; 1 NTW2 in the Municipality of Delta (7\textsuperscript{th} July 2011) with **62 chain actors**. In total **161 participants** with different profiles were registered: farmers and their representatives (agricultural coops of Halstara, of Vasilika and Delta), agronomists, fuel processors & distributors (Hellenic Petroleum S.A.) SMEs representatives (Philippopoulos Energy Technical S.A., Cal West Easy Energy Europe S.A., other independents), professionals (Technical Association of Engineers of Central Macedonia), policy makers representatives of public authorities (Municipality of Delta, Municipality of Thermi, Municipal Councils of Delta & Thermi), researchers, institutes (National Greek Centre of R&D, Aristoteles University of Thessaloniki, Alexandrian Technological Institute of Thessaloniki);

- **3 NTW in Spain**: 1 NTW1 in Madrid **51 chain actors**, and 1 NTW1 in Boecillo (20\textsuperscript{th} June 2011) with **74 chain actors**; 1 NTW2 in Boecillo (20\textsuperscript{th} June 2011) with **35 chain actors**. In total **160 participants** with heterogeneous profiles were registered: farmers and their representatives (agronomist, ACOR, General Agricultural Cooperative Society, URCACYL), representatives of SMEs (Valpuren Banuelo, Cotevisa; NUTRIMENTEC, AGROINDUS, CESEFOR, IDECAL, TOLTEN), fuel processors (Abengoa Bioenergy), engineering
companies (Sener), researchers (Politechnical University of Madrid - UPM, University of Valladolid, Institute for Agrifood Research and Technology - IRTA, Cartif Foundation, ITACyL), National Research Council (CSIC), storage, transport and distribution of fuel company (CLH), Centre for Energy Environment and Technology (CIEMAT), Extremadura Agency and energy agencies (Institute for Diversification and Energy Saving - IDAE), large companies and investors such as MOHES, AQUAGEST, Nicolas Correa.

3 national administrative workshops (NAW) were carried out:

- 1 NAW in Italy in Udine with 23 chain actors: SMEs representatives (Archeo Ed S.r.l., Power Team Consulting S.r.l., Bertagni Consulting S.r.l.), professionals, energy agencies (Nomisma Energia), banks representatives (BCC of Friuli Venezia Giulia), researchers (universities of Padua and Udine), environmental associations (Legambiente);

- 1 NAW in Greece in Thessaloniki with 17 chain actors: representatives of agricultural coops of Halstara and Vasilika, agronomists, fuel processors & distributors (Hellenic Petroleum S.A.) SMEs representatives (Philippopoulos Energy Technical S.A, Cal West Energy Europe sa, other independents), professionals (Union of Engineers of Northern Greece), policy makers representatives of public authorities (Decentralized authorities of Makedonia and Thraiki regions), researchers, institutes (National Greek Centre of R&D, Aristoteles University of Thessaloniki, Alexandrian Technological Institute of Thessaloniki).

- 1 NAW in Spain in Valladolid with 18 chain actors: representatives of IDAE, Regional Government of Castilla y Leon (Ministry of agriculture and livestock), fuel processors (ABENGOA), researchers (Cartif and University of Valladolid), SMEs (NUTRIMENTEC, IDECAL, SOFTCOMPUTING CyL).

3 national intersectorial workshops (NIW) were carried out:

- 1 NIW in Italy in Padua with 23 chain actors: farmers (Coldiretti, U.N.I.M.A.), seeds companies (Assosementi), SMEs representatives (Green Engineering S.r.l.), fuel processors (Bertolino Group), researchers (ENEA, Universities of Padua and Florence, CRA-ING), industrial associations (Assocostieri), Custom Agency, representative of the Italian Ministry of the economic development, ITABIA;

- 1 NIW in Greece in Thessaloniki with 32 chain actors: farmers and their representatives (agricultural coops of Halstara, of Vasilika and Xanthi), agronomists, fuel processors &
distributors (Hellenic Petroleum S.A.) SMEs representatives (Cal West Easy Energy Europe S.A., other independents), professionals (Technical Association of Engineers of Central Macedonia, Association of Industrialists of Northern Greece, Association of petrol stations of Thessaloniki, Union of Agricultural cooperatives of Thessaloniki), policy makers (Ministry of Rural Development), researchers, institutes (Aristoteles University of Thessaloniki, Alexandrian Technological Institute of Thessaloniki);

- 1 NIW in Spain in Madrid with 51 chain actors: representatives of SMEs (Valpuren Banuelo, Cotevisa), fuel processors (Abengoa Bioenergy), engineering companies (Sener), researchers (Politechnical University of Madrid (UPM), National Research Council (CSIC), Centre for Energy Environment and Technology (CIEMAT), Extremadura Agency and energy agencies (IDAE).

As regards with the output related to the task 3.2., 1 consortium intersectorial workshop (CIW) was carried out in Gorizia (Italy) with 13 participants with different profiles: economists (University of Udine), representatives of an UN agency, engaged in the technology transfer (ICS-UNIDO), and consortia serving the agricultural sector.

In order to identify the available pilot experiences about the use of sweet sorghum to produce ethanol and in order to disseminate and discuss them with the stakeholders, InfoFACTORY S.r.l., as subcontractor of CETA in accordance with the Annex I, intercepted conversations online in forum and blog (i.e. scouting online activities).

Consequently a representative of IMA-Bertolino Group (Italy) participated in the NTW2 and NIW in Italy and the details, explained by him in these events, are reported in the “Sweethanol – Intersectorial manual” (D3.3).

In total the EU model was discussed with 368 chain actors in the NTW1, 123 chain actors in the NTW2, 58 participants in the NAW, 106 in the NIW and 13 people in the CIW.

The spread participation allowed a very detailed analysis of the elements of the EU model, basing on the “Sweethanol – Early manual” (D2.1), in which the main topics to discuss were purposely highlighted in grey boxes.

The EU model was improved in the numerous technical aspects and in particular: in the agricultural details (i.e. utilization of long cycle and short cycle varieties in different fields to extend the harvesting period), in the way to preserve sugars and to supply the plant in the whole
An intelligent energy strategy, corresponding to 330 day/year (i.e., concentration of sugar juice, instead of the ensiling strategy) and in the by-products exploitation (i.e., energetic utilization to produce heat and electricity). Furthermore, the economic viability and sustainability were verified in different geographic areas. As regards economic viability, the internal rate of return (IRR), the net present value (NPV), and the payback were used as indicators. Concerning sustainability, the life cycle assessment of the ethanol obtained from sweet sorghum in the EU model was considered and consequently in accordance with the Annex V, Part C, of the Directive 2009/28/EC were calculated the following parameters: emissions from cultivation of raw material (e_c), emissions from carbon stock changes caused by land-use change (e_l), emissions from processing (e_p), emissions from transport and distribution (e_td), emissions from the fuel in use (e_u), emission saving from soil carbon accumulation via improved agricultural management (e_sca), emission saving from carbon capture and geological storage (e_ccs), emission saving from carbon capture and replacement (e_ccr), emission saving from excess electricity from cogeneration (e_ee). The consequent GHGs emissions saving was calculated for each considered geographic area. All the contents of the discussed EU model were explained in the deliverables of the WP3.

The “Sweethanol – Technical manual” (D3.1) describes the agricultural aspects of the sweet sorghum cultivation to use it to produce the 1st generation ethanol (in particular: environmental and economic advantages, agricultural practices, breeding programs, current situation in the sweet sorghum cultivation in the EU) and deepens in detail the EU model. It is reported in 2 forms: as guidelines, in order to apply the model in all the European areas, where sweet sorghum can be grown, and in detail in 4 specific case studies. The guidelines report all the elements to design the chain and the stakeholders, interested to start up new entrepreneurship, will be able to contextualise each element, applying it to the specific local conditions (e.g., agricultural yields correlated to climate and type of soil, logistics based on the range of supply, technical solutions for the processing, energy from by-products correlated to agricultural yields). In the specific case studies some important variables, depending on the size of the decentralised plant and on the geographic area, were able to be fixed and consequently in these cases the EU model was developed with a very high level of detail also for the economic viability and sustainability. The case studies are contextualised in Italy (Po Valley), in Greece (Central Macedonia) and in Spain (Andalusia) and the capacity of the decentralised plant was fixed in 10,000 t/year as anhydrous
ethanol. In Andalusia a further model was contextualised in the hypothesis that sweet sorghum and sugar beet can supply the same plant in different period of the year.

This manual is specifically target at farmers, agricultural associations, fuel processors, SMEs representatives and agricultural companies. In order to disseminate these contents, 2,400 copies were printed and 900 CDs rom were realised.

The “Sweethanol – Administrative manual” (D3.2) describes the guidelines for the EU model and the scenario for its applicability in the EU and in the countries participant in the consortium. This manual is mainly thought for investors, policy makers, representatives of public authorities and energy agencies. In order to disseminate these contents, 2,400 copies were printed and 900 CD rom were realised.

The “Sweethanol – Intersectorial manual” (D3.3) has the contents of both previous manuals (i.e. D2.1, D3.1, D3.2), but it is aimed to maximise the transferability of the project results in the other countries where sweet sorghum can be cultivated (e.g. Romania, Hungary, Croatia, France, Portugal, Bulgaria), reporting also the current pilot experiences of IMA-Bertolino Group in Italy, which is processing sweet sorghum to ethanol. This manual completes the previous ones and it is suitable to all the stakeholders. In order to disseminate these contents, 2,550 copies were printed, 950 CD rom were realised and the electronic files were saved in 850 USB memories (4GB), reporting the logos of the project and of the IEE program (i.e. gadget of the WP6, using the relative economic resources). This was agreed with the Project Officer.

Furthermore the electronic versions of the manuals are downloadable from the “Sweethanol – Website” and the Esse Community.

It must be noted that the development and translation of the three manuals as well as the organization of the NTWs, NAW and NIW required more time for REACM as it was initially estimated in the Annex I.

The agendas, photos and minutes of the national workshops (D3.4) report respectively the schedules of the contributions by the speakers (i.e. experts of the consortium and external experts invited to participate) and the related presentations (in local languages). The agenda and minute of the CIW (D3.5) reports the discussion within the representatives of the consortium, in which some external experts were invited. The deliverables are attached to this report.
CETA, as WP3 leader, coordinated the activities related to the CIW and to the preparation of the manuals.

CETA and INIPA cooperated in the organisation of the workshops in Italy, REACM organised the Greek workshops aided by Halastra-COOP and Cartif and ADABE cooperated in the organisation of the activities in Spain.

**Chain actors training (WP4)**

The activities were performed in accordance with the Annex I, committing to achieve the planned outputs and realising the foreseen deliverable.

As regards with the outputs, the training courses for the different profiles of the stakeholders were organised, built and held (Tasks 4.1., 4.2., 4.3.):

71 training courses for farmers were carried out:

- 24 courses in Italy: in total 406 farmers were trained;
- 17 courses in Greece: in total 386 farmers were trained;
- 30 courses in Spain: in total 450 farmers were trained.

3 training courses for technicians of seeds companies were carried out:

- 1 course in Italy with 5 participants;
- 1 course in Greece with 10 participants;
- 1 course in Spain with 12 participants.

3 training courses for fuels processors and representatives of SMEs were carried out:

- 1 course in Italy with 14 participants;
- 1 course in Greece with 2 participants;
- 1 course in Spain with 11 participants.

6 training courses for policy makers, public authorities representatives and energy agencies were carried out:

- 2 course in Italy with in total 45 participants;
- 2 course in Greece with in total 20 participants;
- 2 course in Spain with total 23 participants.

6 training courses for investors were carried out:

- 2 course in Italy with total 22 participants;
- 1 course in Greece with 2 participants;
2 course in Spain with total 30 participants.

