Country Report Italy
IEA Bioenergy Task 42

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Country introduction

Italy has an overall surface of 30 Mha and a population of roughly 60 ML (0.9% of the word population). In the last years the primary energy demand has been in the range 180-190 Mtoe corresponding to 1.6% of the world energy demand and the overall greenhouse gas emissions have been 563 Mt/y. The CO_2 emissions were 482 Mton corresponding to 2% of the world emissions.

In Italy, the **energetic supply** is still strongly based on fossil fuels and on foreign imports. In 2009 the petroleum products accounted for 41 % of the primary energy demand followed by natural gas, renewable energies and solid fuels. More than 90% of the petroleum products were imported. In a decade, since 2000 up to 2009, the national energetic framework has positively changed with a progressive increment of the renewables use in the energetic balance(+3.8) and a diminution of the petroleum products (-8.5). With respect to 2008, the final energy consumptions in 2009 diminished by 5.6% as consequence of the reduced production of some industrial sectors. In 2010 the primary energy demand to satisfy the internal consumption (5802 PJ) was 7862 PJ. Fig. IT1 reports the data at 2010 as obtained from the Italian Ministry of Economical Development

Renewables could contribute to this scenario in several ways:

- covering the needs especially in those places where connection to grid is not feasible;
- offering alternative sources for enhancing the energetic independence;
- developing new industrial sectors driven by sustainability criteria.

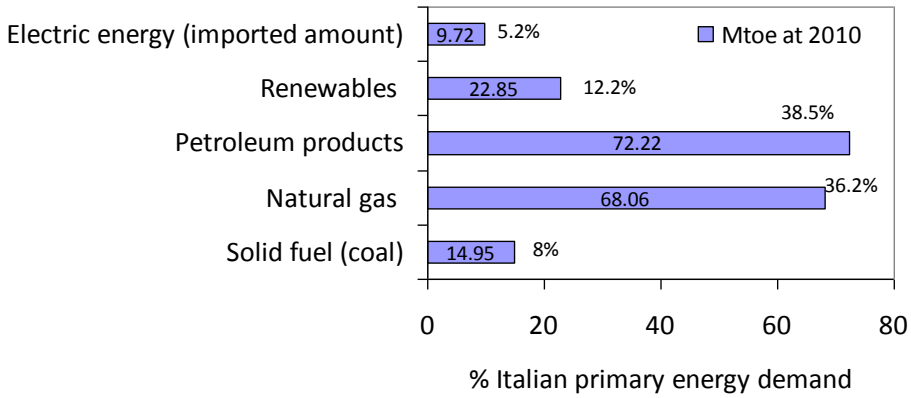

Figure IT1: Italian primary energy demand (Ministry of Economical Development)

Following the **objectives of the European Union** on the use of renewable energies, the so called strategy of 20-20-20, Italy will produce at 2020 17% of the final energy uses from renewables and will reduce the CO_2 emissions by 14% with respect to 2005.

Bioenergy consumption in 2009 accounted for around 259 PJ. However, the Italian potential of biomass has been estimated in the range 630-960 PJ/y, 50% of which could be used for energetic applications. According to some estimations from Itabia[1], if these resources would be efficiently used, they could save up to 419-502 Mtoe with a corresponding reduction of CO_2 emissions of 30 million tons/y.

One of the limiting factors against a wider exploitation of bioenergy in Italy is **availability of biomass from dedicated crops**. According to the last agricultural census (2010), the Italian forests area is 10 Mha, the area

[1] ITABIA is the Italian Biomass Association (http://www.itabia.it/)

used for agriculture (SAU) is 12.9 Mha, while the total agricultural farm area (SAT) is 17.3 Mha. On the whole, up to 4.9 Mha (SAT-SAU) would be in principle available for energy crops. However this is an upper potential. A more reliable potential for the production of energy crops could be considered in the range 0.8-1 Mha. The additional use of lignocellulosic wastes could represent an interesting option for the bioenergy development.

Although not fully exploited, the biomass resources are mainly destined to the production of energy. Only in the last years a few significant initiatives in the field of **bulk chemicals and bioplastics production** from biomass have been developed. The growth of these new industrial sectors implies the development of new productive approaches making use of biotechnologies. In fact, fermentation and enzymatic processes typically used for the production of fine chemicals (i.e. pharmaceutical intermediates, vitamins), can be applied to the conversion of biomass for the production of innovative materials. On the whole, the further use of bioresources for the production of innovative biobased materials could stimulate newborn sectors like the industrial biotechnology.

Energy production and consumption based on biomass

In 2009 roughly 259 PJ of the Italian primary energy demand (7550 PJ) was supplied by biomass (corresponding roughly to 3.4%). Table IT1 details the Italian demand of bioenergy in 2009 as estimated from the analysis of the data from GSE[2] and ENEA[3].

Table IT1: Evaluation of the bioenergy consumption in 2009: a breakdown in areas (elaborations on data from the ENEA's 11th report on Energy and Environment and from GSE annual report on renewables)

Use	Year	Unit	Amount	% of total bioenergy[5]	Feedstock(s)
Heat[4]	2009	PJ	126	48.7	Wood for burning/other lignocellulosic biomass/pellets
Electricity[5]	2009	PJ	56	21.7	Wood for burning/other lignocellulosic biomass/raw vegetable oils
Bioethanol[6]	2009	PJ	1.5	0.6	Distillation products
Biodiesel[7]	2009	PJ	26	10.1	Vegetable oils, oil seed crops
Biogas[5]	2009	PJ	25	9.7	Landfill gas, sewage treatment, animal dejection
Wastes[5]	2009	PJ	24	9.3	The biodegradable fraction of the municipal solid wastes

Figure IT2a displays the overall installed power and the number of plants producing electricity from bioresources. Fig IT2b details the contribution to the overall electricity production at 2010 due to the solid biomass (including the organic fraction of the municipal solid wastes), biogas and bioliquids (vegetable oils).

