Ministero dell'Ambiente e della Tutela del Territorio e del Mare

GOALS OF BIOENERGY IN ITALY

KEY ELEMENTS FOR 2020 OBJECTIVES

Report 2008

ITABIA
Italian Biomass Association

Index Report

Presentation

Biomass and bioenergy, will play an increasingly important role for Italy's energy sector and for the protection of its environment. The correct use of bioenergy clearly reflects the implementation of sustainability principles, which can bring key advantages to the environment, the economy and also society, through the diversification of energy sources, the reduction of Italy's energy dependence and the enhancement of local resources.

A near-zero balance of greenhouse gas emissions achieved through the sustainable production and use of bioenergy entails that its enhancement can be the cornerstone of Italy's national strategy for the reduction of greenhouse gas emissions, particularly of carbon dioxide emissions, in light of the new European 2020 emission targets.

Moreover, the sustainable production of bioenergy can help protect our territory, contribute to better soil management and encourage the conservation and enhancement of marginal areas. Energy crops can in fact contribute largely in the fight against environmental degradation and hydrogeological damage.

By drafting this Report, the Italian Ministry for the Environment, Land and Sea (MATTM) intends to continue its work in improving knowledge about the sector. It is through indications provided by these studies that the barriers hindering the full development of bioenergy in Italy today can be removed more easily. The Ministry's cooperation with ITABIA over the past few years has been confirmed and strengthened by the role of official partner taken on by ITABIA in the Sustainable Energy for Europe 2005-2008 (SEE) campaign.

This campaign, launched in 2005 and coordinated by the Commission (**www.sustenergy.org**) at European level and by MATTM at national level (**www.campagnaSEEitalia.it**), is aimed at raising awareness on sustainable energy across the civil society. To date, more than 100 partnerships have been set up in Italy and over one third of these directly or indirectly work in the bioenergy sector in its various forms: demonstrative projects on solid biomass; feasibility studies for the promotion of biofuels; analysis and studies on bioenergy in Italy; promotion and dissemination of information. The common goal of these initiatives, including ITABIA's initiative, is to raise awareness on the advantages bioenergy can bring to our Country.

CORRADO CLINI
GENERAL DIRECTOR
MINISTRY FOR THE ENVIRONMENT, LAND AND SEA

Foreword

PURPOSE OF THE REPORT

In 2004 ITABIA drafted, on behalf of the Italian Ministry for the Environment, Land and Sea (MATTM), a comprehensive report on "Biomass for Energy Production and the Environment", which not only provided statistical data on biomass energy, but also outlined the principles, concepts, perspectives and directions of the sector, with a systemic and holistic view of bioenergy.

Other scientific and institutional organizations followed suit and processed statistical data on biomass production and use, which helped consolidate and clarify the state of the sector. National, European and international documents were also drawn up, requiring a thorough analysis and assessment of congruence.

In the framework of the campaign for environmental and energy sustainability "Sustainable Energy for Europe 2005-2008 (SEE)", MATTM commissioned ITABIA to draw up a report updated to 2008. The leitmotiv of the 2008 Report is to assess whether national objectives are congruent with European and global directives and with the sector's potential in Italy, using original research instruments, and to examine the gap between current situation and objectives for the next decade, suggesting which political and technical tools may be adopted to fill the gap. A general overview on biomass and its application in the energy sector, agriculture, forestry, industry and environment is provided in the previous report.

THE STRUCTURE

The 2008 Report includes 5 Chapters: the first chapter outlines the general bioenergy framework and the features of the system; the three following chapters analyse the strong and weak points of the national bioenergy system focusing on three pairs of key elements: resources/efficiency; market/good practices; sustainability/guarantees; the fifth chapter provides some suggestions as to the way forward for developing a new National Bioenergy Action Plan.

Acknowledgments

ITABIA would like to express its deep gratitude to all those who have contributed, in various ways, to this Report commissioned by MATTM. Firstly, the unanimous support given by the Board of Managers of ITABIA to the initiative has been decisive and a substantial contribution in collecting data and information, developing and drafting the text has been provided by **Andrea Scarpini**, Vice President, **Matteo Monni**, Secretary General and by the Board Members **Aldo Abenavoli**, **Walter Merzagora**, **Marcello Ortenzi**, **Sergio Piccinini** and **Filippo Stirpe**.

Special thanks go to **Antonio Lumicisi** of the Directorate General for Environmental Research and Development of MATTM for his contribution in the planning of the report and in reviewing some of its chapters. Special thanks also go to **Michela Morese**, from the Global Bioenergy Partnership (GBEP), for the information she has provided and for the precious cooperation that she has fostered with ITABIA since the GBEP preparatory stage.

We are also grateful to **Marino Berton**, AIEL President, **Walter Righini**, FIPER President and **Pietro Giorgio** Director of SEA, for the data they have provided and for the latest debates they have taken part in at the Bioenergy Network kick-off meeting. The network has been set up to strengthen relations between private organizations in this important sector of renewable energy sources.

Finally, it is only right and proper that we remember **Vittorio Bartolelli**, former Vice-President and Secretary General of ITABIA, and two other founding partners of ITABIA, **Carlo Baldelli** and **Francesco Alfani**, who have all passed away prematurely in recent years, for their valuable contribution to outlining the Association's principles, concepts and guidelines. What thirty years ago seemed to be the dreams of idealist youngsters - such as sustainable development, biomass, land protection, social cohesion - have become universally recognised concepts that are shared by the majority of the political, scientific, industrial and social communities.
Here, we wish to gratefully remember them all.

GIUSEPPE CASERTA
ITABIA President

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It is increasingly recognised and acknowledged that bioenergy is a complex system that is deeply interconnected with other production, environmental and socio-economic sectors. Thus, the sector should be approached with a "systemic" perspective.

1.1) THE NATIONAL SITUATION

The search for and use of eco-compatible resources that can improve the quality of life in industrialised nations and, at the same time, ensure progress in emerging countries and poor regions of the world, are priority goals of the third millennium. The key sectors for environmental protection and better human cohesion are: energy, greenhouse gases, the territory. Italy, just like the other countries, thus needs to take up the challenges posed by these sectors, using the available scientific and technological knowledge and tools.