3 training courses for the agricultural associations were carried out:
- 1 course in Italy with 23 participants;
- 2 course in Greece with in total 28 participants;
- 1 course in Spain with 14 participants.

In the consortium 3 seminars were carried out:
- 1 seminar in Italy with 14 participants; this event was planned at the end of the course for fuel processors and representatives of SMEs, spreading the invitations to other stakeholders;
- 1 seminar in Greece with 10 participants;
- 1 seminar in Spain with 15 participants.

In accordance with the Annex I, CETA and INIPA cooperated to plan the training in Italy, REACM and Halastra-COOP cooperated in Greece and Cartif and ADABE in Spain.

In Italy the courses were organised by CETA, in cooperation with INIPA. The staff of CETA held the courses for farmers, seeds companies representatives, investors, policy makers, public authorities representatives and energy agencies. The staff of INIPA alongside CETA taught the farmers’courses. The staff of INIPA held the course for the agricultural associations. The course for fuel processors and representatives of SMEs was held by the Vice-president of Green Engineering S.r.l., which is member of the SC. He held also the seminar, which was performed at the end of the course for fuel processors. This choice is justified by his engagement in the WP2 visits, in the discussion workshops of the WP3 and in the SC meeting of 24th February 2011. The engagement of Green Engineering S.r.l. was formalized through an agreement, using the “Other specific costs” (i.e. “Training course: external teachers for courses and seminar”).

In Greece the training courses were organized by REACM in cooperation with Halastra-COOP. The staff of REACM held the courses in cooperation with two external experts with significant expertise in sweet sorghum cultivation.

In Italy the targets of success, planned in the Annex I, were achieved for all the chain actors and almost achieved for farmers and seeds companies representatives: 406 participants versus 450 for farmers and 5 versus 15 for seeds companies. In both cases many corrective actions were applied.

To recruit farmers different ways of communication were tried: the engagement of many
Regional Federations of Coldiretti, linked to INIPA, direct contact with directors and technical staff of Coldiretti’s provincial federations, technical staff of Coldiretti called farmers more than once, and written and electronic invitations were sent., the organisation of the courses in the framework of agricultural expositions (i.e. Exposition of Agriculture in Foggia, May 2012), the publication of the courses in the website of “Fattorie del Sole”, linked to INIPA, the dissemination with newsletters. In order to maximise their participation in the training, also different schedules were proposed, direct participation of INIPA project managers and national Coldiretti manager in most of the courses organising the courses in the evening (8:30 p.m.) and within a long period of time (February-August 2012). To recruit the seeds companies representatives, the program of the course was publicised also on the review “Informatore Agrario” (n. 26, June 2012) and the potentially interested people were contacted directly by phone (3 calls for each potential participant), after sending the emails with the course program.

The achievement of these specific targets was very hard for different reasons:

- **economic crisis**: the financial capacity of these target groups is very low at the current time and the interest is strongly penalised;

- **unclear framework of incentives to produce electricity and heat from RES**: the attached implementing decree of the legislative Decree 2011/28 for electric RES was issued through 10 months of delay (July 2012, instead of September 2011) and the attached implementing decree of the legislative Decree 2011/28 for the thermal RES is still awaited. Obviously this uncertainty penalised the interest of these target groups, which are particularly cautious investments;

- **lack of incentive to produce biofuels**: in fact the removal of the reduction of taxes was erased since some years and the current policy in this sector does not appear equally effective;

- **overlapping with maize**: which is an well-known crop and at the current time ensures to the farmers adequate profits, representing a strong competitor;

- **many occupations in the period February-August, and particularly during the harvesting time**: unlike other criticisms, in this case specific corrective actions were applied, changing the schedules of the course, basing on the requirements of farmers (e.g. evening course).
In Greece the performed training activities were higher than planned in the Annex I (i.e. 24 courses instead of 22), in order to satisfy the high demand, above all by farmers. Furthermore the achieved results exceeded the target of success for this country and in total 458 chain actors were trained (instead of 360). In order to maximize the participation in the planned events and in the exceeding ones and the impacts of the project, many efforts were made and a higher number of working hours were required than those initial estimated in the Annex II. To recruit participants, different ways of communication were tried: direct contact with farmers, with local authorities, with members of agricultural coops, with the directors of the coops, dissemination of invitations of the training courses, announcements to local radio stations, interviews to TV and radio stations, publications in various websites, interviews in newspapers, articles in newspapers and electronic newspapers, press releases.

In this regards REACM emphasizes that in the negotiation process undertook an important reduction of the estimated hours, although it was the leader of the WP4. It became evident during the implementation of this WP that the actual working load was much higher. In this sense the number of working hours had to be increased in order not to jeopardize the proper execution of the planned activities. Moreover, to better organize the promotion and dissemination of the courses the Greek partner also involved an external expert (Ms. Athanasiadou Eugenia).

For all these reasons the Task 4.2. was more demanding than that estimated in the Annex II and consequently an higher number of working hours were required by the staff of CETA, REACM and INIPA.

As regards with the deliverable, the “Sweethanol – Manual for trainers” (D4.1) was prepared in English by REACM and translated in the local languages by CETA (in Italian), REACM (in Greek) and Cartif (in Spanish).

The “Sweethanol – Manual for trainers” is aimed to describe the EU model for the technicians of the agricultural associations, in order to support them in the technical advice to farmers also after the end of the project. The manual explains the details of the sweet sorghum cultivation (e.g. cultural practices, varieties and hybrids, potential yields, breeding programs), the ways of conservation of sugars, the chain supplying and the different possibilities of engagement of farmers (centralised approach, in which farmers supplying stalks directly to distilleries, and
decentralised approach, in which farmers supplying stalks to crushing units located in a cluster centre - a crushed and syrup production unit), the processing in bioethanol, the EU model, the exploitation of by-products and the main contents of contract farming in the different consortium countries. To this topic contributed specifically INIPA for Italy and Halastra-COOP for Greece and ADABE and Cartif for Spain. Finally the manual reports the current utilisation of sweet sorghum in Asia, where it is used also to produce 1st generation ethanol in decentralised plants.

1,340 CDs rom of the “Sweethanol – Manual for trainers” were prepared and the electronic version is downloadable from the “Sweethanol – Website” and the Esse Community.

In accordance with the Task 4.4. at the beginning of the project the team has created the Centre of Excellence in the Esse Community for the technical assistance to the stakeholders. At the courses the national contacts of the Centre of Excellence were reported to the participants, in order to give eventual technical advice also after the end of training.

**In Italy the Centre of Excellence has the following contacts:**
- Ms. Michela Pin, Mr. Denis Picco and Ms. Alessia Vecchiet for CETA;
- Ms. Luisa Daidone for INIPA, specifically directed to the Italian farmers.

**In Greece the Centre of Excellence has the following contacts:**
- Mr. Kostas Konstantinou and Ms. Irene Tsakiridou for REACM;
- Mr. Sakis Bartsios for Halastra-COOP, specifically directed to the Greek farmers.

**In Spain the Centre of Excellence has the following contacts:**
- Mr. Oscar Leon and Mr. Roberto Marcos for Cartif;
- Ms. Maria Hernando and Ms. Maria Dolores Curt for ADABE, specifically directed to the Spanish farmers.

**On line community (WP5)**

The activities were performed in accordance with the Annex I, realising the planned deliverables and outputs.

As regards the deliverables, the **Esse Community (D5.1)** was created by the subcontractor InfoFACTORY S.r.l. in accordance with the Annex I and it can be used in English, Italian, Greek and Spanish.

The subcontractor InfoFACTORY S.r.l. had in charge the **web monitoring service (D5.2)**, in accordance with the Annex I. In the Esse Community the conversations as forum and blog are
opened to all the members (D5.3 and D5.4), 4 teleconferences (D5.5) can be visualised through the links to YouTube® and some important documents are available in the “Sweethanol - Virtual library” (5.6), which can be read and downloaded by the registered members. The teleconferences were organized with stakeholders on the bioethanol production in India and Latin America, mainly focused on the evaluation of the current situation on the bioethanol production, the raw material production, specifically sweet sorghum, and the new potential projects of bioethanol production. In this aspect, almost all the new projects planning in Latin America and in the US are focused on sugar cane use or second generation biofuels production from lignocellulosic, but the sweet sorghum crop has been studied as an alternative raw material for bioethanol production in India, Latin America (in Argentina, Colombian and Peru have been confirmed) and in Europe (Spain and Italy). On 15th August 2012 825 visualizations of the teleconferences were performed.

The logo of the Esse community (D5.7) was created by the subcontractor Punktone Soc. Coop., selected following the provisions of Article II.9 of the Grant Agreement.

Figure 3: logo of the Esse Community, the online network created in the framework of the project (http://esse-community.eu)

The contents of the Esse Community are aimed to update the stakeholders about scientific, technical and administrative aspects of the ethanol market and the EU model to produce ethanol using sweet sorghum.

The accessible documents are reported in the homepage of the Esse Community: the manuals realised in the framework of the project, articles, information about events of the project and not linked to the project, newsletters and brochure of the project. The updating of the contents was performed also through the web monitoring service by InfoFACTORY S.r.l.. Furthermore the “Sweethanol - Virtual library”, which is accessible only to the registered members, makes
available the Directives of the EC and the national regulation about biofuels. In total 37
documents are present in the “Sweethanol – Virtual library”.

The Esse Community is contributing to increase the visibility of the members and companies,
engaged in the ethanol market. At this aim the companies are reported in a specific part of the
community. On 15th August 2012 the registered companies were 79.
Furthermore the Esse Community acts as virtual space for the technical assistance to the
stakeholders through the Centre of Excellence, in which all the beneficiaries have their technical
managers.

The outputs related to the effectiveness of the Esse Community were realised: **2,763 visits in
December 2010, 14,600 visits in June 2011, 30,680 visits in December 2011** and **43,731 on
15th August 2012**.

On 15th August 2012 **331 members** are registered from the following countries:

- in Europe: Italy, Greece, Spain, Romania, United Kingdom, Portugal, France, Germany,
  Ireland, Malta, Poland, Iceland, Cyprus, Denmark, Finland, Belgium, The Netherlands;
- in Asia: Indonesia, Thailand, Philippines, China, Israel, India, Cambodia, Turkey, Japan,
  North Korea, Pakistan, Saudi Arabia, Singapore, Iran;
- in America: United States, Colombia, Dominican Republic, Argentina, Uruguay, Peru,
  Mexico, Brazil, Guatemala, Canada, Ecuador, Paraguay, Venezuela;
- in Africa: Mozambique, South Africa, Nigeria, Uganda, Kenya, Zambia, Madagascar,
  Zimbabwe, Ethiopia, Egypt, Sudan;
- in Oceania: Australia.

In the EU the most represented countries are Italy, Spain, Greece, Romania, France. Outside the
EU the most interested countries as the US, India, Philippines, Indonesia and Colombia.

The potential members of the Esse Community were contacted and invited at the beginning of the
project, basing on the results of the scouting online, performed by InfoFACTORY S.r.l., as
subcontractor of CETA in accordance with the Annex I. The report of InfoFACTORY S.r.l. is
attached to this report (as electronic version, named “WP5_Contacts_InfoFACTORY.xls”). The
scouting online, performed also in the WP3 (i.e. “WP3 Previous inquiry InfoFACTORY scouting
online” and “WP3 Report InfoFACTORY scouting online”), was aimed to identify the potential
stakeholders with different profiles: seeds producers and farming bureaux, social media and
plant-machinery producers, production plants, services and investors, organisation and enzyme producers. The results of the scouting online were useful in both WPs.