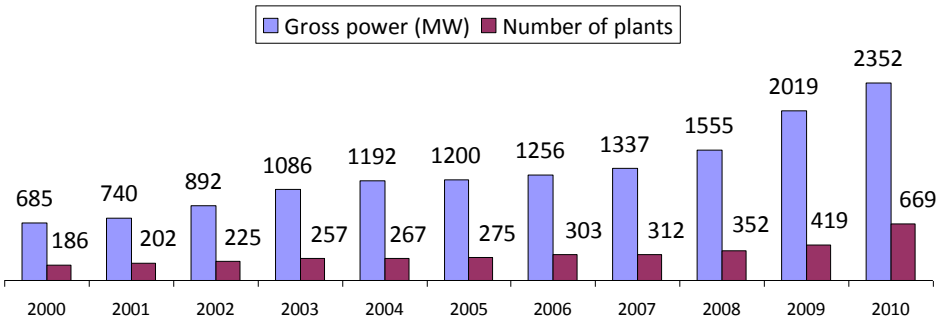

Figure IT2a. Electricity production from biomass (GSE 2010)

[2] Data from GSE, Gestore dei Servizi Energetici -. http://www.gse.it/Eng/Pagine/default.aspx

[3] Data from ENEA, Italian National Agency for New Technologies, Energy, and Sustainable Economic Development http://www.enea.it/it/produzione-scientifica/rapporto-energia-e-ambiente-1/rapporto-energia-e-ambiente.-analisi-e-scenari-2009

[4] Including heat from cogeneration (data from ENEA). This value could be considered a low estimation because it describes only data from the official statistics while the most part of the woody biomass used in the residential sector is not included in the official census.

[5] For the evaluation of the percentage contributions, the electrical production from GSE (2009) were divided by 0.25 accounting for the electrical efficiency.

[6] Data from The European Bioethanol Fuel Association

[7] Data from http://www.plateforme-biocarburants.ch/en/infos/eu-biodiesel.php

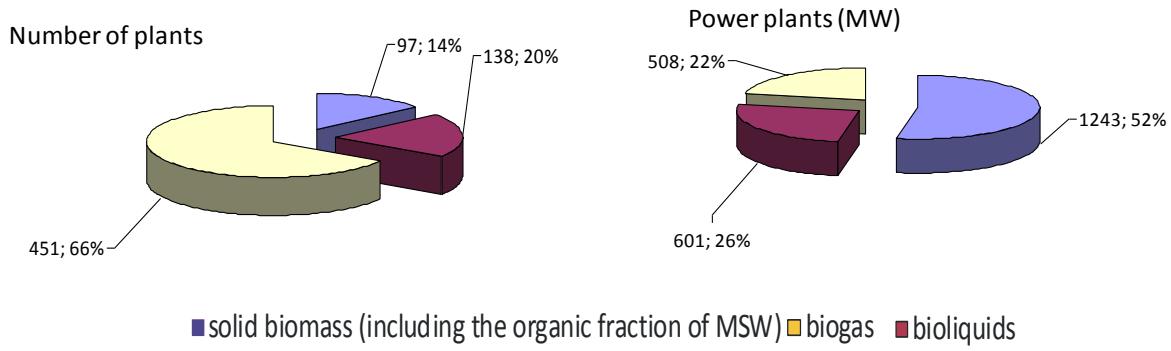

Figure IT2b. Breakdown of electricity production from biomass (GSE 2010): number of plants and overall installed power

In Italy the number of biomass plants for the production of electricity has grown in the last decade. Plants using solids and oils at 2010 were 235, mostly with sizes higher than 5 MW. Mature technologies, namely the combustion, are promptly available for these plant size. However, considering the low Italian biomass production from dedicated crops, these plants could face problems in **reliable feedstock supply.** Besides wood chips, agricultural residues, olive residues, and municipal solid wastes coming from Italian productions, **vegetable oils** are often used. In this regard a sharp increment was reported by GSE in 2009 with a production of 1,447.8 GWh (5.21 PJ) against 64.5 GWh (0.23 PJ) produced in 2008. The oils used are mainly imported. However, the latest updates of the relevant regulation tends to favour the biomass supply from short chain and this should reduce the oils importations in the next years. **Plant sizes** under 5 MW would be more congruent with the Italian biomass resources and with their distribution. The gasification technology could be an interesting option for these scales.

Some opportunities to develop bioenergies could derive from **residual biomass/wastes** or **low inputs dedicated crops** (i.e. Arundo donax) in decentralized applications (1-5 MW electrical). For 1 MW electrical a typical configuration could consist of a fluidized bed gasifier coupled with a gas cleaning unit and a modified Internal combustion engine. In Italy the cost for such configuration is roughly 3,500-4,500 €/$kW_{electrical}$[8]. The main obstacle to the development of such systems is the incidence of the operating and maintenance costs. This requires the development of feeding systems fully automating and reliable technologies (reduced maintenance costs) especially for the cleaning unit.

At 2010 biogas plants (landfill gas and agro-zootechnical wastes) account for 66% of the overall plants This is due to the fact that the technology is mature, has low costs (2,500-7,500€ for installed electric KW) and could be used in small scale decentralized applications.

Concerning the **biofuels** production, Italy has mandatory targets to replace increasing amounts of transportation fossil fuels by biofuels. In 2008 Italy achieved 2% replacement as energy equivalent. The current target at 2012 coincides with that of the previous year. This indicates a certain difficulty of the Italian system to follow the European mandates. Table IT2 summarizes the biofuels targets since 2008 up 2014.

[8] Fiorenza *et al.* Techno-Economic Assessment of an Integrated Biomass Gasification and Molten Carbonate Fuel Cell System for CHP Production, 18th European Biomass Conference and Exhibition, pages 632 - 639

Tab IT2: Italian biofuels targets

Year	Biofuel
2008	2%
2009	3%
2010	3.5%
2011	4%
2012	4%
2013	5%
2014	5.5%

The national **bioethanol** production in 2009 was 72 Mln (20% more with respect to 2008) and was produced mostly from the mandatory distillation of the products from the enological sector. However, this amount decreased in 2010 (Fig IT3). In Italy there are more than 70 ethanol distilleries, but only two plants (Alcolplus and IMA) producing fuel grade ethanol. Almost all the produced amount is exported to northern Europe where it is used as additive for the transportation sector. Roughly 95% of the biofuels supplied in Italy is biodiesel. Fig. IT4 shows the map of the main industrial plants producing **biodiesel** in Italy.