Italy today:

a) Continues to be largely dependent on foreign energy supplies. This dependence account for over 80% of the total Italian demand of 195 Mtoe. The contribution of renewable energy sources (including hydroelectric power) to the last years national energy budget amounted to about 9%, of which 1/3 came from biomass.

b) Is committed to mitigating the greenhouse gas effect by reducing gas emissions. In 1990, greenhouse gas levels in Italy amounted to 550 Mt of CO_2. Current trends will lead to 622 Mt by 2010 (as a mean of the 2008-2012 period). However, under the Kyoto protocol, countries are to reduce their emissions to 519 Mt of CO_2 by 2012. Emissions thus need to be reduced by about 100 Mt of CO_2 /year.

c) Has much abandoned agricultural land, including farm houses that were abandoned 20-30 years ago due to lack of revenue, which are at risk of degradation due to negligence (hydrogeological changes, fire, etc.). Even cultivated agricultural land, where man's presence is remarkable, are at risk due to considerable loss of biodiversity and of the soil's organic substance, and due to wrong agronomic practices that are often the cause of net greenhouse gas emissions. Moreover, Italy's forests cover almost 35% of the national territory, but woods are old and badly managed. There are not enough infrastructures, businesses and forest enterprises for a proper productive management and maintenance of forests and for the supply of cost-effective wood.

d) Has enough primary Renewable Energy Sources (RES) - from the sun to biomass - to solve many adverse problems affecting the energy sector and the environment.

e) Can rely on an industrial and entrepreneurial structure that has strong technological and engineering knowledge also in the RES sector - as demonstrated by the various plants that have been constructed across Italy - but is not fully supported by clear and far-sighted energy policies and innovative research on processes and products.

The rise in environmental emergencies, the pressure and directives of supranational communities, the costs of a balanced socio-economic development call for a review of old national programmes and the creation of a new energy policy, which integrates, **in one single set of rules**, the energy, environmental, industrial, agricultural, forestry and social issues of the RES and Biomass sector.

1.2) BIOMASS: DRIVING FORCES AND CRITICAL ISSUES

The renewable source that today largely contributes to energy and environment budgets is biomass in its various forms, transformation technologies and end uses.

The term biomass generally refers to any type of material directly or indirectly originating from living organisms and, in particular, from chlorophyll photosynthesis. Biomass may be defined as an atypical source of energy having the following features:

- multiple current and potential energy options;
- strong embeddedness in the ecosystem;
- multiple non-energy uses
- wide social implications

The energy use of biomass requires a "systemic" approach that integrates the above-mentioned aspects.

The approach, with its multiple applications, can have a beneficial impact - with varying intensity - on the above-mentioned key sectors and in particular on the following:

ENERGY, by contributing to a remarkable reduction of energy imports;

CLIMATE, by reducing greenhouse gas emissions (CO_2, CH_4, NO_x, etc.) and volatile toxic substances (VOCs, benzene, particulate matter, etc.);

CORRELATED AGRICULTURAL AND INDUSTRIAL ACTIVITIES, by improving agronomic techniques and exploiting

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agro-industrial patents;
MARKET DIVERSIFICATION, by giving particular attention to agricultural products of developing countries.
Besides these positive effects, there are however some "critical issues" that need to be carefully assessed, such as:
COMPETITION between biofuels and food production or other industrial use, between biofuels for transport and biofuels for generation of heating and electricity.
SUSTAINABILITY from various viewpoints: environmental (regarding, for instance, biodiversity, deforestation, etc), social (the acceptability of a plant installation), economic (chain profitability), political (national and local development plans), technical (maturity of technologies and processes).
THE MARKET, which is influenced by the import/export structure (support to EU economies for free market and internal potential); intra/inter EU legal harmonisation.

An environmentally-friendly system can be developed only if there will be a balance between driving factors and critical issues both at global and local levels. That is why a lively international debate between public and private institutes is underway, as explained hereinafter.

1.3) INITIATIVES AND THE CURRENT DEBATE

World energy demand is increasing rapidly. According to the most recent 2007 World Energy Outlook by the International Energy Agency (IEA), economic growth and the increase in the global population will cause world energy consumption to rise by 55% between 2000 and 2030, with demand peaks in developing countries that are projected to contribute two-thirds of this increase. According to IEA, 85% of this demand will be met with fossil fuels, thus causing unavoidable repercussions on the environment and particularly on CO_2 emissions which are projected to rise by 57% over the same period.
This projection is in line with the worst scenarios outlined in the IV Report on Climate by the Intergovernmental Panel on Climate Change (IPCC), which calls for a reduction by 30-50% in global emissions between 2030 and 2050 in order to achieve a safe stabilisation of CO_2 concentration levels (450-550 ppm) within the end of the century and thus avoid irreversible climate changes.

The IEA also reports that over 20,000 billion US dollars will be invested in the next 25 years for oil and gas exploration, and for the construction of electrical plants and infrastructures needed to meet the growing energy demand. A marginal amount will be allocated to the development of renewable sources and bioenergy (in 2008, federal measures in support of renewable energy have amounted to approx. 13 billion dollars).
Considering the average lifespan of energy plants and infrastructures (from 30 to over 50 years), these investments will influence the energy and environmental future of our planet.

The global energy trend can be reversed towards lower "carbon intensity" if alternative energy sources to fossil fuels and highly efficient technologies are used and developed by 2030. To this end, urgent and global measures need to be adopted to:
> "divert" a significant part of investments towards increasing renewables, nuclear power and bioenergy in the energy portfolio;
> promote energy efficiency in all uses;
> change taxing and benefit systems in the energy field, favouring low-carbon sources.

Bioenergies, and particularly biofuels, are an already available option that can offer both immediate response and further technological developments in relatively short periods of time. The use of bioenergy is currently driven by four main factors: **a)** instability of fossil fuel prices; **b)** diversification of energy sources and energy supply areas; **c)** the need to reduce greenhouse gas emissions causing climate change; **d)** the opportunity to boost the development of rural areas by ensuring access to energy and creating jobs.

GLOBAL BIOENERGY PARTNERSHIP: AN ITALIAN INITIATIVE*

In this global scenario, bioenergy is set to play an increasingly important role for our society and it is indeed in this global context that Italy proposed to set up a Global Bioenergy Partnership (GBEP) in the G8 framework. The Heads of State and Government of the G8 + 5 countries (China, Brazil, India, Mexico and South Africa) met in Gleneagles in July 2005 where they agreed to launch the Global Bioenergy Partnership to "promote a wider and more efficient use of biomass and biofuels, particularly in developing Countries where the use of biomass prevails ".

After a process of consultation among the G8 + 5 countries, international organizations and private associations, the Italian Ministry for the Environment, Land and Sea, drafted a "White Paper" on bioenergy, in cooperation with ITABIA and the Imperial College of London, to outline international ongoing activities on the issue and guide the Partnership in its work.

The Partnership, officially launched in New York on 11 May 2006 during the ministerial segment of the Commission on Sustainable Development (CSD14), is a forum that promotes the implementation of efficient policies through the identification of methods and tools that support investments and the abolition of barriers hindering

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the implementation of development cooperation projects. The GBEP also focuses its actions on three strategic pillars: Energy Safety - Food Safety - Sustainable Development.