In the Esse Community were invited also the representatives of institutes/enterprises, equipped with pilot plants processing sweet sorghum (e.g. ICRISAT).

The high number of registered members confirms the effectiveness of the Esse Community and the existing requirement to keep in touch the stakeholders in this economic sector. Consequently the Esse Community represents an actual reference site for the market players from around the world.

Concerning the conversations, the Esse Community evidenced on 15th August 121 314 posts, as sum of the communications in the forum/blog, in Facebook and in Twitter; in accordance with the Annex I, in these social networks the Esse Community has the specific profiles.

The contacts started through the Esse Community (i.e. registered members and related conversations) and the Centre of Excellence, are producing very interesting spin offs, in the EU and outside the EU: 8 technical advices are working in progress, in Romania, US, Indonesia and Cyprus.

At the current time, the Centre of Excellence is treating these relationships and it is plausible that these will be fruitful in order to reach the strategic impacts of the project.

Considering the obtained results, which are very promising for the development in the short term of the EU model in the EU (above all in Hungary and Romania), but also outside the EU, were not implement corrective actions, planned in the Annex I. In fact these results appear more significant than the target of success, indicated in the Annex I (i.e. number of posts), because they indicate an actual impact of the Esse Community to achieve the strategic objectives of the project (i.e. change in the structure of the EU ethanol market and increased awareness about sweet sorghum as ethanol crop). Vice versa, the posts could be numerous but not equally fruitful.

Since the Esse Community and the Centre of Excellence will update and will assist the stakeholders for 5 years after the end of the project, this very positive trend will be able to be confirmed. In order to maximise the utilisation of the Esse Community, it has a link in the “Sweethanol – Website”. Both domains will be maintained for 5 years by CETA.

Cartif, as WP leader, coordinated the activities and the technical manager of Cartif was identified as community manager. CETA coordinated only the network creation, through the subcontractor,
InfoFACTORY S.r.l., in accordance with the Annex I. All the beneficiaries contributed actively uploading documents, articles, posts for the discussion and answering to the stakeholders.

**Communication (WP6)**

The activities were performed in accordance with the Annex I, realising the planned outputs and deliverables and completing the communication actions of the other WPs.

As regards with the outputs CETA, as coordinator, delivered the contributions, required by EACI in June 2010 and August 2012, were delivered: slides of the project and of its results, respectively (D7.1 and D7.3).

Furthermore all the beneficiaries participated in the workshops for the discussion of the EU model at the national and consortium levels in the framework of the WP3 and the relative agendas and minutes (D3.4, D3.5) are attached to this report.

**3 national final conferences** were carried out:

- in **Italy** on 6th June 2012 in Gorizia with **21 participants**;
- in **Greece** on 4th February 2012 in Thessaloniki with **70 participants**;
- in **Spain** on 24th July 2012 in (Boecillo) Valladolid, with **62 participants** and 8 speakers from Cartif Foundation, CTAER, ENCE, ADESVA and BALATA MEDIOAMBIENTE.

The outputs O.3 are attached to this reports.

**1 international conference** was carried out in Thessaloniki (Greece) on 27th June 2012 and **54 people** participated in the event. The output is attached to this report.

The beneficiaries participated to **other 10 conferences**, reporting the results of the project:

- CETA participated in the EIMA international in Bologna (Italy) on 10-14 November 2010. The presentations are attached to this report (O6.5.IT);
- CETA participated in the international final conference of the CROP2INDUSTRY on 31st January 2012 in Bologna. The presentation is attached to this report (O6.5.IT);
- Mr. Eugenio Macchia, member of the SC and delegate of CETA participated in the conference of the SWEETFUEL project on 18th April 2012. The presentation is attached to this report (O6.5.IT);
- CETA participated in the workshop entitled “Renewable energy technologies for productive uses for West Africa” in Trieste (Italy) on 19th April 2012, organized by ICS-UNIDO of the UN. The presentation is attached to this report (O6.5.IT);
CETA and ADABE participated in the 19th European Biomass Conference and Exposition: CETA presented the project (e.g. objectives, work program) “Diffusion of a sustainable EU model to produce 1st generation ethanol from sweet sorghum in decentralized plants”, authors: M. Pin, D. Picco, A. Vecchiet, C.M. Parlagreco, O. Leon, J. Fernandez Gonzalez, K. Konstantinou, A. Bartios; ADABE presented the contribution “Assessment of commercial varieties of sorghum as short cycle crops for biomass and sugar production”, authors: M.D. Cort, M. Sanz, B. Esteban, G. Sanchez, M. Barreiro, J. Fernandez. The electronic version of the poster is attached to this report (O6.5.IT);

Cartif participated in the Conference: Gasohol - Mitos y Verdades, on 10th November 2010, where the Sweethanol Project was described, and where was analysed the current situation of the bioethanol production and use in Peru and in Europe. This conference was organized by the Piura University to determine the advantages and disadvantages of mixed bioethanol (7.8%) with gasoline in Peru and its effect over the engines.

REACM participated in the Conference: “Regional Conference for the sustainable management of Industrial Areas” The Regional Conference for the sustainable management of Industrial Areas (IAs) took place on Thursday February 16th 2012, in Thessaloniki at the premises of Aristotle University of Thessaloniki. The Conference was focused on trends and opportunities for sustainable development for Greek Industrial Areas and in this context, the outputs of the Sweethanol project were presented by REACM;

REACM participated in a two-day event on “Sustainable Development” organized on Saturday 5th and Sunday 6th of November, during the “POLIS 2011” Fair in Thessaloniki (8th International Exhibition for local government, public and social sector & private enterprises) where the scope and the objectives of the Sweethanol project were presented to local stakeholders as well as to UNDP officials from Skopje who joined the event;

INIPA participated in the EIMA international in Bologna (Italy) on 10-14 November 2010, explaining the project;

INIPA held a lesson during the GEM Master (Green Economy Management), on 6th March 2012. The presentation is attached to this report (O6.5.IT).

As regards with the deliverables, the “Sweethanol – Website” (D6.1) was realised by Creative Media-Xefteri Theodora, selected following the provisions of Article II.9 of the Grant Agreement
The “Sweethanol – Website” during the period May 4th 2011 to August 15th 2012 had 5,905 pageviews and 2,395 visits. The “Sweethanol – Website” allows to download the public deliverables. On 15th August 2012 432 downloads of public deliverables were performed.

The restricted access website is the “Sweethanol – basecamp”, which has been the main daily communication system in the consortium during the project lifetime.

The “Sweethanol – Brochure” (D6.2) was realised with the description of the project and of the Esse Community in English, translated in the local languages (i.e. Italian, Greek, Spanish), printed and disseminated in all the events. It is downloadable from the “Sweethanol – Website” and from the Esse Community. 4,700 copies of the “Sweethanol – Brochure” were printed.

10 “Sweethanol – Newsletters” (D6.3) were realised in English, translated in the local languages and disseminated through the “Sweethanol – Website” and the Esse Community. Furthermore they were send to the registered members.

3 international scientific papers in English were published (D6.4):


2. in the Proceeding of the XIX International Symposium of Alcohol Fuel in Verona (Italy, 10-14 October 2011, ISBN 978-88-7743-369-5) by CETA (title: Sweet sorghum to produce in Italy sustainable ethanol, electricity and heat in decentralised small-medium biorefinery), authors: M. Pin, D. Picco, A. Vecchiet, E. Macchia;

3. in the Proceedings of the International Conference on Biofuels for Sustainable Development of Southern Europe (Bio4SuD). The article has been official accepted for oral presentation (title: Sweethanol EU model of 1st generation bioethanol from sweet sorghum in decentralized plants) in Thessaloniki (Greece), July, 2012 by REACM.

3 national scientific papers in local languages were published (D6.5):

1. in Italy by CETA in the review Informatore Agrario (title: Dal sorgo la filiera che produce bioetanolo, elettricità e calore, translation: The chain to produce bioethanol, electricity and heat using sweet sorghum) in June 2012;
2. in Spain a monograph on the sorghum energy crop (in Spanish) was submitted by the Secretary General of ADABE to the Ministry of Agriculture of Spain; it is going to be published in the Series “Hojas Divulgadoras” of the Ministry (title: *El sorgo como cultivo energetico (Sorghum bicolor (L.) Moench.),* translation: *Sorghum as energy crop (Sorghum bicolor (L.) Moench.).*) (Number 2142 HD. NIPO: 280-12-168-2. ISBN: 978-84-491-1224-9. Legal Deposit: M-31093-2012);

3. in Greece by REACM in the review Agronomy Association of Macedonia and Thrace Journal in June 2012 (title: *Sweet sorghum cultivation for bioethanol production*).

22 technical and popular articles in local languages were published (D6.6).

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<tr>
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<td>Il Punto, 14th February 2011</td>
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<td>Il Punto, 13th June 2011</td>
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<td>Review of the Polytechnic University of Madrid, 12nd May 2011</td>
<td>Producción de bioetanol a partir de sorgo dulce en Europa</td>
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<td><a href="http://www.upm.es">www.upm.es</a> (*)</td>
<td>El sorgo como cultivo energetico (Sorghum bicolor L. Moench)</td>
<td>Production of bioethanol from sweet sorghum in the EU</td>
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<td><a href="http://www.upm.es">www.upm.es</a> (**)</td>
<td>Encuentro Europeo para la promoción del sorgo azucarero para bioetanol.</td>
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<td>TIERRAS magazine</td>
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<td>(submitted on June 2012; publication pending). ISSN: 1889-0776.</td>
<td>O γλυκός σόργος θα αντικαταστήσει την βενζίνη</td>
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<td><a href="http://www.greenagenda.gr">www.greenagenda.gr</a></td>
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<tr>
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<td>Η καλλιέργεια του γλυκού σόργου για την παραγωγή βιοθερμικών</td>
<td>Sweet sorghum cultivation to produce bioethanol</td>
<td>REACM</td>
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</tbody>
</table>
The “Sweethanol – Logo” (D6.7) was realised by the subcontractor Punktone Soc. Coop., selected following the provisions of Article II.9 of the Grant Agreement.

REACM, as WP6 leader, coordinated the communication activities, whereas each beneficiary contributed in accordance with the Annex I. REACM prepared the English versions of the “Sweetanol – Brochure” and “Sweetanol – Newsletters”; CETA translated them in Italian, REACM in Greek and Cartif in Spanish.

REACM, CETA and ADABE each one prepared a scientific paper in English. CETA prepared the national scientific paper in Italian, ADABE prepared the national scientific paper in Spanish and REACM prepared the national scientific paper in Greek.

INIPA prepared 9 technical and popular articles in Italian for the review “Il Punto” of Coldiretti, ADABE prepared 4 technical and popular articles in Spanish and REACM prepared 9 technical and popular articles in Greek.

IEE/ 09/902/S12558298 SWEETANOL
Finally CETA in cooperation with INIPA organised the final national conference in Italy, REACM in cooperation with Halastra-COOP organised the final national and international conferences in Greece, and Cartif with ADABE cooperated to organise the Spanish final conference.

Some deliverables (e.g. "Sweethanol – Website") were produced later than when indicated in the schedule, caused by the wait of approval of the 1st amendment by EACI. The following actions were carried out in order to catch up.

The participation in the conferences was lower than the targets of success: 153 versus 300 participants in the national conferences (21 in Italy, 70 in Greece, 62 in Spain) and 54 versus 120 in the international conference.

In order to maximize the involvement, different measures were applied in addition to the communication in the "Sweethanol – Website" and in the Esse Community.

For the Italian final conference a special newsletter was send through the electronic review "Energheia", that has 12,000 contacts of stakeholders in the national energy sector. Furthermore INIPA linked an article on the “Fattorie del Sole” website, which has 6,500 contacts of farmers, giving more information about the conference.