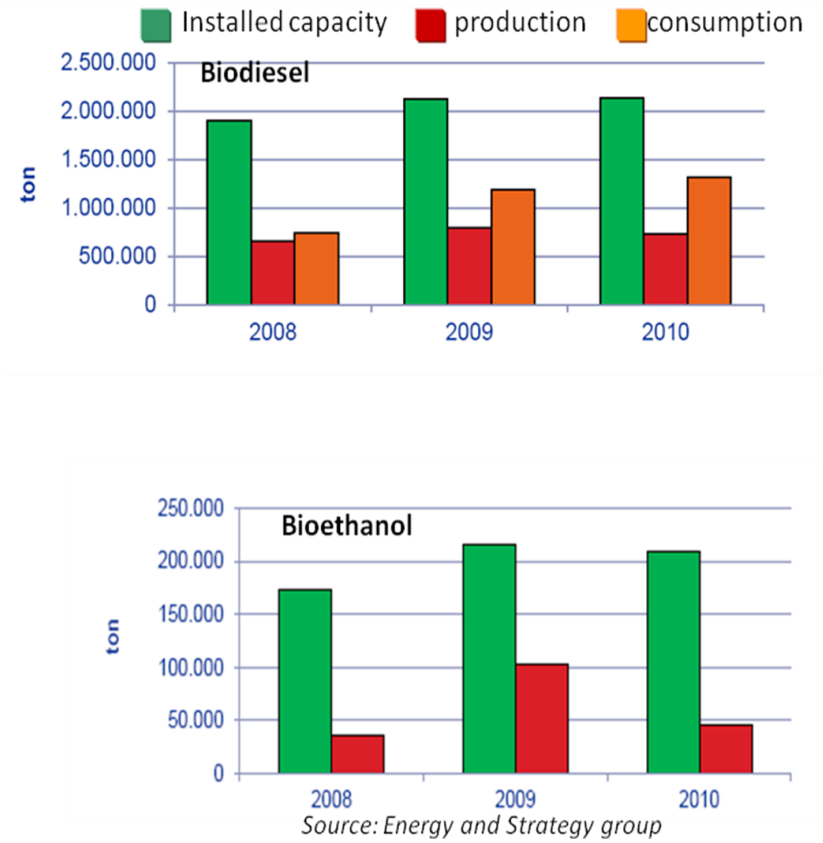

Fig IT3: biofuels production in Italy

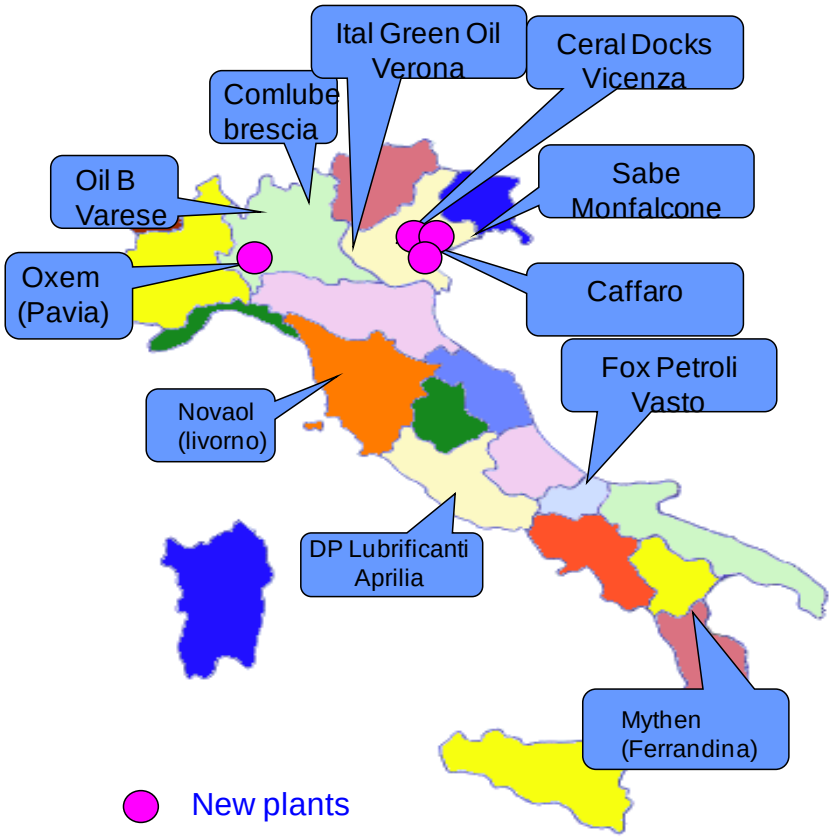

Figure IT4: Main industrial plants producing biodiesel in Italy

In 2009 there were in Italy 19 biodiesel plants with a total production capacity higher than 2 Mton/y. In the same year, 694,000 t were produced, 90,000 t were exported and 465,000 were imported. The raw materials for biodiesel production are mainly imported oils (rapeseed oil for 70 percent of the total and soybean oil for the 20 percent). This is due to the high costs of the national productions and to the limited availability of lands to be destined for oil crops. On the whole, the Italian production capacity of biodiesel appears not fully exploited. One major cause is the absence of stable regulatory frameworks. If the industrial capacity would be fully used it could create also an interesting production of **glycerin**. At the moment, the major part of this co-product is resold as crude product.

Italy is a country with a high density of population and this could limit the wide development of dedicated crops for biomass production. Table IT3 lists the biomass availability in 2010 as obtained by the Italian Ministry of Economical Development.

Table IT3: Biomass availability in 2010 (kt). Data form the Italian Ministry of Economical Development

	Wood	**Biomass for electricity**	**Biodiesel**	**Total**
National production	9,594	7,070	799	17,463
Imported	4,286		798	5,084
Exported	58		101	159

Most farms have small dimensions (around few hectares) and they are not able to face high investment costs that are at risk to not be repaid. **Short rotation coppice** (SRC) has become popular in recent years, with over 4000 ha already planted, almost exclusively with poplar, in the North, along the Po Valley, because its

abundance of water[9]. More recently, the use of **Arundo donax** has been considered for the production of biofuels and bioenergy. It is a non edible biomass that could be cultivated for energetic purposes thanks to the low inputs required for its growth. The use of this crop as feedstock for the production of lignocellulosic bioethanol is part of the Italian industrialization strategy followed by the Mossi and Ghisolfi group. According to their tests in the Crescentino territory (Northern Italy), this crop would require less than 1.2 nitrogen kg/ton biomass dry matter (DM)[10]

Despite the obstacles outlined, the use of biomass both for electricity and heat production has registered a positive trend in the last years (Fig. IT5, Fig IT6).