After its first year of activity, the Partnership's mandate was renewed at the G8 summit of Heiligendamm (7 June 2007): "We invite the Global Bioenergy Partnership (GBEP) to continue to work on the most significant experiences in the field of biofuels and to move towards the sustainable and successful development of bioenergy ".

The GBEP brings together policymakers, private and public stakeholders, as well as international agencies and experts of bioenergy.

The Partnership's current members are: Brazil, Canada, China, France, Germany, Italy, Japan, Mexico, Russia, The Netherlands, United Kingdom, United States of America, the United Nations Food and Agriculture Organization (FAO), the United Nations Conference on Trade and Development (UNCTAD), The United Nations Department of Economic and Social Affairs (UNDESA), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), the International Energy Agency (IEA), the United Nations Foundation, the World Council for Renewable Energy (WCRE) and the European Biomass Industry Association (EUBIA).

Members with observer status are: Austria, India, Indonesia, Israel, Kenya, Morocco, Mozambique, South Africa, Sweden, Tanzania, Tunisia, the European Environment Agency (EEA), the European Commission and the World Bank.

Italy has been given the task to preside over the partnership, with the support of Mexico as co-chair. The GBEP is chaired by Corrado Clini, Director General of the Italian Ministry for the Environment, Land and Sea, in cooperation with the GBEP Secretariat, which is located at the FAO offices in Rome, and with Italy's financial support.

PARTNERSHIP OBJECTIVES

The GBEP provides its Partners with a mechanism to organize, coordinate and raise international standards of research , development, commercial application and marketing for the production, conversion and use of biomass for energy purposes, paying particular attention to developing Countries.

The Partnership's main objectives are:

> to develop a high-level political dialogue on bioenergy, support national and regional policies and promote them on the market, enhance international cooperation;

> to favour an efficient and sustainable use of biomass and develop practical projects in the bioenergy sector;

> to encourage the exchange of technical and technological information and knowledge through identification and promotion of potential bilateral and multilateral cooperation sectors;

> to facilitate the integration of bioenergy in the energy markets, by analyzing and overcoming existing barriers hindering its develop met;

> to act in a transversal and synergic way with other relevant activities, to avoid duplication.

The GBEP works in synergy with other relevant international initiatives, namely: FAO's International Bioenergy Platform (IBEP); International Biofuels Forum (IBF); International Partnership for the Hydrogen Economy (IPHE); Mediterranean Renewable Energy Programme (MEDREP); Methane to Markets; Renewable Energy Policy Network for the 21st Century (REN21); Renewable Energy and Energy Efficiency Partnership (REEEP); UNCTAD BioFuels Initiative, Bioenergy Implementing Agreements of the international Energy Agency.

The very intense and articulate work programme is described in **Addendum A1.1** of this chapter (also visit the website www.globalbioenergy.org).

*CONTRIBUTION BY MICHELA MORESE (GBEP)

THE EU "ENERGY AND CLIMATE" PACKAGE

On the 23 January 2008 the European Commission adopted a new **Energy and Climate Package**, encompassing a draft proposal for a Directive on the promotion and use of energy from renewable sources. The Directives sets out binding objectives for Member States in order to achieve 20% of energy consumption from renewable sources by 2020. Projections by the Renewable Road Map of January 2007 showed that biomass would contribute significantly in achieving the 20% target. Moreover, the European Council document of March 2007 on integrated climate and energy policy and the subsequent, ongoing European debate on the New Directive on Renewable Energy Sources, give particular importance to three key issues:

> defining the 2020 objectives on the basis of national perspectives and expectations;

> supporting biomass and bioenergy trade;

> providing clear and transparent certification of chains.

A lively debate on this Directive is underway, prior to its possible approval in 2010.

This proposal for a Directive by the Commission changes the reference framework because it only lays down the objective of saving energy for transport, electricity and heating, leaving to Member States the freedom to use the measures they deem most suitable to achieve the goal. In this respect, the following issues need to be

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taken into account:
> the Directive shall be transposed into Members States national legislations by 31 March 2010;
> each State shall adopt a National Plan to make its measures operational;
> regulations shall be adopted to streamline administrative procedures.

THE DIRECTIVE INCLUDES THE FOLLOWING (see a synthesis in **Addendum A1.2**):

- Objectives and scope of application (Art. 1)
- Definitions (Art. 2)
- RES Targets and National Action Plans (Art. 3, 4)
- Calculation of the share of energy from RES (Art. 5)
- Criteria for setting the guarantees of origin of biomass (Art. 6, 10)
- Administrative procedures (Art. 12)
- Information and training (Art. 13)
- Access to the electricity grid (Art. 14)
- Sustainability criteria for biofuels (Art. 15, 16)
- Calculation of the greenhouse gas impact of biofuels (Art. 17)
- Reports by the Members States and Monitoring by the EC (Art. 19, 25)

The Directive paves the way for very interesting developments to be pursued:

- A quality step forward in the development of RES;
- The creation of a legal framework including thermal energy production;
- Improvement and streamlining of the general legal framework.

An important agreement on the Directive was reached (8 December 2008) between the EU Parliament, Council (27 Members States) and Commission, during the Climate Conference in Poznan. The agreement is intended to support all the sectors that deal with the energy use of biomass, including second generation biofuels, biogas and the technological chains for thermal energy production. Particular attention is paid to energy efficiency on end use energy, sustainability criteria and National Action Plans. On 17 December 2008 the European Parliament approved the *Package* by a large majority.

BIOFUEL PLATFORMS

The Directorate-General for Research of the European Commission, launched the European Biofuels Technology Platform (EBTP) in June 2006 - formally recognized in April 2007 - after a document on analyses and projections was drafted by the Biofuels Research Advisory Council (BIOFRAC). The EBTP objective was to identify and promote the necessary research, development and evidence that the Biofuel chain can cost-effectively supply 25% of the energy for road transport in an economically and environmentally sustainable way.

Development concerns both raw material production and conversion technologies, with the involvement of public and private stakeholders. The sectors of interest are:

BIODIESEL CHAIN - transesterified vegetable oils produced from oilseed or proteoleaginous plants;

ETHANOL CHAIN - alcohols from fermentescible carbohydrate originated from sugary and starchy plants, as well as residues of agriculture, agroindustry and other sources of organic origin;

SECOND GENERATION FUELS - produced from lignocellulosic source.

The chains mainly have environmental needs: capture of CO_2 and less air pollution in the transport sector.

Other 16 Members States subsequently formed National Platforms and Mirror Groups to maintain relations with the European Platform and the single National Platforms.