In Spain, the national conference was promoted by Cartif by email directly to more than 200 companies related with bioenergy sector, and through dissemination in associations of bioenergy and biomass production. Apart from this promotion, during the courses in Andalusia, Extremadura, Castilla la Mancha, Castilla y León and so on, have been made specific contacts with speakers and companies that were used for the promotion of the conference.

In Greece the national conference was organized during the International Fair for Agricultural Machinery, Equipment and Supplies which takes place every two years in Thessaloniki. The Fair attracts a high number of farmers, agronomists, individuals, engineers and representatives of SMEs, public authorities and policy makers. The agenda of the conference was announced in the official program of the International Fair of Thessaloniki and was sent to the contact list of the organization “International fair of Thessaloniki” (more than 10,000), the agenda was also distributed to the contact list of REACM and Halastra-COOP. The scope of the Conference and the agenda was presented at the “Sweethanol – Website” and the website of the company as well.
It is possible that the achievement of the targets of success for these events was penalised by the numerous events of the project, carried out in the same period in the framework of the WP4. In fact the training courses and the final seminars involved a lot of stakeholders and the treated topics were similar, although some widening was performed in the conferences by external experts.

**In total the topics of the project were disseminated to 2,732 people:** 668 chain actors in the WP3, 1,526 chain actors in the WP4, 331 stakeholders are active members of the Esse Community, 207 people participated in the conferences.

**IEE dissemination activities (WP7)**

In accordance with the Annex I, the dissemination activities were performed upon request of EACI.

4 fact-sheets were prepared: June 2010, December 2010, August 2011 and August 2012 (D1.3) (Task 7.1).

Slides with the description of the project (i.e. backgrounds, objectives and main steps, expected results, partners and contacts) were delivered to EACI in June 2010 (D7.1) and slides with the results of the project were prepared in August 2012 (D7.3).

In September 2010 CETA identified some measure indicators, which can be used to assess investments, primary energy consumption, percentage of renewable energy and reduction of greenhouse gases (D7.2). In December 2010 the deputy of the PM was interviewed by phone about the objectives and activities of the project. The interview was reported as article in the IEE-Magazine in the section “News”. For each measure indicator, a difficulty value was identified (Task 7.2).

The project coordinator participated in the “IEE co-ordinators training”, which was carried out in Brussels (Belgium) in 27-28 May 2010. The acquired suggestions were applied in all the following activities, such as the meeting (e.g. collection of impression at the end of the KOM) and the communication in the consortium (Task 7.3).

### 2.2 The EU model to produce ethanol from sweet sorghum in decentralised plants

Sorghum is a multipurpose crop because it supplies high yields in biomass, sugar and grain depending on the chosen varieties.
At the current time the sweet sorghum varieties provide 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. Actually, in order to 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 side, grain on the other side.

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

**Figure 5: scheme of the plant to process sweet sorghum in bioethanol and energy commodities**

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

Bagasse, which is the lignocellulosic residue of the crushing unit, is dried and burnt in CHP plant to get electricity and heat.

Vinasse, which is the residue of the distillation and rectification unit, is a feedstock for the anaerobic digestion, to use in co-digestion eventually with other substrates like for example manure as microbial inoculum. The obtained biogas is purified and burnt in CHP plant to get electricity and heat.

This approach for processing sweet sorghum allows different variations that can be applied in the planning of a specific chain model to supply decentralised small-medium plants in the EU.
In fact, the conversion of the sugar juice in bioethanol and the energetic exploitation of bagasse and vinasse can be the sole production line or can be one of the production lines implemented in the plant.

These different strategies are explained in detail in the specific chapters. In particular, the use of sweet sorghum as sole feedstock is deepened in three case studies (i.e. in Italy, in Greece and in Spain) and the feasibility for processing sweet sorghum plus another raw material (i.e. sugar beet) in the same plant is reported in the Spanish conditions.

All these applications have some common elements regarding the dimensioning of the chain supply, the technological contents of the processing and the by-products exploitation. Consequently, the following paragraphs are aimed to give the main guidelines, which are common to the different applications. They are the indicative input data to perform a feasibility study and at this aim they require a contextualisation to each specific situation.

2.2.1 – Dimensioning of the chain supplying

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. As appropriate this dimensioning regards the whole plant (if sweet sorghum is the sole feedstock) or the specific production line to obtain 1st generation bioethanol from this crop (if the plant processes different raw materials).

Two elements are required in the assessment: the agricultural surface 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 of 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.
Macro scenarios to plan the chain supply

<table>
<thead>
<tr>
<th>Type of environment</th>
<th>Agricultural yield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type MEDITERRANEAN</strong></td>
<td></td>
</tr>
<tr>
<td>Low fertility soils</td>
<td>Irrigation</td>
</tr>
<tr>
<td>Dry climate</td>
<td>Biomass yield 10.3-35.0 t/ha db</td>
</tr>
<tr>
<td></td>
<td>Bioethanol yield 1.5-6.0 t/ha</td>
</tr>
<tr>
<td></td>
<td>1.9-7.6 m³/ha</td>
</tr>
<tr>
<td></td>
<td>40.5-162.0 GJ/ha</td>
</tr>
<tr>
<td>Medium fertility soils</td>
<td>No irrigation</td>
</tr>
<tr>
<td>Temperate oceanic climate</td>
<td>Biomass yield 14.3-19.0 t/ha db</td>
</tr>
<tr>
<td></td>
<td>Bioethanol yield 2.1-3.4 t/ha</td>
</tr>
<tr>
<td></td>
<td>2.8-4.4 m³/ha</td>
</tr>
<tr>
<td></td>
<td>56.7-91.8 GJ/ha</td>
</tr>
<tr>
<td>Irrigation (emergency)</td>
<td>Biomass yield 30.0-40.0 t/ha db</td>
</tr>
<tr>
<td></td>
<td>Bioethanol yield 4.3-6.1 t/ha</td>
</tr>
<tr>
<td></td>
<td>5.9-7.9 m³/ha</td>
</tr>
<tr>
<td></td>
<td>116.1-164.7 GJ/ha</td>
</tr>
</tbody>
</table>

Table 1: yields in biomass and bioethanol obtainable from sweet sorghum in some reference type of environments

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. 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-Sept 2010).

These data are the input to calculate the hectares which must be cultivated with sweet sorghum in order to supply the plant, basing on its capacity. Nevertheless, for each specific situation the calculated surface could require a wider area, for example if rotations with other crops are proposed in the considered region in order to protect the soil fertility.

These values of macro scenario, of course, require a following careful contextualisation to calculate the actual dimensioning of the chain supply.
Range of supplying

Concerning the distance between the plant and the fields, different evaluations have to be integrated. The main elements are the impact of the 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 supplying), 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 supplying 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 supplying and its repercussions, in the following table 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 supplying 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 obtained bagasse and vinasse, which are linked to the cultivated agricultural land and then to the assumed capacity as anhydrous bioethanol.

The main elements to dimension the related units are reported in the specific paragraph (7.4 Exploitation of by-products).
2.2.2 – Processing of the sweet sorghum biomass in bioethanol

The technological sections for the production line of 1st generation bioethanol are: the sugar extraction unit, the concentration unit for the storage of the sugar juice, the fermentation unit, the distillation and rectification units and finally the dehydration unit.

Sugar extraction 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 carried out 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 of 93-98%, considering a range of 85-93% of extraction yield using a rolling mills series (from 3 to 5 rolling mills) and a range of 93-98% of extraction yield using a continuous diffuser.

In case of crushing into horizontal or vertical power mills, the working 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.
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.

Alternatively, the operation of the diffuser is based on systematic counter that puts the raw material under current washing by means of imbibition water. In practice, this is achieved by forming a bed of shredded stalk or first mill bagasse on a conveyor. Water is added at the discharge end of the conveyor and percolates through the bed of bagasse and the perforated slats of the conveyor. The water dissolves the sugar in the bagasse and the thin juice thus formed is collected in a hopper. This juice is moved forward one stage by pumping and the process is repeated until the juice reaches maximum concentration at the feed end of the diffuser. The diffuser may be conditioned either for single-flow or for parallel-flows juice circulation.
Usually the diffusers are designed from 35 m to 52 m long; the cross section is rectangular and diffusers of different capacities are made in different widths. The conveyor grids and screens are supported by 2 outboard type roller chains with a pitch of about 3 feet. These chains are supported at the extreme ends by sprockets. At the driven end, the sprockets are coupled through a gearwheel and pinion to a variable speed hydraulic drive or electric gear-motor drive.

The conveyor itself is made of articulated frames to which the screens are fixed. The screens and frames are rigidly attached to corresponding links of the 2 chains. These chains are fitted with self-lubricating bushings. The rollers ride on parallel rails. The return rails are completely exposed underneath the housing, giving full visibility and accessibility to the screens. The
thickness of the bed varies from 1.5 m to 2 m. The space between the 2 conveyor spans is occupied by a large tank with a sloping bottom split into individual hoppers by means of vertical plates. These vertical plates have horizontal slots, at specified levels, through which the juice overflows to the next hopper. At the end of the conveyor, there is a revolving scraper to even out the flow of bagasse which falls in an outlet hopper. This hopper is provided with a conveyor for removing the bagasse. The diffuser is equipped with lifting screws in the press-water feedback area.

During the whole duration of its passage through the diffuser, the bed of stalks is submitted to intensive sprays of juice of progressively decreasing concentration. The juice is evenly sprayed above the bed by a series of overflowing troughs extending on the whole width of the housing. One of these troughs is fitted above each juice-collecting hopper and designed to distribute uniformly the juice across the bed, with an accuracy of 2%.

The last trough is fed with pure water. All the juice hoppers have the same width. They collect the juice percolating from each juice distributor through the bed of stalks. Each hopper is piped to an individual high capacity centrifugal pump. Each pump is piped to take juice from one hopper and to spray it above the preceding hopper (in opposite direction to the movement of the bed). A last single pump feeds the richest juice to the rich juice tank. Another pump of great capacity continuously circulates rich juice on the fresh prepared stalks of sweet sorghum. The intensive flow of stalks or first mill bagasse is fed into the diffuser by a drag type cross conveyor so designed as to spread the feed evenly on the diffuser conveyor. Juice from the rich juice tank is pumped to the factory. The diffuser is operated and controlled from a central panel on which all instruments are grouped.

The main advantages of the continuous diffusion are:

- high extraction achieved in combination with existing milling equipment or in completely new extraction plants;
- low initial cost of the overall extraction plant because diffusers are designed to work with conventional sweet sorghum stalks preparation and milling equipment. The diffusers can be installed outdoors;
- low maintenance costs because of massive design and extremely slow movement of the main conveyor;
- low operational costs: diffusers are completely automated and can be operated by 1 man per shift. Lubrication costs are negligible;
- low power requirements: live steam is not needed. Steam of low-pressure is used for juice heating in the diffuser. All moving parts are driven by electric motors;
- very wide capacity range: diffusers can operate without modifications and without loss of efficiency from 30% to 10% over nominal capacity. By varying the bed height and conveyor speed, the capacity range may be extended even more. The design of the diffuser is such that unforeseen increases in capacity can, to a certain extent, be met by the addition of washing stages to existing diffusers;
- absence of fermentation: the diffusers are designed to eliminate all static zones where fermentation could develop. The return span of the diffuser conveyor is washed at every cycle to prevent contamination of the feed by pieces of bagasse sticking to the screen. The diffuser is fitted for pH control and for operation at optimum temperature;
- bagasse discharge is by gravity at the tail end of the diffuser: a special scraper is provided to even out the flow of bagasse and provide a continuous feed to the dewatering mills. The diffuser can be completely discharged for long stops and must not be cleaned manually;
- juice quality is good: systematic clarification of last mill juice enables removal of impurities early in the process and contributes towards the production of juices which are easy to clarify and which present no problems in the boiling house;
- heat economy: all heaters are of the type used for mixed juice heating in sugar factories. The diffuser is completely enclosed and insulated.