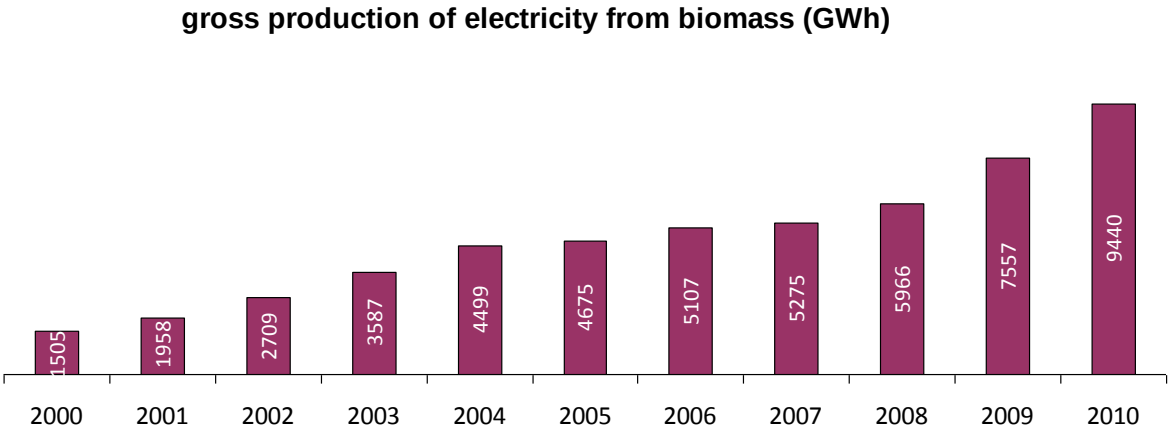

Figure IT5: Electricity production from biomass (data from GSE).

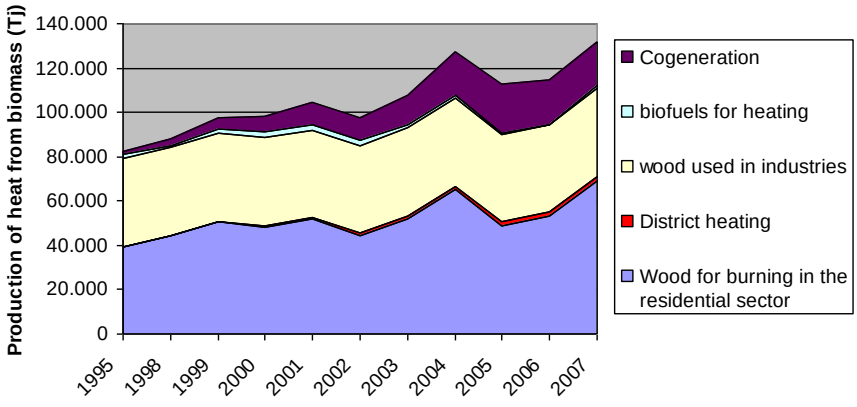

Figure IT6: Heat from biomass (data from ENEA)

The production of **heat from renewables in 2009** has been estimated to be 45 PJ from industrial plants (woods and heat from cogeneration) and 81 PJ from domestic uses (wood and tele-heating sector) [11]. This last consumption could be underestimated considering that it includes only data retrieved from the official statistics concerning the commercialized woody biomass.

[9] Spinelli *et al.*, Biomass and Bioenergy Volume 33, Issue 5, May 2009, Pages 817-821
[10] De Bari *et al.* , *19th European Biomass Conference & Exhibition*, Berlin (Germany), 6-10 June 2011
[11] Rapporto ENERGIA E AMBIENTE: analisi e scenari 2009, ENEA

Table IT4 displays some of **the national feedstocks** available for bioenergy production. With the exception of the first and the third items in the table describing biomass exclusively used for the production of energy, the other figures listed describe the overall national potential. In particular the last seven items in the table represent the Italian potential as surveyed by ENEA in its *national atlas* of biomass[12]. An important basin of raw material for bioenergy are the residual lignocellulosic biomass from agro-industrial activities (such as straw and pruning) and from forest management. Some estimations through the ENEA's atlas indicate that the Italian potential is 24Mt/y but only a limited part of these resources is accessible. In fact, logistic aspects play an important role. Figure IT6 shows a typical map as obtained from the ENEA's atlas. The **market price of lignocellulosics** ranges from a minimum of 34 €/ton for straw up to 110 €/ton for nuts shells. The major oscillations are reported for pruning with an upper value of 107 €/ton[13]. Biomass collection and transportation heavily affect the cost of biomass. According to same evaluations from the University, the cost of rice straw would be increased from 33 €/tDM to 77 €/tDM at extending the collection basin from 5 to 20 km[14].

The figures reported in table IT4 for the lignocellulosic residues describes the overall production. Part of these feedstocks has already some **market destinations**. For instance, part of the wood collected in woodlands is destined to the furniture and carpentry industry. Another part of this wood along with that from pruning and explants of old fruit trees is already used for the production of energy in small size plants (domestic heating, small boilers). Part of the residual straws from the agricultural activities are burned or remains in the fields with the purpose of releasing into the soil some important organic compounds. Finally, part of the straw is used for animal feed. On the whole, what is the Italian potential of lignocellulosic feedstocks for the production of bioenergy and biobased products? Some evaluations from Pari[15] claim that up to 54% of the lignocellulosic biomass produced in Italy could be used for energetic application toward the 25% currently used. Di Blasi *et al*.[16] found that 40-60% of the Italian straws and 5-10% of the wood from pruning and explants have already a market destination.

[12] Data from: http://www.enea.it/enea_paese/sistema_elettrico/Censimento_biomasse

[13] Prices of the agricultural products in 2002 reported by an Italian Board of Trade (Parma)

[14] http://www.iea-bioenergy.task42-biorefineries.com/publications/stakeholder-meetings

[15] Pari L., Energy production from biomass: the case of Italy, Renewable Energy 22, 2001.

[16] Di Blasi C., Tanzi V. and Lanzetta M., *A study on the production of agricultural residues in Italy*, Biomass and Bioenergy 12, n. 5, 1997.

Table IT4: National biomass feedstock available for bioenergy production

Source	Year	Unit (Mm^3 or kton)	Amount
Woods for energetic applications[17]	2010	Mm^3	5.2
Wood industry residues[18]	2009	Mton	0.676
Wood pellets/briquettes	2010	Mton	1.5[19]
Sludge from the treatment of the MSW (dry matter)[20]	2003	Mton	0.9
Wastes (organic fraction)[21]	2009	Mton	3.74
Straw[22]	2007	Mton	15.7
Pruning [22]	2007	Mton	4.9
Olive husk(s), dregs of pressed grapes[22]	2007	Mton	1.3
Forest wood [22]	2007	Mton	2.2
animal slaughter wastes[22]	2007	Mton	0.5
Bovine manure[22]	2007	Mton	10
Swine manure[22]	2007	Mton	17