In line with European Platforms, Italy too formed the Italian Biofuels Technological Platform in January 2008 (called Biofuels Italia) whose mission is to *"contribute, through guidelines, system studies, promotion of research, dissemination and evidence, to the development of chains for the production and use of biofuels for transport, agricultural machines and motorboats that are competitive, environmentally-friendly and capable of creating a sustainable biofuels market"*.

The Italian Platform shall assess and answer a series of questions on strategy, competition, research. Namely:

STRATEGIES

- Is the biofuel industry strategic in Italy?
- Which would be the advantages for agriculture?
- What is the estimated available land that can be used for energy purposes in Italy?
- What type of land is potentially most suitable for biofuels?
- Which agronomic techniques should be used in the various crop growing situations?
- Which are the main drivers in the Italian economic system for biofuel use?
- Which are the mechanisms that can encourage Italian productions?
- Is a free market always beneficial?

COMPETITION

- To what extent and under which conditions can Italian agriculture contribute to the production of biofuels?
- Will this contribution affect Italy's capability to produce quality food?
- What are the relations between use of land for biofuels and for other non-food-related uses?

RESEARCH

- Relation between first and second generation technologies, that is development of the former to pave the way for the latter.
- Recovery and protection of activities - started back in the 80s/90s - on second generation biofuels in line with 7th European Commission Framework Programme (CE/FP).

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- Creation of support structures for monitoring activities, legal proposals, training, communication, technical assistance, promotion of studies, research and experiments.
- Large-scale validation of results obtained.

THE SUSTAINABLE ENERGY EUROPE CAMPAIGN*

Significant importance in this context is attached to the campaign aimed to spread good practices - with particular focus on environmentally-friendly initiatives - , which is supported by the European Project "Sustainable Energy Europe (SEE)" and where Italy is actively involved.

The SEE Campaign was launched by the European Commission in 2005 in order to raise awareness on energy issues. The campaign also aims at the sustainable use and production of energy by the various European energy stakeholders (public sector, private sector, citizens, organisations, etc.). One of the key features of the Campaign is the creation of sustainable energy partnerships for renewables, energy efficiency and energy saving that involve and develop a wide spectrum of projects and programmes in various strategic areas, such as the Regions, Cities, Transport and Construction. In a nutshell, the SEE campaign provides support for reaching the European Union 2020 targets.

In Italy, the Ministry for the Environment, Land and Sea is the national "focal point" of the SEE campaign and to date over 100 partnerships have been formed, achieving the best performance of all EU Members States. Along with a high number of partnerships, Italy has submitted top quality proposals and projects. Indeed, 6 Italian partnerships were among the 26 best European partnerships that were selected by the European Commission and 3 of them won SEE 2008 Awards (which the Commission grants to the most worthy projects) in their respective categories.

Italian stakeholders have mainly focused on the bioenergy sector: Local Authorities, Specialised Research Centres, Associations, Businesses and local Energy Agencies have in fact promoted many bioenergy-related initiatives, which have led to the formation of strategic partnerships. It is worth mentioning the partnership with ITABIA that has led to the planning and drafting of the 2008 Report "Bioenergy Goals in Italy - Key Elements for 2020 objectives".

In the SEE framework, the Covenant of Mayors plays the very important role of involving European cities directly in the achievement of the EU 2020 targets. Since 50% of energy in Europe is on average consumed in cities, their involvement in the reduction of greenhouse gas emissions and in the promotion of the bioenergy sector is of strategic relevance. The Ministry for Environment will coordinate these activities in Italy, together with the European Commission, with the aim of involving the highest number of cities.

More information on the SEE campaign in Italy, the list of Italian partners and initiatives, and information on how to join the "Covenant of Mayors" can be found on the website www.campagnaSEEitalia.it.

*CONTRIBUTION BY ANTONIO LUMICISI (MATTM)

1.4) THE FUTURE OF BIOENERGY IN ITALY: STRENGTHS AND WEAKNESSES

WEAKNESSES IN THE SYSTEM

Italy's growing interest in the use of biomass as an energy resource and the almost unanimous acknowledgment of the advantages that can be gained from the proliferation of bioenergy in the Italian economy, are strengths that place Italy at the same level as other European and non-European nations.

The ongoing developments, particularly in the use of biomass for heating and electricity, reveal Italy's strong industrial background and great research potential. Nonetheless, bioenergy is not yet used in many market applications and its potential has not yet been fully developed.

This is due to a number of factors and obstacles, which, still today, delay its development. Very briefly, the weaknesses of Italy's biomass system can be summarized as follows.

Little attention to successful chains (district heating, district cooling, co-combustion, co-generation, biofuels) both in terms of energy conversion efficiency and in terms of social acceptability;

Weak systemic approach of the projects (few connections with agriculture and forestry).

Unreliable basins of biomass production (little attention to the condition of agricultural and forestry soil).

Difficulty in developing multiannual supply chain agreements among sector operators (shortage of company consortia or associations encompassing agricultural and industrial producers and companies dealing with supply, first biomass conversion, plant management and maintenance and, finally, distribution of electricity and/or heating produced).

Existence of numerous and unrelated legal and technical norms (there are about 100 norms in Italy without including regional provisions).

Little involvement of local populations (little perception by the population of direct benefits related to the use of biomass as a source of energy).

It must be borne in mind that biomass is the only renewable source that needs to be produced before it can be collected and used; its chain, that stretches from production to final use, needs to be considered as a

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whole and planned in terms of efficiency, according to size and extension of supply basins and in a way that it is compatible with the local territorial and socio-economic context.

THE PILLARS

The pillars on which the future of bioenergy will be built in Italy - as well as in other world regions - are: Policy, Entrepreneurship, Research.

» POLICY

The policies currently in force in Italy are fragmentary and inconsistent.

NATIONAL STRATEGIC DOCUMENTS

The first national strategic documents date back to 1998 when the then Ministry for Agriculture and Forestry Policies (MIPAAF) launched the *National Biomass Renewable Energy Programme (Programma Nazionale Energia Rinnovabile da Biomasse, PNERB) and the National Plan for the Enhancement of Agricultural and Forest Biomass (Programma Nazionale per la Valorizzazione delle Biomasse Agricole e Forestali, PNVBAF),* in compliance with CIPE (Inter-ministerial Economic Planning Committee - Comitato Interministeriale per la Programmazione Economica) decision n. 137 of 19/11/98 “Guidelines for national policies and measures on reduction of greenhouse gas emissions”.

Unfortunately, since 1998 no new National Plan has been developed to adapt activities to the new situations. Moreover, the plans for the rationalisation of legislation on RES have fallen through due to the difficult situation that has developed in the Italian Parliament over the past years. Financial Laws have been the only useful instruments for bringing innovation (even though the current Government in office seems to have decided not to use this instrument). Some remarks on the 2008 Financial Law are reported in Addendum A1.3.