The continuous diffuser gives high yield on the extraction and low power consumption, and also the juice has low amount of interfering and contaminants that must be removed before the concentration step.

If sweet sorghum juice contains soluble solids (e.g. anthocyanins and chlorophyll) and insoluble solids (e.g. starch granules), these components have to be separated to process the sugar juice to bioethanol.
Good quality juice can be made after carrying out evaporation with continuous skimming 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.

The evaporation of the sugar juice must be done with a good quality product, eliminating the solids content and other interfering. This purification can be done with the addition of lime and CO₂ for flocculating these compounds and eliminating them by filtration.

Once the juice is clarified, the evaporation process carries out. The evaporation process will be done in a falling film evaporator working under vacuum to ensure the minimum energetic consumption and the best quality of the sugar juice. The previously clarification is needed to ensure the reduction of incrustations and soiling on the pipes and on the concentration unit.

**Falling film evaporator**

The concentration is the strategy chosen to preserve sugars and to supply the plant in the months after the harvesting of the sweet sorghum biomass. This section is required in both cases: sweet sorghum as sole feedstock and sweet sorghum and another raw material as feedstock.

The aim of this stage is the concentration of the sugar juice from 12-16 °Brix to 45-85 °Brix, depending on the storage period for the concentrated juice. This process increases the osmotic pressure in the liquid and avoids any bacterial or yeast development.

The falling film evaporator concentrates the sugar juice in several steps (between 2 and 4, depending on the final concentration), working under vacuum to ensure a low temperature process, lower steam consumption, and lower sugar degradation. At each concentration step, the diameter of the tubes of the falling film evaporator is increased to reduce fouling and to maintain the performance of concentration. From this step, the water condensed after the concentration could be used on the sugar extraction unit, minimizing the water consumption on the total process.
Figure 10: falling film evaporator

**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.
Table 3: conditions for the pasteurisation of sugar juice

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Time</th>
<th>Pasteurisation type</th>
</tr>
</thead>
<tbody>
<tr>
<td>63 °C (145 °F)</td>
<td>30 minutes</td>
<td>Vat Pasteurisation</td>
</tr>
<tr>
<td>72 °C (161 °F)</td>
<td>15 seconds</td>
<td>HTST</td>
</tr>
<tr>
<td>89 °C (191 °F)</td>
<td>1.0 seconds</td>
<td>HHST</td>
</tr>
<tr>
<td>90 °C (194 °F)</td>
<td>0.5 seconds</td>
<td>HHST</td>
</tr>
<tr>
<td>94 °C (201 °F)</td>
<td>0.1 seconds</td>
<td>HHST</td>
</tr>
<tr>
<td>96 °C (204 °F)</td>
<td>0.05 seconds</td>
<td>HHST</td>
</tr>
<tr>
<td>100 °C (212 °F)</td>
<td>0.01 seconds</td>
<td>HHST</td>
</tr>
<tr>
<td>138 °C (280 °F)</td>
<td>2.0 seconds</td>
<td>UP</td>
</tr>
</tbody>
</table>

2. **Preparation of yeasts**: yeasts are re-hydrated 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 batch process or in continuous one.

- **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 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 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 has to 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 have to be applied in the transport phase.

**2.2.3 – Energetic exploitation of bagasse**

Basing on its own characteristics, the dried bagasse, residue of the extraction unit, can be burnt in CHP plant to produce electricity and heat.
Bagasse characterisation

<p>| | |</p>
<table>
<thead>
<tr>
<th></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 4: main characteristics of bagasse, obtained in a TRPF milling system, to plan its energetic exploitation

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

Considering the biomass yields and the LHV, the reference values in order to design the unit for the combustion of bagasse in CHP plant are reported in the following table.

Energy exploitation of bagasse

<table>
<thead>
<tr>
<th>Type of environment</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type MEDITERRANEAN</strong></td>
<td></td>
</tr>
<tr>
<td>Low fertility soils</td>
<td></td>
</tr>
<tr>
<td>Dry climate</td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>Bagasse yield</td>
</tr>
<tr>
<td></td>
<td>Available energy</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></td>
</tr>
<tr>
<td>Temperate oceanic climate</td>
<td></td>
</tr>
<tr>
<td>No irrigation</td>
<td>Bagasse yield</td>
</tr>
<tr>
<td></td>
<td>Available energy</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation (emergency)</td>
<td>Bagasse yield</td>
</tr>
<tr>
<td></td>
<td>Available energy</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5: main elements for the dimensioning of the unit of bagasse exploitation in some reference type of environments

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, most of all, on the electric power. The following figure 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 the combustion of sorghum bagasse is the high content in ashes (3-5% db) that 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 has been issued by the manufacturer. The management of ashes depends on the law of the specific country.

2.2.4 – Energetic exploitation of vinasse

Vinasse, residue of the distillation and rectification units, has a chemical composition which is suitable to the production of biogas through the anaerobic digestion.

![Figure 11: application fields of the different cogeneration systems](image)

Table 6: main characteristics of vinasse to plan the anaerobic digestion

<table>
<thead>
<tr>
<th>Vinasse characterisation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter</td>
<td>6-7%</td>
</tr>
<tr>
<td>Volatile matter</td>
<td>85-90%</td>
</tr>
<tr>
<td>BOD$_5$</td>
<td>40-50 gO$_2$/l</td>
</tr>
<tr>
<td>COD</td>
<td>70-90 gO$_2$/l</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>750-850 mg/l</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>1.5-2.5 g/l</td>
</tr>
<tr>
<td>pH</td>
<td>4.4-4.6</td>
</tr>
</tbody>
</table>
The dimensioning of the anaerobic digester is correlated to the vinasse availability and then to the capacity as anhydrous bioethanol and to the HRT.

Concerning the vinasse yield, the theoretical correlation coefficient is 7-8 litre 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, 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 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 the following table.

<table>
<thead>
<tr>
<th>Biogas characterisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
</tr>
<tr>
<td>CO₂</td>
</tr>
<tr>
<td>H₂</td>
</tr>
<tr>
<td>N₂</td>
</tr>
<tr>
<td>CO</td>
</tr>
<tr>
<td>H₂S</td>
</tr>
<tr>
<td>O₂</td>
</tr>
<tr>
<td>LHV</td>
</tr>
</tbody>
</table>

Table 7: main characteristics of biogas

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 the elements to dimension this unit are summarised in the following table.
Energy exploitation of vinasse

<table>
<thead>
<tr>
<th>Type of environment</th>
<th>Yield *</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type MEDITERRANEAN</strong></td>
<td>Methane 340-1,030 Nm³/ha</td>
</tr>
<tr>
<td>Low fertility soils</td>
<td>Available energy 7.9-23.7 GJ/ha</td>
</tr>
<tr>
<td>Dry climate</td>
<td>2.2-6.6 MWh/ha</td>
</tr>
<tr>
<td><strong>Type TEMPERATE</strong></td>
<td>Methane 500-790 Nm³/ha</td>
</tr>
<tr>
<td>Medium fertility soils</td>
<td>Available energy 11.6-18.4 GJ/ha</td>
</tr>
<tr>
<td>Temperate oceanic climate</td>
<td>3.2-5.1 MWh/ha</td>
</tr>
<tr>
<td>Irrigation (emergency)</td>
<td>Methane 1,070-1,420 Nm³/ha</td>
</tr>
<tr>
<td></td>
<td>Available energy 24.9-32.7 GJ/ha</td>
</tr>
<tr>
<td></td>
<td>6.9-9.1 MWh/ha</td>
</tr>
</tbody>
</table>

* calculations with the application of the actual methane yield

Table 8: main elements to the dimensioning of the unit of vinasse exploitation in some reference type of environments

The obtained biogas is burnt in a CHP plant which can be based on Diesel engine or gas micro-turbine.

The utilised Diesel engine requires some modifications in order to work with the Otto cycle in the combustion of methane: especially it is fitted out with a carburettor and the spark plugs. At the current time these modified engines are already available on the market. Heat is recovered through a 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 nitrogen removal carried out by sweet sorghum growth.

2.3 Review of deliverables, including not achieved results

D1.1 9 (nine) “Agendas and minutes of the project meetings” were produced in accordance with the Annex I and report the schedules of the technical meetings and SC meetings and the treated topics to plan the following activities and to assess the performed ones.
D1.2 2 (two) “Annual reports of SC on the progress of activities” were produced in accordance with the Annex I and collect the comments and the assessment of the SC. The first annual report is focused on the achievement of the targets of success indicated in the Annex I, whereas the second annual report evaluates the applicability of the EU model and its transferability in other countries in the EU.

D1.3 2 (two) “Half-year analysis for outside communication on work progress” were produced in accordance with the Annex I and summarise the main results and lessons learnt during the project. In total 4 fact-sheets were prepared referring to the different periods of the project lifetime.

D1.4 “Publishable report” was produced in accordance with the Annex I and basing on the recommendations of the Project Officer of the EACI and reports the main results of the project, explains their contribution to achieve the specific and strategic objectives and describes the EU model shared with the stakeholders and the consortium experts.

D2.1 “Sweethanol – Early manual” was produced in accordance with the Annex I and describes the background useful for the following discussions of the WP3. In particular some important topics to discuss are evidenced in the grey borders.

D2.2 “Sweethanol – Video” was produced in accordance with the Annex I. This video was divided in the six stages, an introduction where was presented the Sweethanol Project and the current situation and history of the bioethanol production, the travel to India, travel to Spain and travel to Peru, describing the production, raw materials and models in each country, interviews to stakeholders and chain actors, and a final conclusions. The quality of the video is not too high due to the travels´ videos have been done with normal cameras (limiting the cost in this part), but the final result has been able to include more than the travels, including history, interviews, introduction and so on, to complete and improve the final video.

D3.1 “Sweethanol – Technical manual” was produced in accordance with the Annex I and contains the descriptions of the cultivation of sweet sorghum, its processing into 1st generation bioethanol, the general guidelines to design the chains and the plants in the different environments of the South Europe and the applications of these guidelines in 4 case studies in the consortium countries. The contextualisation in the case studies allowed to obtain a high detail
level in the data, also about the economic viability and environmental sustainability. In fact the
designing can be exemplified to address the feasibility studies, but the economic data depend on
the local specificities: for example the cultivation costs vary basing on the requirements of water
and fertilisers and the transport phase impacts on the biomass costs. Concerning the
sustainability, the life cycle assessment includes the agricultural inputs, yields, distances, type of
transport and energy supply and other parameters, which can be fixed only in specific situations;
consequently, the GHGs emission saving can be calculated in specific contests, introducing the
fixed variables in an official tool (i.e. BIOGRACE public tool).

D3.2 “Sweethanol – Administrative manual” was produced in accordance with the Annex I and
contains the guidelines of the EU model, but also the main information about the politico-
Economic conditions in the consortium countries. The integration of the technical topics with the
administrative ones allows to complete the scenario for its understanding by the policy makers,
investors, representatives of energy agencies and public authorities.

D3.3 “Sweethanol – Intersectorial manual” was produced in accordance with the Annex I and
integrates the technical aspects (i.e. agricultural, technological, energetic) of the chain and plant
with the politic-economic conditions, in order to give all the information to the stakeholders,
which want invest in the ethanol market utilising sweet sorghum, in the EU and outside the EU
(i.e. Croatia). It is different from the previous manuals, because the treatment is completely
integrated, the transferability of the EU model outside the consortium is assessed and the pilot
experiences are reported to promote new entrepreneurship.