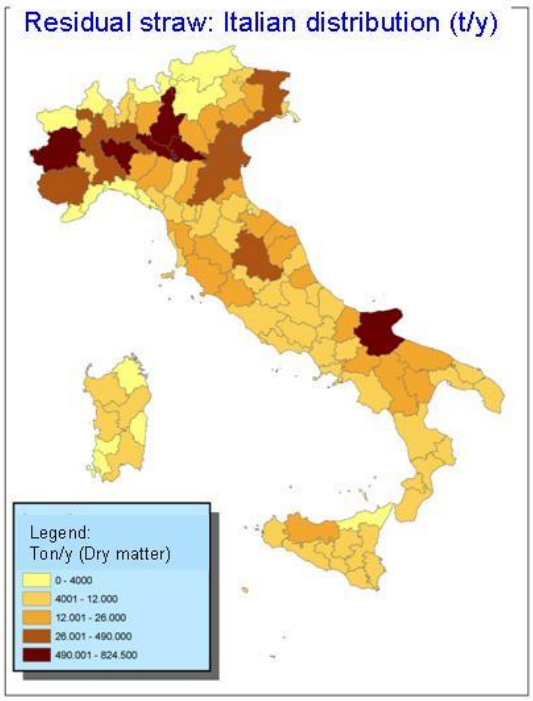

Figure IT6: map of the Italian availability of the residual straws (ENEA's national atlas of biomass)

Taking into account these estimations, roughly 50% of straws and 80-90% of wood surveyed could be available for a further development of the bio-based industry.

[17] This data mainly include wood chips (Data from ISTAT)
[18] Data describes the wood residues used for the production of wood packagings and other wastes. (Data from the national report on wastes elaborated by ISPRA, 2011)
[19] The amounts of pellets domestically produced is less than 800,000t/y (data from the Biomass Energy Report 2011 of the Politecnico of Milan. www.energystrategy.it)
[20] Data from The Environmental Ministry (collected for the European Commission in agreement with the directive 86/278/CEE)
[21] Data from ISPRA (2011)
[22] Data from the ENEA's National Atlas of biomass

Biomass used for non-energy purpose

Table IT5 lists some biomass for non-energy purpose. Tables IT6 and IT7 summarize, respectively, the main process residues of the paper production and their destination.

Table IT5: biomass for non-energy purpose (data from FAO[23] and ISTAT[24])

Use	Year	Unit	Amount
Round wood[24]	2010	Mm^3/y	1.5
Wood for pulp/ paper and particle board[24]	2010	Mm^3/y	0.37
Wood for other industrial, non energetic applications[24]	2010	Mm^3/y	0.73
Wastes paper production[25]	2009	Mton/y	2.96
Chemicals from biomass			nf[26]
Cereal production	2009	Mton/y	17.4
Sugar beet production	2009	Mton/y	3.3
Sugar production	2008	Mton/y	0.5
Starch production (potatoes)	2009	Mton/y	1.75
Starch production (maize)	2009	Mton/y	7.9
Oilseed production			
peanut	2009	kt/y	0.140
rapeseed	2009	kt/y	50.2
sunflower	2009	kt/y	199.4
soybeans	2009	kt/y	468.2
sesame	2009	kt/y	1.2
Algae production			nf

The residues of the **paper production** are mainly constituted of sludge coming from the water treatment process (chemico-physical and biological). The process scraps are reused through the process itself. Finally, some additional wastes come from the recycle of pulp paper. Only 24% of the wastes is used for energy production toward an European average of 50%.

Table IT6: main process residues of the paper production and their destination[27] (%)

Dangerous wastes	0.2
Chemico-physical treatment	23.5
Biological treatment	16.8
Pulping residues	22.1
Deinking process	13.1
Other wastes	24.3

Table IT7: main destinations of the paper production residues[27] (%)

Cement and bricks	15.9
Energy production	23.7
Composting and agriculture	6.7
Landfill	19.3
Environmental restoration	22.8
Other industries	11.6

[23] http://faostat.fao.org/site/636/default.aspx#ancor
[24] http://agri.istat.it/jsp/NewDownload.jsp
[25] (Data from the national report on wastes elaborated by ISPRA, 2011)
[26] Not found

Assuming that the pulping and deinking residues have an average energy content of 2,500 kcal/kg and considering that Italy has an annual production of 400kt, these residues have an energetic potential of 90 ktoe[27].

Most of the agricultural productions listed in table IT5 are destined to the food market. A particular mention deserves the sugar market. Although Italy was one of the largest producers of white sugar (from sugar beet), it has been significantly impacted by the EU sugar regime reform. Following the latest **Common Organisation of the sugar Market** (COM) signed in November 2005 by the European Miniisters of the agriculture, several incentives were made available for reducing the sugar production from sugar beet by 50%. This fact has determined the closure or reconversion of 16 plants over 21. Some refunds were given for the plants dismantling and other funds were destined to reconversion projects aimed at reattivating the local agroindustrial chain. The most part of the ex-sugar plant were planned to produce energy from biomass. Table IT8 lists the initial conversion projects for the ex-sugar plants

Table IT8: Initial conversion projects for the Italian sugar plants

Plant Name	Foreseen industrial activity
Porto Viro	Bioethanol (2 mln litres bioethanol), sugar packaging
Casei Gerola	Bioethanol (2 mln litres bioethanol), sugar packaging
Finale Emilia	Sugar packaging and commercialization
Ostellato	Electric energy (electric power 90 MW) from vegetable oils (palm oil)
Bondeno	Electric energy (electric power 24 MW) from vegetable oils (palm oil)
Villasor	Electric energy (47 MW) from biomass + biodiesel + production in greenhouse
Castiglione F.	Electric energy (47 MW) from biomass + production in greenhouse
Fermo	Electric energy (23 MW) from biomass + production in greenhouse
Russi	Electric energy (30 MW) from biomass + production in greenhouse
Manfredonia	Sugar cane refining (300,000 ton)+ electric energy from biomass/ vegetable oils (21-34 MW)
Forlimpoli	Electric energy (22 MW) from biomass

Figure IT7 shows the map of the main sugar producing plants that will be converted. Most of them are located in the Emilia Romagna Region