Often, legal and promising provisions have not come into force due to a lack of implementation regulations (or due to delayed issuing thereof), due to continuous changes in legal and technical norms over time, and due to long and tiring authorisation procedures. Even the transposal of European Directives has been affected, by being delayed and partial.

Drafting a Single Document encompassing all the norms that have been passed over the years seems to be an impossible task, but streamlining and merging some essential strands is not impossible, rather, it is desirable. Once the European Directive on RES is approved, Member States may develop one single transposal Legislative Decree where current RES norms can be put together.

CURRENT DRAFT LAWS (2008)

The Italian Parliament is discussing 5 main draft laws that directly or indirectly regard bioenergy:

C. 337: Provisions to encourage the production and use of biofuels produced from biomass;

C. 357 Provisions to develop and promote agro-energy production;

C. 983: Provisions to promote renewable energy of agricultural origin;

C. 1139: Provisions to promote the recovery of biomass and the production and use of biofuels of agricultural origin.

C. 1699: Provisions about agro-energy and biofuel utilization.

The above-mentioned proposed laws should not only be aimed at respecting the Kyoto objectives, but also at transposing into national law the European Directive on RES. Although the Directive has not come into force yet, its aims and structure have already been set out. It may thus be reasonable to start considering the guidelines that shall be followed. With this in mind, the above-mentioned proposals could be the opportunity for the Government to rationalise and streamline regulations on RES.

During the term of office of the previous Government (though short), a quality step forward was made with regard to incentives for RES, through the new regime of Green Certificates, by raising the goals for incorporating biofuels in fossil fuels and by improving energy efficiency laws. The above-mentioned proposed provisions are aimed at making further progress. This is certainly a good approach, but policy-makers need to pay much attention to avoid a useless duplication of regulations.

Positive provisions include the development of a national agro-energy plan (although reference to a comprehensive bioenergy plan would be more appropriate) and the promotion of agro- and bio-energy districts, chain agreements with traceability and framework contracts.

With regard to biofuels, the proposed laws confirm concerns over the use of crops for food or for energy. It is worth remembering that these concerns affect Italy only marginally compared to other countries.

The shared intention is to favour:

› The short agriculture chain, even if it is the agro-industrial chain (as long as it is environmentally sustainable) because it can help significantly in achieving the 10% incorporation target.

› Second generation biofuels.

A widespread debate on some aspects of the provisions under discussion has developed among sector stakeholders, leading to the formation of cooperation networks, such as the Steering Committee, created on the initiative of ISES Italia, which encompasses numerous private organizations involved in RES promotion and development. The Commitee’s purpose is to urge political and institutional decision-makers to give a further boost to the sector, in light of the ambitious, but real, 2020 targets. Addendum A1.4 shows one of the first documents

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signed by Committee members "An energy revolution in Italy".

» ENTREPRENEURSHIP

Italy has a solid industrial structure capable of managing mature technologies for the production of heating and electricity - even through cogeneration - as well as biodiesel and bioethanol for transport. Despite uncertain credit benefits and unclear authorization procedures, to date numerous plants have been opened in three large agro-energy districts of Northern Italy and in some regions of Central Italy: around 130 district heating plants with an overall power output of just under 400 MW thermal and about 500 small, medium and large plants - with over 400 being powered by biogas - that can generate electricity with an estimated overall installed power of 1300 MW_{el}. Many of these plants are examples of excellence for their organization, high social consensus and remarkable success. Italy's biofuel production capacity amounts to about 2,000,000 t/ year (only 25% of it exploited in 2007), which comes mostly from plants producing biodiesel.

The main Italian businesses engaged in the use of wood biomass for energy are companies having plants of varying size and structure and different end consumers that use the heat and electricity they produce. The businesses have different legal status and can be Joint Stock Companies, Cooperative Companies, Company Consortia or No-profit associations.

In Italy, the stakeholders that use biomass of different origin to produce heating and / or electricity can be divided into two categories:

› Owned and/or management companies of district heating stations using virgin wood biomass to produce and distribute domestic heating (District Heating).

› Owned and/or management companies of power stations using only wood biomass of agricultural and/or industrial origin, or a mixture of biomass and waste fuel, to the production and transfer of the electricity produced to the state-onwed company Gestore dei Servizi Elettrici (the "Electrical Services Operator", known as GSE)".

The first category is mainly represented by Fiper, the Italian Federation of Energy Producers from Renewable Energy Sources, encompassing 20 businesses, and the Alto Adige Biomass Consortium, which encompasses 38 public and private companies.

The second category is instead represented by a more complex and slightly inhomogeneous network of private Companies that have developed their initiatives thanks to grants for current expenses that were once given through CIP 6 and are now awarded in compliance with the Green Certificates.

This category is represented by numerous private groups, such as Falck, through the company Actelios; Sicet, the Marseglia and Saviola groups; the companies of the rice groups Curti, Scotti and Ticino; the group of distilleries Caviro, Biomasse Italia, and the companies of the Bioenergie group.

» RESEARCH

In the 1990s, Italy was at the forefront of R&D, forestalling the EU's current orientation. Below is a list of some of the activities that were started in the 1900s.

ENEA Trisaia: biorefinery of biomass, second generation biofuels, gasification, energy crops;

Università dell'Aquila: enzyme hydrolysis of cellulose to produce ethanol, innovative gasificaiton;

Università di Bologna, Perugia, Tuscia, Genova, Firenze: research studies on energy crops;

MIPAAF's experimental institutes (now known as CRA, Research Centres) performing research Projects (PRISCA);

The Agro-biochemical Research Centre (CRA) performing experiments on numerous varieties of Topinambur;

SES (FIAT Group): gasification of wood biomass to power small cogeneration units (TOTEM – Total Energy Modulus);

ENEL - CRAM: experiments on biomass ground crops for electricity production

Some of these research activities have continued, even if on a smaller scale and without adequate funding, namely:

- Synthesis biofuels (CREAR).
- Algae (University of Genoa, Assocostieri).
- Second generation Ethanol (M&G Group).
- Hydrogen from biomass bacterial metabolism (EniTecnologie).
- Algae and euphorbiaceae as a new way for sustainable biofuel production (Department of Mechanics and Aviation, CIRPS, University of Rome 'La Sapienza').

Renewed impulse needs to be given to basic and technological research, even through a national R&D research programme.

1.5) THE ITALIAN GOVERNMENT POSITION PAPER (SEPTEMBER 2007)

The latest official reference document on the national situation and perspectives of biomass and bioenergy is the Government's Position Paper on *"Energy: issues and challenges for Europe and for Italy"* (10 September 2007), submitted to the European Commission. This document sets the ground for future material. An excerpt on biomass is reported below.