D3.4 3 (three)“Agendas and minutes of the national workshops” were produced in accordance
with the Annex I, reporting the schedules of the events and the presentations of the experts of the
consortium, but also the contributions of the external experts invited in the workshops to enrich
the discussion and solve eventual technical and administrative questions (e.g. agricultural
mechanisation, preservation of sugars, authorisation).

D3.5 “Agenda and minute of the consortium intersectorial workshop” was produced in
accordance with the Annex I, reporting the schedule of the CIW and the contributions of the
experts of the consortium.
D4.1 “Sweethanol – Manual for trainers” was produced in accordance with the Annex I and reports all the elements, which can be useful to the technicians of the agricultural associations to the technical advice to farmers during the project and after its end. In particular, in addition to the guidelines of the EU model, it explains the details of the cultivation of sweet sorghum (e.g. available hybrids, agricultural practices) and of the contract farming.

D5.1 “Sweethanol – Online community” (i.e. Esse Community) was produced by the subcontractor InfoFACTORY S.r.l. in accordance with the Annex I and it can be used in English, Italian, Greek and Spanish. It was created with the Wordpress CMS, using the social plugin BuddyPress. The community members can: (i) post comments (ii) enter the discussion forum and post topic and/or reply (D5.3 and D5.4) (iii) view the future project events (iv) access the “Sweethanol - Virtual library” (D5.6), where they can found specific articles and technical resources (v) display photo gallery about visits they have made (vi) stay in touch with the community with an alerting system that advise every new article or forum topic are posted (D5.2) (vii) create new events and insert the map where those events are. The Esse community is always connected to Twitter, and specific discussion groups were created on Facebook.

D5.2 8 (eight) report of the “Web monitoring service” were produced in accordance with the Annex I and it was in charge of the subcontractor InfoFACTORY S.r.l.. They allowed to monitor the vitality and liveliness of the Esse Community and to upgrade automatically its contents with new articles about sweet sorghum.

D5.3 “Sweethanol – Forum” was created by the subcontractor InfoFACTORY S.r.l. in accordance with the Annex I and it is part of the Esse Community as regards with the possibility, which is offered to the registered members, to discuss about specific topics related to the project (e.g. ethanol market, sweet sorghum utilisation in the ethanol production). For example after read an article of the Esse Community, the users can leave comments and also discuss on the forum, which is a discussion space open to all users.

D5.4 “Sweethanol – Blog” was created by the subcontractor InfoFACTORY S.r.l. in accordance with the Annex I and it is part of the Esse Community as regards with the possibility to illustrate in chronological order the articles and project activities.
D5.5 4 (four) “Teleconferences” were produced in accordance with the Annex I. In this case, has been made the record in mp3 of several teleconferences made between staff of the Project partners and bioethanol producers in Latin America and Asia, and with ICRISAT researchers in India, concerning the bioethanol production and potential raw materials.

D5.6 “Sweethanol – Virtual library” was created by the subcontractor InfoFACTORY S.r.l. in accordance with the Annex I and it is part of the Esse community to allow the registered members to exchange knowledge each other. In this section there are articles related to different topics written by international experts and researchers.

D5.7 “Sweethanol – Logo of the online community” was created by the subcontractor Punktone Soc. Coop., selected following the provisions of the of Article II.9 of the Grant Agreement. It customises the main dissemination deliverables of the project.

D6.1 “Sweethanol – Website” The website was created by the Greek subcontractor “Creative Media Xefteri Theodora” in accordance with the Annex I. The English contents of the website were developed by REACM and translated by the partners. It includes the following sections:

→ project description & objectives of the project: description of all project phases with objectives, activities, referents
→ Introduction to the work programme & projects documents: description of the tasks the expected results and timetables, download area of technical working documents produced by partners
→ project partners: description of involved partners, contact with persons working as local contact point, link to local websites;
→ news: presentation of related news in Italy, Spain and Greece
→ events: presentation of the events organised in each participating country included the relations to the national and international conferences
→ link to the “Sweethanol - Online community” (i.e. Esse Community)
→ downloads: all the manuals, newsletters, brochure developed under Sweethanol are available in 4 languages
→ a section with restricted access linked to the “Sweethanol Basecamp” available access only for the partners
The website will be maintained through the next 5 years in line with the Annex I.

**D6.2** “Sweethanol – Brochure” was produced in accordance with the Annex I in English, Italian, Greek and Spanish. It describes the topic and the activities of the project, the Esse Community and the partnership. Furthermore in each consortium country it indicates the national beneficiaries and their contacts.

**D6.3** 10 (ten) “Sweethanol – Newsletters” were produced in accordance with the Annex I in English, Italian, Greek and Spanish. Their contents regard: (1) the description of the objectives of the project, (2 and 3) the description of the visits of the WP2, (4) the description of the workshops of the WP3, (5) the description of the Esse Community, (6) the training for the chain actors, (7) the contributions of the expert participating in the final conference in Italy, (8) the main elements reported in the final international conference in Greece, (9) the description of the EU model and (10) the results obtained at the end of the project.

**D6.4** 3 (three) “International paper” were produced, two more than it was assigned in the Annex I. They were published in the Proceedings: a) the International Conference on Biofuels for Sustainable Development of Southern Europe (Bio4SuD) (Greece 30/07/2012) b) the European Biomass Conference and Exposition in Berlin (Germany, June 2011, ISBN 978-88-89407-55-7) and c) the International Symposium of Alcohol Fuel in Verona (Italy, October 2011, ISBN 978-88-7743-369-5).

**D6.5** 3 (three) “National scientific papers” were produced in accordance with the Annex I. In Italy it was published 1 paper in the Supplement of the “Informatore Agrario” (n. 25, June 2012). In Greece, it was published in the “Agronomy Association of Macedonia and Thrace” Journal in June 2012 (Title: Sweet sorghum cultivation for bioethanol production). In Spain Quoting Sweethanol, one scientific monograph on the sorghum energy crop (in Spanish) was submitted by the Secretary General of ADABE to the Ministry of Agriculture of Spain. The title of is the following “El sorgo como cultivo energetico (Sorghum bicolor (L.) Moench.”), published in the Series “Hojas Divulgadoras” of the Ministry (title: El sorgo como cultivo energetico (Sorghum bicolor (L.) Moench.), translation: Sorghum as energy crop (Sorghum bicolor (L.) Moench.)); Number 2142 HD. NIPO: 280-12-168-2. ISBN: 978-84-491-1224-9. Legal Deposit: M-31093-2012
D6.6 22 (twenty two) “Technical and popular articles” were produced, six more than it was assigned with the Annex I.

D6.7 “Sweethanol – Logo” was created by the subcontractor Punktone Soc. Coop., selected following the provisions of the of Article II.9 of the Grant Agreement. It customises the main dissemination deliverables of the project.

The targeted results, which were not achieved during the project lifetime, are:

- participation of chain actors in the visits of the WP2: 10 versus 18. The main reason is due to the co-financing, which was required to the participants to cover the expenses related to the hotels;

- participation in the CIW of the WP3: 13 versus 25. The main reason is due to the difficulty to engage the stakeholders in numerous events in a short period. Considering the profiles of the participants, the consortium discussion was very fruitful and this gap had not any significant consequences;

- participation in the training courses of the WP4: the involvement of some profiles of stakeholders was difficult: in particular farmers and representatives of seeds companies in Italy and fuels processors and investors in Greece. The reasons are different in the 2 countries. In Italy some actual situations penalised the engagements of farmers and representatives of seeds companies: economic crisis, unclear framework of incentives to produce electricity and heat from RES, lack of incentive to produce biofuels, overlapping with maize, many occupations in the period February-August, and particularly during the harvesting time. In Greece the investments by fuel processors and SMEs and by investors are feeling the effects of the economic crisis.

- participation in the final conferences of the WP6: 153 versus 300 in the national conferences and 54 versus 120 in the international conference. The main reason is linked to the difficulty to obtain a high participation in different events, which are organized in a same period about a very specific topic. In fact all the profiles of stakeholders were engaged in the training activities. Despite this, it is important to underline that the results of the project were disseminated to 2,732 people in the activities of the other WPs and they are available in the
“Sweethanol – Website” and in the Esse Community and they will be maintained for further 5 years.

Some targeted results have been not achieved at the current time, but the consortium will able to work to achieve them:

- number of downloads of the “Sweethanol – Video” (D2.2) and “Teleconferences” (D5.5): at the current time 623 versus 750 and 825 versus 1,100, respectively. Considering the reduction of downloads of the documents, during the courses organized in Spain, the “Sweethanol – Video” was showed to the participants. Considering the amount of participants to the courses, approximately 550 people could see the video and the project promotion;

- number of posts in the Esse Community: at the current time 314 versus 640. Considering the high interest for the Esse Community and the topics of the project, testified by the current technical advices started through the Esse Community, the number of posts is not believed a significant indicator of the effectiveness of the Esse Community;

- number of accesses to the “Sweethanol – Website”: 5 on the average, daily. It must be noted that Esse Community was created before the “Sweethanol – Website” and the interested visitors had the Esse Community as the referent website for their information regarding the topic of the project. From the 2,359 visits, 558 visitors are from Greece, 314 from Italy, 225 from Spain and the rest from different countries. In total people from 78 distinct countries, visited the website. The results of the website monitoring are attached to this report (Appendices). In Greece special mention was given about the “Sweethanol – Website” during each event organized by REACM in the framework of the project.

The outcome in Italy after training courses led to the giving of more information about technical assistance/consultancy for farmers.

The outcome after training courses led to the giving of more information about the current incentive to produce electricity from biomass, on 6th July the framework of incentives was changed.
The impact of the action in Spain was masked by the new regulations on bioenergy (particularly the RD 1/2012, BOE Núm. 24) and the well-known economic recession of Spain. However, Cartif and ADABE have assisted to the chain actors during the training courses, answering their questions and giving them all the information required and both of them will do the same beyond the end of the project.

2.4 Review of impact of the action

The achievement of the strategic objectives, indicated in the Annex I, requires a period, significantly higher than the duration of the project.

As regards with the change in the structure of the EU ethanol market, at the current time the consortium is engaged in 8 technical advices to start up some chains to use sweet sorghum as ethanol crop in decentralised plants in the EU and outside the EU. If these initiatives will end positively, the achievement of the planned impacts could be next.

As regards with the increased awareness about sweet sorghum as ethanol crop, the values of GHGs emissions and relative saving were calculating, in accordance with the official methodology of the Annex V, part C of the Directive 2009/28/EC (using the BIOGRACE public tool), and they are available to the inclusion in the next updated version of the Directive. Concerning the decrease in the footprint of the ethanol production, consequent to the use of sweet sorghum, it requires a longer time, than that the project lifetime.

2.5 Success stories

A. Engagement of the chain actors in the discussion of the EU model in Italy

This experience was very fruitful for the applied methodology and for the obtained sharing of the results.

As regards with the methodology, in the NTW1 and NAW the proposed EU model was described to the participants by the PM and some elements were deepened by external experts:

- in the NAW contributed to the discussion of the aspects of the EU model: 1 representative of the Ministry of the economic development, 1 representative of a bank interested to support the entrepreneurship in the agro-energy sector, 1 representative of a national association, which promotes the biomass in Italy (i.e. ITABIA);
- in the NTW1s contributed to the discussion of the aspects of the EU model: researchers of the Universities of Turin, Florence, Padua and other research centres, such as ENEA, CRPA S.p.A., CRA-ING, 1 representative of ITABIA, 1 representative of a SME, engaged in the ethanol sector (i.e. Green Engineering S.r.l.).