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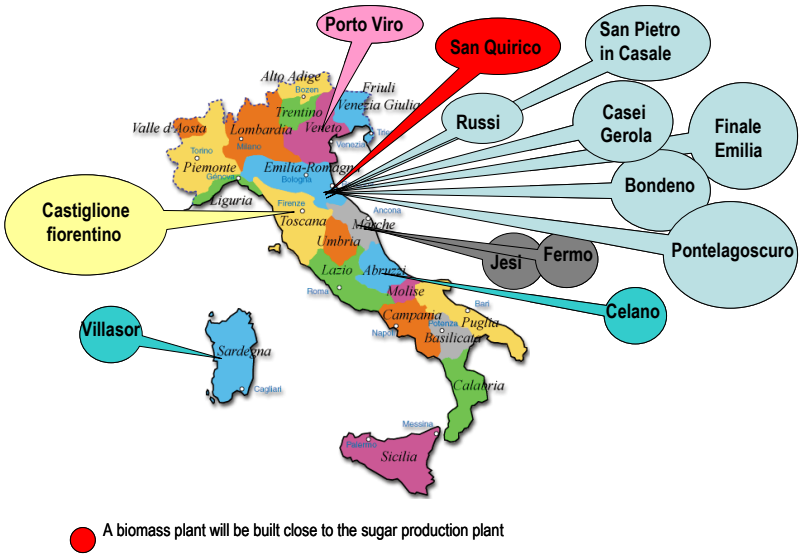

Figure IT7: main Italian sugar producing plants

[27] Environmental report of the Italian paper industry (data 2006-2007), 2009 (produced by ASSOCARTA)

Some of these new plants for the production of bioenergy have high power and are destined to import part of the biomass used. For instance, the project in Castiglione F. is a plant of 47 electrical MWh fed with 40 kton/y of vegetable oils (obtained from sunflower and other oil crops and ¾ imported) and 220 kton/y of lignocellulosic biomass such as cane and aspen chips produced in a basin of 50 km. In several cases the original reconversion projects were changed. For instance, the plant in Casei Gerola will be destined to the production of 50 thermal MW and 14 electric from biomass. It will be fed with biomass planted on 3000 ha, 70% of which destined to fibre sorghum.

Policy issues related to biomass, bioenergy or biorefineries

In the September 2007, the Italian Minister for the European politics presented to the UE Commissioner the first position paper containing the Italian strategy to achieve the objectives 20-20-20 of the Spring European Council. The latest document containing indications on the **Italian actions plan for the renewable energies** has been more recently published by the Minister of economical development in June 2010. With respect to the **electrical energy** production from renewables in 2005, the amount at 2020 will be twice as much. Bioenergy will account for 19% with 6TWh coming from anaerobic fermentation, to say both from controlled anaerobic digestion and from landfill gas. The long term strategy is that of improving the gas capture and reducing the production of energy from this source. Table IT9 shows the trajectory of renewable electricity production from the various technologies at 2010 and 2020.

Concerning the production of **thermal energy** (heating and cooling) the document contains a forecast of 10,456 Mtoe and biomass represents the 54% of the total production from renewables (table IT10).

Table IT9: Estimation of the total contribution (installed power (MW) and gross electricity production (GWh and PJ)) for each technology using renewable sources in order to achieve the objectives established at 2020 (National actions plan for renewable energies, Ministry of Economical Development, 30 June 2010)

	2010			2020		
	MW	GWh	PJ	MW	GWh	PJ
Hydropower plants						
<1MW	444	1,737	6.25	650	2,281	8.21
1-10MW	2,250	7,459	26.9	3,250	9,796	35.3
>10MW	13,886	32,946	119	13,900	29,923	108
Geothermic source	754	5,632	20.3	920	6,750	24.3
Solar source	2,505	1,976	7.11	8,600	11,350	40.9
photovoltaic	2,500	1,967	7.08	8,000	9,650	34.7
solar thermodynamic	5	9	0.03	600	1,700	6.12
Wind source	5,800	8,398	30.2	12,680	20,000	72
onshore	5,800	8,398	30.2	12,000	18,000	64.8
offshore	-	-	-	680	2,000	7.2
biomass	1,918	8,645	31.1	3,820	18,780	67.6
solids	1,026	4,758	17.1	1,640	7,900	28.4
biogas	453	2,129	7.66	1,200	6,020	21.7
biofuels	439	1,758	6.33	980	4,860	17.5
Total	27,557	66,793	240.5	43,820	98,880	356
Cogeneration	420	2,695	9.70	1,000	5,855	21.1

Table IT10: Estimation of the gross thermal energy production i(n PJ)[28] from each technology using renewables in order to achieve the objectives established at 2020 (National actions plan for renewable energies, Ministry of Economical Development, 30 June 2010)

	2010	2020
Geothermic energy (direct use with the exception of the geothermic heat at low temperature for heat pumps)	9.4	12.6
Solar	4.73	66.3
Biomass	93.7	237
Solids	92.4	220
Biogas	1.09	11.1
Biofuels	0.29	6.28
Renewable energy from heat pumps	53.3	121
Total	**161**	**438**

[28] Direct use and district heating

Finally, concerning the renewable **energies in the transports sector**, 79.5 PJ will be produced in Italy (table IT11) and 41.9 PJ will be imported. The last column in table IT10 reports the weighted contributions[29] of each source to reach the European objective of 10% replacement of fossil fuels.

Table IT11: Estimation of the total energy production in PJ for each technology using renewable sources in order to achieve the objectives established at 2020 in the transportation sector (National actions plan for renewable energies, Ministry of Economical Development, 30 June 2010)

	2010	2020	2020 (weighted contributions)
Bioethanol/bio-ETBE	**6.20**	**25.1**	**26.29**
Amount produced from wastes, residues, lignocellulosics	0.795	4.19	8.38
Imported amount	0.75	8.37	8.37
Biodiesel	**36.3**	**78.70**	**89.2**
Second generation	3.01	10.5	21
Imported amount	3.06	33.5	33.5
Hydrogen from renewable	**0**	**0**	**0**
Electricity from renewable	**7.12**	**15.4**	**21.55**
Road transport	0.25	4.10	10.25
Other transport modes	6.87	11.3	11.3
Others (i.e biogas, vegetable oils)	**0.21**	**2.1**	**2.1**
Total	49.8	121	139.14 (10% replacement)

No specific policies are available in Italy for biorefineries.

Biorefinery related funding programs

Italy does not have funded research programs specific for biorefineries. A few opportunities were available as part of the recently launched "**Industria 2015**" program funded by the Ministry for Economic Development. It supported investments in demonstration and research projects[30]. The projects duration is 3 years and most of the approved projects are already in progress. The program provided at most 15 M€ for each project and not more than 5 M€ for each participant. The percentage of financing was 50% for the industrial development and 25% for the research activities. The program was not specific for the biorefineries but promoted those activities, for instance production of biofuels, that can be considered near the industrial development. Seven projects on 30 concerns bioenergy and energy from wastes (52 M€).

There are also some **calls for proposals** related to bioenergy production that have been recently opened in different regions of the country (i.e. Piemonte, Lombardia, Emilia Romagna, Liguria, Veneto).