A general principle reported in the document is: *"The community objective requires a careful and detailed assessment of the national potential and a clear definition of the role of renewable energy imports taking account of different situations that characterise Member States, namely*

1. The systemic framework

land, climate, available natural resources, technological development". And it continues to say: *"The commitment towards one single objective ought to be based on credible consumption scenarios, taking account of energy efficiency commitments and the scenarios presented by the Member States".* Moreover, *"the choice between consuming end-use energy or primary energy is relevant when setting the target: transformation losses, for example, would not be taken into account if end-use energy were chosen".* Finally: *"biomass trade among EU Countries should be encouraged, in order to benefit from the opportunities created by the different situations".*

The above-mentioned document estimates the national potential of biomass, expressed in primary energy, that can be used in 2020 (see also **Addendum A1.5**):

ELECTRICITY	3.0	Mtoe*
HEAT	9.3	Mtoe
BIOFUELS	4.2	Mtoe
TOTAL	**16.5**	Mtoe

*14,50TWh

The route to be followed to achieve 16.5 Mtoe by 2020 can be chosen after analysing the current situation. The report provides the following biomass primary energy consumption for 2005 :

ELECTRICITY	1.35 Mtoe
HEAT	1.88 Mtoe
BIOFUELS	0.30 Mtoe
TOTAL	**3.53** Mtoe

As a matter of fact, these data do not include biomass that is self-produced and self-consumed outside commercial circuits, namely for domestic heating. ITABIA has carried out an in-depth study on this use by drawing on and processing partial data from various sources. Results have shown that primary energy consumption for heating was about 4 Mtoe, instead of 1.88 Mtoe, amounting to a total supply of primary energy of about **5.65 Mtoe** in 2005.

To achieve the 2020 objectives, Italy will need to double its current biogenic raw material consumption. That is why the following ought to be examined:

- if sufficient raw materials and efficient technologies are available (Chapter 2 - Resources/Efficiency);
- if current, ongoing activities are consistent and well structured (Charter 3 - Market/Good Practices);
- if there is awareness and there are the instruments to guarantee sustainable initiatives (Chapter 4 - Sustainability);
- if an overall development plan can be laid down (Chapter 5).

1] Addenda

A1.1) THE GBEP WORK PROGRAMME

In line with the Partnership's "Terms of Reference" and with the current state of the international debate on bioenergy, the GBEP partners have selected the following priority areas in their programme of work:

1. Draw up a Report on bioenergy development in G8 + 5 Countries. The GBEP Report "A Review of the Current State of Bioenergy Development in G8 +5 Countries" was published on 13 November 2007 and represents a milestone for the future work of GBEP.

2. Favour the sustainable development of bioenergy and facilitate cooperation on practical bioenergy projects.

3. Harmonize methodologies to measure the reduction of greenhouse gases produced by biofuels for transport and solid biomass.

4. Deal with communication and dissemination of information concerning bioenergy.

1) The GBEP Report "A Review of the Current State of Bioenergy Development in G8 +5 Countries".

The Report, drawn up under the supervision of FAO and the GBEP Secretariat, provides an overview of the current bioenergy development in G8 + 5 Countries, and offers guidance on how to tackle critical issues of bioenergy promotion in order to enhance market development.

Bioenergy accounts for about 10% of world primary energy supplies. Production is mainly local and it is the +5 Countries which resort mainly to this source for energy purposes (first China, followed by India, USA and Brazil). However, the percentage of bioenergy used compared to overall energy consumption is also increasing in the G8 Countries, mainly in Germany, Italy and the United Kingdom.

This growth is related to four factors: instability of fossil fuel prices, energy security, climate change and rural development. The Report underlines that safety of energy supply and climate change are essential for G8 + 5 Countries. Rural development too is important, but it has greater relevance in the +5 Countries where greater attention is addressed to the reduction of poverty.

The Report also points out that the bioenergy market is strongly dependent on support measures, because production is not yet sufficiently competitive compared to fossil fuel prices. The most common form of incentive used is the feed-in tariff. In the G8 Countries, voluntary quota systems are common too, while blending mandates are becoming increasingly utilized in +5 Countries.

The Report also underlines some critical issues that hinder the development of bioenergy. Firstly, there is recognition that bioenergy, despite being potentially "green", is not always produced in a sustainable manner. In order to overcome these difficulties, bioenergy sustainability criteria are being set (see on the matter the proposed Directive of the European Commission). However, the lack of an international sustainable framework for sustainability is one of the main barriers hindering bioenergy development on international markets. Moreover, adequate efforts are needed to ensure that the development of sustainability criteria and certification systems contribute to achieving environmental targets with no hindrance to international trade, particularly with regard to exports from developing Countries. Finally, commercial barriers need to be lifted and trade-distorting subsidies are to be gradually removed in order to help build a fair competitive market.

2) Favouring the sustainable development of bioenergy and facilitating cooperation on practical bioenergy projects.

On the basis of the GBEP Report and in light of the G8 2005 and 2007 mandates, the Partnership is assessing the way forward to favour bioenergy sustainable development and facilitate cooperation on practical projects. The GBEP, led by Great Britain, established a Task Force for Sustainability to develop voluntary international sustainbility criteria. The reference framework shall be used by all bioenergy stakeholders and for defining national policies and international cooperation programmes.

3) Harmonizing methodologies to measure greenhouse gases (GHGs) produced by biofuels for transport and solid biomass.

Another GBEP priority activity, through the Task Force, is to harmonize methodologies to measure GHGs produced by biofuels for transport and solid biomass for the production of heating and/or electricity. This reference methodological framework may be used by policy-makers of both developed and developing Countries, when defining policies on energy and climate change mitigation at national and international level. The Task Force, led by the United States, is developing guidelines with a series of questions that will help governments and institutions calculate the savings made with bioenergy.

The Task Force shall draw up a draft reference framework by the end of 2008 and a final version shall be available by Spring 2009.

4) Communication and dissemination of information concerning bioenergy.

Any communication activity promoted by GBEP is aimed at raising awareness and disseminating information on bioenergy. GBEP's communication strategy focuses on:

A. creation and update of the web-

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site www.globalbioenergy.org. Inaugurated in May 2007, the website provides information on bioenergy and outlines the Partnership's activities;

B. creation and dissemination of information on the Partnership;

C. participation in various international conferences and meetings on bioenergy, as well as organisation of specific events;

D. organisation of a communication campaign on printed material and web sites at national and international level.

A1.2) CONTENT ANALYSIS OF THE RES DIRECTIVE (CONTRIBUTION BY EDITA VAGONITE, AEBIOM, EUROPEAN BIOMASS ASSOCIATION)

The European Commission on 23 January 2008 proposed a Directive on Renewable Energy Sources. This proposal was analyzed by the European Parliament and will be adopted by both - the European Parliament and the Council, hopefully still in 2009.