In the discussion, following to these contributions, different points of view were emerged to solve some questions: for example the mechanisation of the harvesting, the criticisms of ensiling and concentration as alternative strategies for the preservation of sugars, the agricultural costs and the threshold of economic viability for farmers, the eventual impact of sweet sorghum on the yields of the following crops, which are cultivated in the same fields, the ways of exploitation of the by-products, the impacts of transport and logistics on the environmental sustainability of obtained ethanol.

The participants, which contributed actively to the discussions, were: Assocostieri, IMA-Bertolino Group, Coldiretti, Consorzi Agrari d’Italia S.p.A., U.N.I.M.A., Assoseimenti, Customs Agency, Lyondell Basel Italia.

In the NTW2 the discussion was deepen with the participation of some chain actors, which were actively involved in the discussions of the NTW1s, in order to complete the sharing of the EU model: Green Engineering S.r.l, ENEA, University of Florence, University of Padua, University of Padua, CRA-ING, IMA-Bertolino Group, Assocostieri, Coldiretti, Consorzi Agrari d’Italia S.p.A., U.N.I.M.A., Assoseimenti, Agenzia delle Dogane.

The discussion was focused above all on the economic viability, on the environmental sustainability of obtained ethanol and on the pilot experience, reported by IMA-Bertolino Group.

In the following NIW, in the round table were invited also the representative of the Ministry of the economic development and the representative of ITABIA, in order to complete the points of view.

All the participants were invited to express their own opinions about the EU model. Consequently the strengths and weaknesses emerged clearly and as far as possible the criticisms were solved in same seat. Some questions were not able to be solved immediately, but they required a further widening and however have been acknowledged, solved and explained in the deliverables D3.1, D3.2 and D3.3. As regards with some of these questions, they have not a sole
solution, but they require specific evaluations. This is the case of the economic threshold of economic viability for farmers, because it changes significantly in different agricultural areas, suitable to the sweet sorghum cultivation. The range of price, proposed to farmers in the EU model, is viable in the areas, where irrigation is not necessary to obtain good yields (at least 65 t/ha as fresh biomass), for example in Friuli Venezia Giulia region, whereas is believed profitless in other environments, where rainfall is not sufficient to satisfy the requirement of the crop. In fact an important strength of the EU model is its designing, which is performed considering the specificities of the territory, to exploit its own agriculture. But at the same time, only some territories are able to put up this chain. The discussion, opened to broad-spectrum stakeholders, allowed to clarify the actual potentiality of sweet sorghum as ethanol crop in Italy, which is proving to be good.

B. Development of a concept and basic project
In Spain after the end of the project, has been begun the development of a concept and basic project for developing an industrial plant of bioethanol from sweet sorghum and Helianthus tuberosus in Spain. The production capacity of this plant is going to be similar to the scale implemented in the production model of Sweethanol project, thus, the viability of this project is going to ensure the results obtained in Sweethanol project.

C. Major achievement towards the production of bioethanol from sweet sorghum in Greece
This was the first time in Greece that a constructive effort was made to promote and group together all the important chain actors in the country such as:
- the Ministry of Rural Development
- the Ministry of Environment, Energy and Climate Change
- the Hellenic Petroleum S.A.
- the Regional Union of Central Macedonia Municipalities
- the Decentralised Administration of the regions Macedonia and Thrace
- the Union of Agricultural Cooperatives
- the Union of petrol Stations
- the Technical Chamber of Greece
- the Federation of Industries of Northern Greece
- the Centre for Renewable Energy Sources
- the Hellenic National Centre for R&D
- the Aristoteles University of Thessaloniki
- the University of Thessali
- the Agricultural University of Athens
- the Alexandrian Technological Institute of Thessaloniki
- the Union of Agronomists
- biofuels Technology suppliers
- seed companies
- various agricultural coops
- agronomists
- farmers,
towards the production of bioethanol from a single energy crop. More than 450 people were trained on issues related to the bioethanol production and sweet sorghum cultivation and more than 250 attended the workshops and conferences. The Sweethanol project provided the opportunity to the Greek community to be informed on the potential that the country has in producing bioethanol and achieving the target of 10% replacement of conventional fuels used in the transport sector until 2020. In Greece currently is under development the law for bioethanol production and the sweet sorghum has been included under the main energy crops to be used as a primary source for bioethanol production thanks to the information that the Ministry representatives received through the project. Furthermore the Hellenic Petroleum S.A., which owns and operates three refineries, in Aspropyrgos, Elefsina and Thessaloniki, with nominal annual refining capacity of 7.5 million tons, 5 million tons and 3.4 million tons crude oil respectively, has been informed about the Sweethanol EU model and has been aware of the potential of bioethanol production to the point that is conducting a worldwide research for information on equipment, producers, sweet sorghum suppliers and pertinent data.
3. Lessons learnt

3.1 Management

The cooperation among the beneficiaries has been very fruitful, although some criticisms happened (i.e. the withdrawal of Marex and BAR at the beginning of the project). It means that the activities were well planned, the beneficiaries have been collaborative and the communication has been fluent. The “Sweethanol – Basecamp” has contributed to improve the daily communications between the half-year meetings.

The main lesson drawn from the management activities concerns the estimation of the working hours. In fact for many activities the working hours, indicated in the Annex II, were underestimated. In particular this happened:

- in the management of the WP1, above all caused by the withdrawal of the Romanian partners, which required many unforeseen working hours; in fact a postponement of three months was required in the 1st amendment. Furthermore, a higher number than that planned was required in the coordination of the consortium to meet deadlines;
- in the visits of the WP2, because they were planned based on the availability of the host organisations (e.g. ICRISAT, TATA Chemicals Ltd), and consequently the travels required times longer than that foreseen;
- in the WP4, because the recruiting of the participants in the training courses required many working hours, because many different channels were tried.

Another lesson learnt from the management regards the estimation of budget for some items, which were overestimated in the Annex II.

For CETA this happened in the costs for the organisation of events and for the printing of manuals. The reason is the utilisation of free rooms for the most discussion workshops of WP3, training courses of WP4 and conferences of WP6. As regards with the printing of manuals, a cheaper supply was found. Furthermore some costs were not required, such as for the teleconferences and the corrective actions of WP5.

3.2 Communication and Dissemination

In the framework of the project many communication and dissemination events were performed: in the consortium countries were organised and performed 15 national workshops (NTW1s,
NTW2s, NAWs, NIWs, 1 consortium workshop (CIW), 92 training courses, 3 seminars, 3 national conferences and 1 international conference. Furthermore the activities and results of the project were presented in other 10 external events in the EU and also outside the EU (i.e. Peru) and during the visits at agricultural institutes, technology suppliers and plants, in the context of the WP2.

In total 2,732 people were informed about the topics of the project and the EU model, due to the recruitment by the beneficiaries. These events and the contacts with many people contributed to learn some lessons. An important lesson drawn from these activities concerns the channels, which must be utilised in the recruiting the people. The effectiveness of the Esse Community has not been very high in the recruiting, whereas it has been very useful for other aspects, for example to update the stakeholders, to create new contacts and to answer to their specific questions. On the contrary the major successes in the recruitment were obtained when the stakeholders are contacted directly by phone. The human contact is proving to be the most effective channel, because is able to get a message and to give the desired explanations. Instead the electronic contact (e.g. email, newsletters) is effective in well-established relationships, and the communication within the consortium confirms it, but it is quite fruitless to start up new relationships and to motivate the people. This is even more true for farmers, whose familiarity with the informatics is very low.

As regards with the communication tools, the CD rom resulted a little bit unwelcome, whereas the printed version is widely preferred. This perception was acknowledged preferring the USB memory as electronic version of the D3.3, using the budget foreseen for the gadgets of the project (instead of the traditional notes and pens).

As mentioned above, the Esse Community has resulted an effective tool to maintain the relationships among the chain actors and it is contributing actively to create and increase a network. The Esse Community will be the point of reference about the topics of the project also in the next years. At the current time the participation of farmers in the Esse Community is low and the agricultural associations represent the main intermediary to engage these chain actors.

Concerning the applicability of the contents of the project (i.e. the EU model), tested in the dissemination activities of the project, the Italian energy policy is moving towards the support to sweet sorghum as ethanol crop. In fact at the current time, in accordance with the ministerial
decree of 6th July 2012, sweet sorghum is specifically supported when it is used to produce electricity in short chain, because in Italy is considered a non-food crop. The next expected step is the acknowledgment of a specific bonus for the ethanol obtained from this crop, exactly as is the case of other non-food ethanol raw materials (e.g. residues of wine chain), which have the double counting to achieve the target by 2020.

After 8 years of European Directive implementation on biofuels, bioethanol plants are yet to be installed in Greece. This fact along with the existing legislation implies that the construction of such units could be crucial. Greek farmers showed a great interest in cultivating sweet sorghum comparing its yields and the cost of cultivation which is 30% less than the respective of corn cultivation. Furthermore the Hellenic Petroleum S.A. which is one of the potential investors in the bioethanol field has started to examine, after the information received by the Greek partners, the construction potential of a plant using sweet sorghum. Representatives of the Ministry of Environment, Energy & Climate Change and the Ministry of Rural Development received all the results of the Sweethanol project and were informed about the details of the Sweethanol model in order to take into consideration the use of sweet sorghum as a primary source for bioethanol production and the sustainability critical factors of such plants, one of which is the electricity price produced from the by-products of the juice extraction and distillation unit.

In the case of Spain, although the modification on the tax paid by kWh produced from biomass has been reduced drastically, the production model is very interesting focused on specific areas of Spain. In this case, the sweet sorghum can reduce the GHGs more than the amount indicated by the EC directives, thus, the sustainability is ensured. The economic aspect of the production process from sweet sorghum must be consider with an auto-consumption of power and thermic energy from the bagasse, considering the inputs of the process the bioethanol produced mainly. This affect to the scale of the process, although the maximum capacity of the plant is fixed by the time needed to arrive the raw material from the land to the plant. Thus, the maximum capacity can be close to 30,000 m³/year to ensure the viability of the process.

The implementation in Spain can be done mainly in Andalusia and Extremadura, although there are other regions where can be implemented this kind of projects, like Castilla la Mancha or Aragon. In the current situation, the biggest bioethanol company of Spain, Abengoa, is working on the development of second generation of bioethanol, due to the type of bioethanol plants that
it has in Spain (from cereals, that aren’t going to reduce the GHGs over the 35%), although the best raw material, at this moment, are others, like sweet sorghum, due to the technical aspects (second generation is not clear and the production has several problems on the efficiency).

In Italy some material on the issue of the project will be widely distributed to farmers at local level in the Coldiretti Offices during next months.

3.3 Common Dissemination Activities

The “IEE co-ordinators training”, attended at the beginning of the project, gave many important information to set up correctly the communication and the activities of the project. This information was shared with the co-beneficiaries at the KOM and was reported to the following coordinator, Mr. Maurizio Trevisan, which succeeded to Mr. Alessandro Bon since 1st June 2011. Experience as a whole the consortium learned the importance of identifying a logical ordering of the various steps necessary for the definition of a project. The creation of a concept map and a plan of action, tells us how many factors are likely to be neglected or the energy can be wasted if the efforts are not driven by the right questions asked in a logical order.

3.4 Conclusions

The main conclusions concern the expected impacts of the action in the short term, which are different in the consortium countries.

Conclusions in Italy

At the current time the national ethanol production is focused mainly on the alcoholic fermentation of agro-industrial residues of the grapes and fruit processing, because it does not require the establishment of chain, but it can utilise feedstock, which is already available. Furthermore the ethanol obtained from residues benefits from the double counting to achieve the target by 2020 for the contribution of RES in the consumption of transport.