In 2010 a call was launched by the **Ministry of Agriculture (MiPAAF**) for building, completing or improving plants for the production of energy from biomass[31]. The selected projects could obtain a financial support up to 40% of the eligible project costs (not more than 500,000€). The overall call budget was 20,000,000.

[29] In the calculation of the conformity of the target production to the objective of 10% replacement, the biofuels from wastes, residues and lignocellulosic materials counts twice. Furthermore, the electricity from renewables used for the road transport counts 2.5 times

[30] http://www.industria2015.ipi.it/

[31] http://www.enama.it/it/pdf/biomasse/bando/Bando%20Enama%2016%20febbraio%202010.pdf

Another national funding source was the so called **NOP 2007-2013** (national Operational Programme) promoted by the Ministry of University and Research[32]. The program, launched at the beginning of 2010, supported the industrial research activities aimed at stimulating the innovation of the productive system and at generating new sectors. Some funds were available for the sector of "Energy and energy conservation" including the development of technology, products and processes for the renewable energy. The overall budget was 465M€. The cost of each project could not be higher than 25 M€ and lower than 5M. The percentage of financing was similar to that of Industria 2015.

More recently, within the European call **ERANET** WOODWISDOM2, the Italian Ministry of Agriculture and Forest activities (MIPAF) granted 300.000 € for projects under the topic " Forest for multiple needs of society, including enhanced productivity and optimised use of forest feedstock" and topic "Advanced products and technologies for primary wood processing and manufacturing of wood and fibre-based products". The scale of the activities is the base and applied research. Still in this program, the Italian financing does not include the full biorefinery assessment but regards only specific steps of the entire system.

Running commercial biorefineries

In Italy, **Novamont** has established a fully-integrated process of **bioplastics manufacturing**. Novamont is the first and only manufacturer in the world that could produce a wide range of bioplastics from monomer to polyester and compounds. The main product of their process from maize are compostable bioplastics produced from the starch proteins (i.e. tableware and films). **Mater-Bi**, the trademark, is a starch-based biodegrade material. The process consists in a destructuration of the starch proteins, amorphous amylase and amylopectine, which are then complexed with polyester through hydrogen bonding. Novamont has one monomer-manufacturing plant, one plant producing polyester, one making compound bioplastics and a research and development centre. All are in Italy, in **Terni**. In 2009 it had a capacity of 80,000 tonnes/y, and it was expected to be increased by 60,000 within the first three-months of 2011. The amount of maize used for the product preparation is 25-30% and it mainly comes from Italian productions located in the Veneto Region (northern Italy). Concerning the use of vegetable oils, Novamont has projected a new plant for the production of monomers from vegetable oils by using a proprietary technology. The plant will use 25Kton of vegetable oils for producing 15 kton of monomer to be used in the preparation of the polyester **Origo Bi.**

Two further initiatives will be developed by Novamont in the next future. The first regards the conversion of an old industrial plant located in Northen Italy (Adria) in a new fermentation plant of **20 kt/y of BDO**. The plant is called **Materbiotech**. The group has an important partnership with Genomatica. The second initiative regards a biorefinery plant located **in Porto Torres** (Sardinia) following a joint venture between **ENI-Polimeri Europa** and Novamont. The biorefinery complex contains 7 plants and has required investments of 500M€. It will produce monomers, rubber additives, lubrificants, bio-fillers and bio-plastics.

Demo and pilot plants

Another important Italian actor in the biorefinery sector is the **Mossi and Ghisolfi group**, the World's largest producer of PET for packaging applications with head office in Tortona (Italy). It is the third largest producer of cellulose acetate for plastic end-use. M&G-Chemtex strategy for bioethanol production can be summarized in three main issues:

[32] http://www.ponricerca.it/PonRicercaEnglish/Public/PonRicerca/Home/home.aspx

1. improving critical steps of the second generation bioethanol production process (pretreatment, enzymatic hydrolysis and fermentation);
2. demonstrating the whole supply chain, from feedstock to product utilisation;
3. built an efficient second generation industrial demonstration unit with an output of 40,000 tons/y of lignocellulosic bioethanol (see www.biolyfe.eu for more information).

Chemtex-M&G is part of a joint venture, Beta Renewables, that will produce biofuels and bio-chemicals through the Chemtex's pretreatment and hydrolysis process

In the field of third generation biofuels, the so called **Gela-Project** coordinated by ENI aims at testing the technical and economic feasibility of a process based on the **biofixation of CO_2 by microalgae**. The plant located in Sicily will use CO_2 and discharge waters produced by the oil refining plants for the growth of the microalgal biomass that can be converted into biofuel and/or other energy vectors. Most of the testing activities are performed at the Gela refinery, where since 2007 a small scale pilot plant made up of photobioreactors and open pools is operating. In 2009 Eni built a pilot plant extended over one hectare and a full scale demonstration plant will follow (2000 m^2 open ponds-150 m^2 photobioreactors)

Finally, in 2012 **DSM and Roquette** is going to open a commercial scale 10,000 tonnes/year bio-based succinic acid plant in Cassano Spinola, Italy.

Table IT12: Demo and pilot plants

Company	Feedstock	Products	Description	Size
Mossi and Ghisolfi	Lignocellulosics crops/wastes	Bioethanol	Production of ethanol to be used as fuel/additive. Raw materials for PET.	40 kt/y
ENI	CO_2 and discharge waters from the oil refining plant in Gela	Microalgae	Production of microalgal biomass that can be converted into biofuel and/or other energy vectors	1 hectare (pilot)
Royal DSM N.V.	starch or cellulose	Succinic acid	yeast based fermentation	10 kt/y

Major RTD activities

Table IT 13 lists the Italian organizations involved in recent European projects on bioethanol production

Table IT 13 Italian participation in the European projects on bioethanol production

Acronym	Project name	Duration	Organization
NILE	New Improvements for Ligno-cellulosic Ethanol	2005-2010	ENI tecnologie
ETOILE	Bioethanol production via lignocellulosic fermentation of olive oil residues	2008-2010	Labor
BABETHANOL	New feedstock and innovative transformation process for a more sustainable development and production of lignocellulosic ethanol	2009-2013	University of Udine
NEMO	Novel high performance enzymes and micro-organisms for conversion of lignocellulosic biomass to ethanol	2009-2013	CHEMTEX
BIOLYFE	"Second BIOethanol process: demonstration scale for the step of Lignocellulosic hYdrolysis and Fermentation"	2010-2013	Chemtex, ENEA, Agriconsulting

Table IT 14 describes some Italian funded projects on the biofuels production (first and second generation). Furthermore, an Italian project is cited concerning the use of C5 sugars from lignocellulosics as platform molecule for the production of biofuels and chemicals.