SCOPE AND BACKGROUND (ARTICLE 1)

The package contains proposals to implement the decisions agreed by EU leaders in March 2007, including:

- 20 % of total EU energy consumption to come from renewables by 2020,
- 20% increase in energy efficiency,
- 10% of transport biofuels target,
- 20% reduction in EU greenhouse gas emissions by 2020.

In order to reach the targets (and to implement decisions) agreed by the Council, the Commission proposes the following tools: mandatory renewable energy and transport biofuels targets for all member states, rules for guarantees of origins establishing the trade between member states, administrative procedures (removing barriers), electricity grid connections and sustainability criteria for transport biofuels.

DEFINITIONS (ARTICLE 2)

This article provides the definitions for renewable energy, biomass, final energy consumption, bioliquids, biofuels, district heating and cooling, guarantees of origin, support scheme and renewable energy obligation. Most of these definitions were already included in the renewable electricity directive 2003/77/EC.

RENEWABLE ENERGY TARGETS AND NATIONAL ACTION PLANS (ARTICLES 3, 4)

This article sets national renewable energy targets for all 27 member states of the EU (for Italy 17% of the final energy consumption) as well as interim renewable energy targets (Annex IB). The member states will have to adopt national renewable energy action plans with binding targets for heating and cooling, electricity and transport biofuels from renewables by 31 March 2010 at the latest. It is up to member states, however, to decide on the mix of contributions from these sectors to reach their national targets, choosing the means that best suit their national circumstances. Nevertheless, each Member State will have to achieve at least a 10% share of renewable energy (primarily biofuels) in the transport sector by 2020.

CALCULATION OF RENEWABLE TARGET (ARTICLE 5)

For calculation of renewable energy target, the proposal takes into account final energy consumption (energy commodities delivered for energy purposes to final consumer) rather than primary energy use (used in various previous Commission documents such as the White Paper on renewable energy, Biomass Action Plan, Biofuels Directive etc). The counting of final energy for the biomass sector means that bioenergy producers will consider the conversion efficiency from primary to final energy.

GUARANTEES OF ORIGIN (GDO) (ART. 6, 7, 8, 9, 10)

In order to give more flexibility to member states the system of non-obligatory trading of certificates has been established in the proposal of the Directive. This means that Member States will be able to buy guarantees of origin (certificates providing/indicating the renewable origin of energy) from other Member States if they fail to reach the national target. Guarantees of origin will be issued (upon producer's request) to renewable heating and cooling and electricity plants, the production capacity of which is of at least 5 MWth. A guarantee of origin will be of the standard size of 1MWh.

ADMINISTRATIVE PROCEDURES (ARTICLE 12)

The proposal states that Member States will have to modify their existing national rules on administrative procedures (authorization, certification and licensing of renewable energy production plants) in order to eliminate regulatory and non-regulatory barriers. Member states will have to choose by 30 June 2011 whether to establish a single administrative body responsible for authorization, certification and licensing applications, or to provide an automatic approval of planning and permit applications if the authorizing body has not responded within the set time limit.

HEATING AND COOLING SECTOR (ART. 12, 13)

This proposal creates - for the first time - an EU-wide legislative framework for market development of renewable heating and cooling technologies.

Beside the obligation to include the heating and cooling sector in national RES action plans, the renewable heating will strongly benefit from the introduction of minimum requirements

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of renewable energy use in new and refurbished buildings. Member States will have to require local authorities to consider the installation of renewable heating, cooling and electricity equipment and systems, as well as district heating and cooling, when planning, designing, building and refurbishing industrial or residential areas. The proposal foresees certification schemes for installers of renewables systems, including small-scale biomass boilers and stoves. This certification scheme will have to be recognized by other Member States. Member States are required to promote the use of renewable energy heating and cooling systems and equipment that achieve a significant reduction of energy consumption. Provisions for better information and training on renewable energy for architects, planners and accreditation of installers will also play a key role in the development of renewable heating and cooling and electricity sectors.
Furthermore, in the case of biomass for heat, Member States will have to promote conversion technologies that achieve a conversion efficiency of at least 85% for residential and commercial applications and at least 70% for industrial applications.

ELECTRICITY (ARTICLE 14)

According to the proposal, Member States must take the necessary steps to develop grid infrastructure in order to further develop the use of electricity from renewables. Member States shall provide for priority access to the grid system of electricity produced from renewable energy sources. The Commission proposes that Member States require transmission system operators and distribution system operators to set up and publish their standard rules on costs of technical adaptations, such as grid connections and grid reinforcements, which are necessary in order to integrate new producers feeding electricity produced from renewable energy sources into the interconnected grid.

SUSTAINABILITY CRITERIA (ART. 15, 16, 17)

Biofuels and other bioliquids that do not fulfil the environmental sustainability criteria in Article 15 shall not be taken into account.
The sustainability criteria are established not only for Biofuels for transport but also for bioliquids (liquid fuels from biomass for cogeneration and heating purposes). First criterion is that greenhouse gas emissions saving from the use of biofuels and bioliquids should be at least 35%. The GHG savings are calculated on a lifecycle basis and compared to the conventional fuels that the biofuels go to replace. The proposal indicates greenhouse gas saving values for all type of biofuels as well as the rules of calculation. Second criterion requires that biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value (land that had this status in January 2008) such as areas designated for nature protection purposes, forest undisturbed by human activity and highly biodiverse grassland. The production of biofuels is also forbidden on the land with high carbon stock (land that had this status in January 2008) such as wetlands and continuously forested areas.
The biofuels and bioliquids will have to meet the standards set in the Council regulation (1782/2003) and in accordance with the minimum requirements for good agricultural and environmental conditions.
These criteria will be a subject of further improvement. The Commission will report in 2010 and 2012 to the European Parliament and the Council on sustainability criteria and if necessary propose corrective actions.
The Commission will also have to submit a report (to the European Parliament and the Council) regarding the need of sustainability scheme for other types of biomass by 31 December 2010 at the latest.

TRANSPORT BIOFUELS (ARTICLE 18).

The Directive states that biodiesel share is obligatory from 2015. Member States will have to ensure that diesel fuel comprises from 5 to 10% biodiesel and complies with other fuel specifications set out in the Directive. Such fuel will have to be made available in all filling stations that sell diesel by 31 December 2014. For a period 2010 - 2015, the Directive provides an obligation for biodiesel share from 0 to 7% for 2010.

The biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material will count double comparing to other biofuels. When designing their support systems, Member States may encourage the use of biofuels which give additional benefits - including the benefits of diversification offered by biofuels made from wastes, residues, non-food cellulosic material, and ligno-cellulosic material - by taking due account of the different costs of producing energy from traditional biofuels on the one hand and from biofuels which give additional benefits on the other hand.