In 2011 the internal capacity was 215,000 tons (IMA-Bertolino Group 172,000 t/year and Caviro Distillerie S.r.l. 43,000 t/year) and 48,722 tons of ethanol were produced. Caviro Distillerie S.r.l. processes wine residues and IMA-Bertolino Group mainly applies the dehydration of imported ethanol.

The internal production covers a small part of the internal ethanol demand, whereas importation plays a major role and this trend did not change during the project lifetime. Instead in this period
is changed the regulation of the sustainability of ethanol, since the Directive 2009/28/EC was acknowledged by the legislative decree 28/2011 and the ministerial decree of 23rd January 2012 and decree-law 83/2012 have contributed to this regulation. Since 1st January 2012 the traded ethanol (deriving from the internal production or imported) must be certified as sustainable in accordance with the EU criteria.

Then the ethanol demand is created by law, acknowledging the target by 2020 of the Directive 2009/28/EC, whereas the supplying of sustainable ethanol is in part national (partially benefitting from the double counting), but above all based on the importation.

In this situation in Italy there is a large market space, also considering the EU regulation of the importation (March 2012), which has closed loophole of the last years. Also for this reason the project activities have been specifically aimed to disseminate the opportunity offered by sweet sorghum. Then the project contributed actively to overcome the barriers due to absence of know-how.

But a persistent non-technological barrier is the profile of the Italian agricultural sector, which is characterised by a high fragmentation and strong tie to the traditional food arable crops (i.e. mainly corn in the North and wheat in the South).

The high fragmentation imposes the engagement of a high number of farmers in the chain to obtain the required fields (e.g. 4,000 hectares requires up to 450 farms), with relevant criticisms in the start, management and coordination. The logistic during the supplying of chopped biomass makes this situation worse, because the organisation of the harvesting yards is quite complicated (considering the fast degradation of sugars and the distance from the processing plant) and many people and machineries must be coordinated.

The strong tie to the traditional crops restrains the motivation of farmers to try innovative crops, such as sweet sorghum, and only significant improvement of the incomes can act in this direction. Consequently the threshold of economic viability, in term of arrangement between the IRR for investors and the price of biomass for farmers, is the critical point. This threshold has been calculated in the EU model, but it is acceptable or not, depending on the specific areas and on competition conditions with food crops and other energy crops which are more profitable both in terms of production and incentives connected to the renewable energy sector. For example in the middle plan of Friuli Venezia Giulia region sweet sorghum gives high yields without
irrigation and the same proposed price for the fresh biomass is profitable for farmers. On the contrary if irrigation is required to obtain adequate yields, the cultivation costs increase and the price is less profitable. As consequence the EU model appears applicable in some areas of Italy. The next actions (e.g. technical advices, updating through the Esse Community, further dissemination events) will be focused on these territories, in order to strive to achieve the expected impacts, in term of diversification of feedstock, decentralisation of production and engagement of farmers in the ethanol sector.

As regards with the increase of the awareness about sweet sorghum as ethanol crop, in Italy this impact is considered achieved, because the EU model was shared and disseminated, applying a strict method, and the values of GHGs emissions for the different phases of the chain have been calculated.

Conclusions in Greece

REACM with the support of HALASTRA Coop, organized a plan to foster the aim of the Sweethanol project and perform its activities in the area of central Macedonia mainly, were the two partners are located. The target groups that were contacted are a) Ministries responsible for Bioethanol legislation b) Research Institutes with expertise in sweet sorghum and bioethanol production, c) Companies with expertise in bioethanol plants construction d) Fuel processors & investors, e) Agricultural coops, Farmers, seed companies and Agronomists to be involved in the bioethanol chain, f) Local authorities, policy makers to foster the local energy planning. More specifically the main conclusions-results of the actions deployed are given below:

a) Ministries: The Greek partners communicated with representatives of the Ministries who are in charge of developing and implementing the legislation on biofuels. More specifically with Mr. Zacharopoulos, Deputy Head of Petroleum Policy Directorate/ Ministry of Environment, Energy and Climate Change and Mr. Anastopoulos, Director of the Division of Tobacco, Aromatic & Medicinal Plants/ Ministry of Rural Development. Both are members of the Committee for Bioethanol production issues in Greece. The Sweethanol EU model was discussed with the representatives of the Ministries and special attention was given to the advantages of sweet sorghum, the potential to be cultivated in Greece, the results of pilot cultivations in Greece, the importance of electricity price (produced from biomass) in the sustainability of the bioethanol plant and other issues related to the bioethanol production. The sweet sorghum is included in the...
list of the energy crops to be used as primary source for bioethanol production under the Greek law.

b) Research Institutes: it was very essential from the beginning to contact Scientists in Greece with expertise in sweet sorghum cultivation and involve them in the project. The Greek team found two Agronomists Experts that conducted pilot cultivations of sweet sorghum in Greece, one from the Alexandrian Technological Institute, Dr. Dimas Kitsios and one from the University of Thessaly, Dr. Theophanis Gemptos. Both the experts presented their results to the training courses and explained in detail the cultivation technique, the advantages and disadvantages of the crop, the inputs, the yields and other data related to the cultivation of sweet sorghum techniques. Additionally Dr. Stella Bezergianni, Chemical Engineer from the Greek National Centre for R&D (CERTH), who has conducted a research in the sustainability of bioethanol produced from different energy crops (including sweet sorghum) was also approached and participated in the Sweethanol workshops and International Conference.

c) Companies with expertise in bioethanol plants construction. Since Greece has no bioethanol plants yet, it was difficult to find experts in this sector. Technology suppliers acting in Greece are more experienced in biodiesel production. A company that has knowhow in bioethanol plants was the “Philippopoulos Energy Technical S.A” but with no previous experience in bioethanol plants construction. REACM made an extended research and found an American company that implements bioethanol plants in USA and through them they managed to come into contact with “Cal West Easy Energy Europe sa” and its representative Mr. Xenofon Karapas who attended the workshops in Thessaloniki and provided info regarding the technology equipment used for bioethanol production.

d) Fuel processors & investors: In Central Macedonia is operating one of the biggest distillation plants of Greece of Hellenic Petroleum SA. The company established in 2006 the Hellenic Petroleum - Renewable Energy Sources S.A. (ELPE-RES SA) the purpose of which is the production, distribution and trade of renewable energy sources, as well as its participation in other companies for the production, import, distribution and trade of renewable energy. This company is also considered the most significant potential investor for bioethanol production. For this reason ANATOLIKI SA/REACM had many discussions with the Director of ELPE-RES SA regarding the sustainability of a bioethanol plant using sweet sorghum as an energy crop. ELPE
participated in the workshops, in the training courses as well as in the international conference where it had the opportunity to meet and have further discussions with the other project partners. ELPE-RES SA expressed its willingness to invest in a bioethanol plant, showing a great interest in sweet sorghum as they learned about the advantages that it has in producing thermal and electrical power from its by-products.

e) Agricultural coops, Farmers, Seed companies and Agronomists: Since there are no bioethanol plants it was extremely difficult to attract the interest of farmers. For this reason the Greek Partners made extra efforts to involve the presidents of the agricultural associations and the Mayors of the municipalities that sweet sorghum can be planted. An external expert was also involved to help with the organization and the communication with farmers and agricultural coops. All this effort had as a result to train 386 farmers, 160 farmers more than it was assigned in the Annex I. Farmers expressed their willingness to cultivate sweet sorghum once the bioethanol plants start their operation in Greece. According to the experts in sweet sorghum cultivation the cost of the cultivation is 30% less than the respective of corn and the farmers will have a final income around 17€/ton which for the Greek farmers is sufficient (sweet sorghum may be sold at 30€/ton wb).

f) Local authorities, policy makers: the Local authorities’ representatives were approached to discuss how the local energy planning should be deployed in order to obtain the best results from bioethanol production. Furthermore, Mayors played a significant role since most of the rural municipalities face serious unemployment problems and the cultivation of a new energy crop in these municipalities will create new jobs in the future; thus Mayors highlighted the dissemination of the Sweethanol project in their areas in their efforts to create new opportunities for growth in their municipalities.

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 implement 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. For this reason also, it was very important the contribution of Sweethanol project in the country.
Conclusions in Spain
The model in Spain was initially based on the integration of electricity and ethanol from the same raw material, from sweet sorghum stalks, on a small production scale. While the elimination of premiums for the kW power produced from biomass (and any renewable source) have to rethink the balance of income and expenditure, and the feasibility of the investment.
The solution to maintain the viability of the investment for such facilities is to increase the production capacity and the operational period of the plant. Thus, higher performance is achieved in the balance of income and expenditure.
At the legal level, implementing the European directives for promoting the production and use of bioethanol (2009/28/EC and 2009/30/EC), and evaluating which is the energy and CO\(_2\) balance of sweet sorghum in Spain, it has been that the crop meets the European requirements of sustainability, both marked for 2013, as existing from 2020, based on the use of residual bagasse for the production of thermal energy.
This fact, coupled with the use of cereals and food destination without biomass will not meet sustainability requirements from 2013, requires that the domestic producers, Abengoa, reconsider the type of production and the raw materials used. Research and current trends suggest that residual lignocellulosic biomass feedstock will be the future for the production of second generation bioethanol, although the experimental results obtained in semi-industrial plants still have not produced a satisfactory result and viable for scale implementation. The transition between unsustainable raw materials and commodities second generation (not economically viable right now), requires the introduction of alternative crops that allow the maintenance of a sustainable production, as it was shown to achieve the sweet sorghum.
The implementation of this crop in Spain is located to a number of specific areas, so that is not a global solution for the whole country. Specifically, there has been adequate returns in Extremadura, Andalusia and Aragon, areas where irrigation is possible and that can provide a high yield per hectare involving the possibility of increasing the capacity of the production plant without extending the radius plant action over 50 km, beyond which is used too long in the transport of the raw material, resulting in higher cost and losses and, therefore, sugar alcohol.
Achieving industrial development of this raw material for bioethanol production, right now, should come associated with the use of bagasse and thermal power generation focused on
consumption (not allowed the new Spanish legislation). In case that in the coming years will reimpose the premium power from biomass, this income will be considered as an additional benefit of the viable project.

**Transferability**

Finally, as regards with the transferability of the project results in the other EU countries, where sweet sorghum can be cultivated, a first consideration concerns Romania, which remains a country that is very suited to the application of the EU model and for this reason the withdrawal of BAR and Marex is sorry. Likely this country will able to benefit from the project results, because some important initiatives are carrying out in Romania.

Romania has a lot of hectares of land to cultivate and to stimulate the agriculture a tax has been imposed to farmers for the uncultivated fields (95 €/ha per year). The abandonment of fields is a problem in Romania, where in total 1.3 million hectares are not cultivated with a loss estimated in 300 million € per year.

A program for the National Rural Development has been started by the Government with particular attention for the RES and it foresees a change in the crops cultivation in favour of new crops to introduce.

For these reasons sweet sorghum can be cultivated for bioethanol and power production from its by-products. In Romania, with a lot of land and no big bioethanol production plants, the possibility of having decentralised small-medium plants with a certain amount of involved farmers could easily become a reality.

Other countries, where the project results could be transferred, are Hungary, Bulgaria and Croatia and the interest of investors in the Balkan peninsula and in South East Europe has emerged also in the training courses, performed in Italy (e.g. Finest).
4. Library and sources for the EU model

i CETA


iv Pin M., Picco D., Vecchiet A., Macchia E., 2011 “Sweet sorghum to produce in Italy sustainable ethanol, electricity and heat in decentralised small-medium biorefinery”, Proceedings of the 19th International Symposium of Alcohol Fuels, Verona, Italy, 10-14 October 2011


vi CETA


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