Table IT 14 recent Italian funded projects

Funding Ministry	Project acronym	FULL TITLE
MIPAAF	MULTISORGO	Integrated production of bioethanol and biogas from **sweet sorghum**: technological, economic, energy and environmental aspects
	FITOPROBIO	**Phytodepuration** treatments using cellulosic biomass to obtain second generation ethanol"
	BIOSEGEN	**Innovative chain** for the production of second generation biofuels from agricultural and agro-industrial residues and biomass crops.
MSE INDUSTRIA 2015 call "Energy Efficiency"	PRIT	Development of an **Italian pretreatment technology** for the production of second generation bioethanol (coordinated by Chemtex)
		Production of second generation Biofuels from residual biomass (coordinated by SICARB s.r.l)
MIUR (PRIN)		Catalytic upgrading of the C5 fraction in the lignocellulosic biorefineries

Table IT 15 lists the Italian participation in some European projects on the biorefineries topics (energy crops, thermal and biochemical technologies/processes, new materials, process design and integration).

Table IT 15 Italian participation in the FP projects in the field of biorefineries

Acronym	Project name	Duration	Organization
CLYCARGAS	Clean syngas from carbonaceous materials for highly efficient electric energy generation	2005-2008	CSM
HYVOLUTION	Non-thermal production of pure hydrogen from biomass	2006-2010	STUSAR
SWEETFUEL	Sweet Sorghum - An Alternative Energy Crop	2008-2010	University of Bologna
SUSTOIL	Developing advanced biorefinery schemes for integration into existing oil production/transesterification plants	2008-2010	University of Foggia
GreenSyngas	Advanced cleaning devices for production of green syngas	2008-2011	University of Bologna
Forbioplast	Forest resource sustainability through bio-based-composite development	2008-2012	University of Pisa
Tygre	High added value materials from waste tyre gasification residues	2009-2013	ENEA, Elastrade S.R.L., Febe Ecologic, Societa Italiana Carboni Attivi Vegetali Srl
BIOCHEM	BIOCHEM	2010-2013	aster, sviluppo chimica
EuroBioRef	EUROpean multilevel integrated BIOREFinery design for sustainable biomass processing	2010-2014	CIRCC (University Consortium Chemical reactivity and Catalysis)

Italian Stakeholders

Table IT 16 lists the main Italian stakeholders and describes some competences of each organization

Table IT16: Main Italian stakeholders

Name	Short Description
Industry	
Fab-Fidia advanced bioplolymers	Production of biopolymers (i.e. hyaluronic acid)
Novamont S.p.A.	Production of biodegradable plastics
Roquette of Cassano Spinola	Biopolymers from renewables
Chemtex (Mossi&Ghisolfi)	Production of PET
Resindion SRL	Immobilized Enzyme Supports
ENI	Production of bioenergy
Assodistil	Consortium of private companies producing alcoholic beverages through fermentation
Marcopolo engineering	Biogas production and collection
Biofin laboratories	Strains and technologies for fermentation processes
Bioindustrie Mantova	Tailored bioreactors systems
Biosphere	Production of cross linked hyaluronic acid
Lambert SpA	Pigments and biosurfactants
Phenbiox	Extraction of bio-phenols from wastes
Sprin Technologies	Industrial biotechnologies and biocatalysis for the production of biofuels and biobased products
Research Institutes	
CNR	Researches on biochemistry of proteins and enzymology (Institute of Protein Biochemistry)
Centro di Ricerca sulle Biomasse (Perugia)	1. Researches to optimise biomass production, processing and energy conversion in terms of efficiency, profitability and environment. 2. certification of biofuels and bioenergy as well as energy and environmental labelling of products and processes related to biomass energy production, by means of quality certifications; 3. support to energy/environment regulatory in order to determine facilitations, permit procedures, law constraints, grants; 4. training in the field of energy driven biomass use; 5. dissemination of information on the environmental benefits of bioenergy.
Universities	
Università dell'Aquila	D evelopment of innovative gasification technologies
Università di Milano Bicocca	Research activities on the production of engineered strains of *S. cerevisiae*
Università degli Studi della TUSCIA	Use of biomass for bioenergy production
Università di Bologna	Production of biomass and energetic utilization
Politecnico di Torino	Technologies for biomass conversion

Università di Padova	Researches on engineered microrganisms
Università di Bari	Researches on the use of aquatic biomass for the production of bioproducts and biofuels
Università di Messina	Researches activities on chemical catalysis in the sector of biorefineries
Governmental Organisations	
ENEA (National Agency for New Technologies, Energy and Sustainable Economical Development)	ENEA, Natioanl Agency for the new technology, Energy and sustainable Economic Development has a specific mission in the applied research activities, technology transfer and dissemination of innovation. In particular, in the Research Centre "La Trisaia" (in the south of Italy) ENEA has constructed complete platforms for the conversion of biomass/wastes, comprising a number of bench scale, pilot scale and demonstrative scale. In the last 10 years ENEA CR Trisaia has been involved in several R&D projects in the field of second generation bioethanol from lignocellulosic residues including poplar chips, residual straws, corn stover, waste paper, crops from phytodepuration, arundo donax etc (projects: BIOH2, BIOPAL, TIME, FITOPROBIO, BIOLYFE, PRIT). Thanks to its competences and infrastructures, ENEA is one of most suitable Italian stakeholder for implementing biorefinery systems. *The main competences can be summarize as follow:* ***ENEA Research Centre of Trisaia (in Southern Italy):*** 1. *Pilot scale steam pretreatment of biomass and fractionation into the main components (biorefinery approach);* 2. *Production of second generation bioethanol;* 3. *production of biodiesel from waste oils through chemical-catalized transesterification process (recent activities)* 4. *Development of innovative gasification technologies and implementation of effective process configurations at pilot scale: fixed bed reactor; steam gasification in fluidised bed reactor, gasification with oxygen to obtain hydrogen rich gas;* 5. *Syngas cleaning technologies trough physical and chemical methods;* 6. *Gas separation by using the membrane technology* 7. *design and construction of prototypes through the internal mechanical shop with many years of experience in constructing components and prototypes in the bioenergy field;*
Non-governmental Organisations (NGOs)	
Others	
CRAB-Avezzano	Biotechnological products and processes development and optimization, provision of chemical, biochemical and microbiological analysis in agro-industry, food-industry and environmental fields. Production of microorganisms, vitamins and proteins from natural sources.
Associazione IT SusChem	Association aimed at developing the activities of the Italian platform IT-SUSCHEM. Among the activities: development of the biorefinery systems

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