POZNAN CONFERENCE (8 December 2008): **Final Agreement on Renewable Energy Directive**

In Poznan there was reached a final agreement on renewables Directive. The below article includes the major points of the directive relevant to biomass sector.
"The final agreement on renewables Directive was made at the negotiation session between the European Parliament, Council (27 EU Member States), and the Commission. The directive will boost all biomass sectors

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including second generation biofuels, biogas but especially the heating and cooling technologies.
According to this Directive, Member States (MS) will have binding national targets and will have to clearly indicate how they will meet those targets through detailed national action plans. The EU Commission will monitor these plans and launch infringement procedures against member states who failed to implement the Directive.
The Commission will adopt by 30 June 2009 a template for the national action plans. Member States will have to submit these plans by 30 June 2010.
National support schemes and the 20% renewables targets will not be affected by the review in 2014.

The Directive brings major changes for **heating and cooling sector** by requiring MS to introduce measures in order to increase the use of renewable energy sources (RES) in the buildings sector. Member States will have to establish the minimum levels of renewable energy to be used in new buildings as well as in existing buildings. These levels will have to be applied from 2015 at the latest. Member States will permit these minimum levels to be fulfilled inter alia through district heating and cooling produced using a significant share of renewable energy sources.
Energy efficiency is highlighted together with the use of RES. In order to achieve a better energy efficiency, final energy will be counted towards renewables target and MS will have to implement additional measures to promote cogeneration, passive, low or zero energy buildings.

As for **biomass definition**, the agreement wipes out the "separated biodegradable fraction of waste" from the biomass definition which means that a significant part of unseparated biodegradable waste, would be counted towards renewables target. The final agreement rejects the EP will to get rid of peat as a non-renewable energy. However, there are restrictions for peatlands within the sustainability criteria.

BIOFUELS AND SUSTAINABILITY CRITERIA

As for **biofuels**, 10% binding target was kept but electricity and second generation biofuels will receive more support that other RES for transport. The consumption of electricity in transport shall be considered to be 2,5 times the energy content of the renewable electricity input. The contribution made by biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels. Furthermore, sustainability requirements for this type of biofuels are less strict.

As regards to CO_2 emissions reduction, the agreement indicates that the greenhouse gas savings from the use of biomass fuels in transport should be 35% until 2017 and 50% from 2017 (60% for the installations built after 2017).
The sustainability criteria remain applicable only to transport biofuels and bioliquids for the moment. However, the Commission will report on requirements for a sustainability scheme for energy uses of biomass, other than biofuels and bioliquids, by 31 December 2009 at the latest. The final agreement also indicates that the criteria should be applicable for both European and imported biofuels. The sustainability criteria states that the biofuels should not be made from raw material obtained from land with high biodiversity value such as primary forest and other wooded land, highly biodiverse grassland, areas designated for nature protection purposes etc. The sustainability criteria includes the restriction for high carbon stock land such as wetlands, forest land with of more than 1 hectare with trees higher than 5 metres and a canopy cover of more than 30%, peatland (unless it is proven that the cultivation and harvesting of this raw material does not involve drainage of previously undrained soil). Further to that there are other restrictions related to indirect land change, soil, water and air protection.
Also a review will be made in 2014 on biofuels focusing on the minimum greenhouse gas emission saving, indirect land use changes, social impacts, biodiversity, availability of electricity or hydrogen from renewable sources.

A1.3) REMARKS ON RECENT FINANCIAL LAWS

Law n. 244 of 24 December 2007 (Financial Law for 2008) sets forth the benefit scheme for the use of renewable energy in the production of electricity based on a mixed system of "feed in tariffs" and incentives granted through Green Certificates.
The new scheme establishes that electricity production plants using renewable energy that become operational in 2008 can benefit from the Green Certificate (GC) incentive for 15 years. GCs are issued by the GSE for each recognised plant according to the net production of electricity from RES multiplied by the coefficient of the type of source used (reported in Table 2 annexed to the law). Alternatively, plants with a power output below 1 MW can benefit from discounted tariffs that are set by the Authority for electricity and gas. The previous law is instead applied to all the plants that became operational before 2008.
Legal Decree n. 159 of 1 October 2007, that was passed as Law n. 222 of 29 November 2007 (Related to the Financial Law) projected a change in the GC scheme by setting forth the interesting perspective of producing electricity from agricultural biomass,

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both from dedicated crops and subproducts in a supply chain or radius of 70 kilometres. In this hypothesis, the value of GCs is increased with coefficient 1.8 and their duration extended to 15 years. As an alternative to green certificates, an all-inclusive tariff of Euro 0.30 per KWh over 15 years is applied for plants with a capacity below 1 MW.

After some demur from the European Commission Services, the scheme conceived for the short supply chain, particularly the all-inclusive tariff for plants with a capacity below 1MW, may be changed.

In the meantime, the Ministry for Economic Development passed a Ministerial Decree outlining the rules for implementing the new Green Certificate system, while the system for the short supply chain shall be established in a decree to be passed by the Ministry for Agricultural Policies, which will have to take account of the mentioned changes.

One of the weaknesses of the financial law is that it lays down that GCs are to be issued only for the production of electricity from RES without establishing any incentive whatsoever for cogeneration. Given the binding commitments of the European Directive (that will soon come into force) and the possible limited availability of resources, it would be reasonable to ensure a rationalisation of resources, both upon implementation of the financial law and in future provisions.

A recent resolution of the XIII Permanent Commission on Agriculture of the Chamber of Deputies commits the government to maintaining the existing laws on the production and incentives for the use of renewable energy sources of agricultural origin. Reference is made in particular to what is set forth in the 2007 financial law on the production of electricity in "small" plants (up to 1 MW) from biomass that is available locally or supplied according to supply chain agreements. The resolution underlines the need for a rapid definition of the implementation provisions mentioned in the 2008 financial law in order to set, on a permanent basis, the all-inclusive tariff of minimum 0.28 Euro/kWh el. That is produced in "small" plants that use biomass, biogas and, in particular, pure vegetable oils. Specific measures also need to be taken to support the agro-energy sector in the production of biomethane.

The legal decree on agriculture, which has not yet been presented to Parliament, also explains that plants owned by agricultural, agro-food, breeding and forest businesses using biomass and biogas can combine the tariff and other public incentives as capital gains or interest subsidy with advance capitalization that does not exceed 40% of investment cost.

A1.4) AN ENERGY REVOLUTION IN ITALY (ROME, 10 DECEMBER 2008)

The climate-energy package and the 2020 targets mark an important turning point in the Italian energy sector and an avant-garde stance is of the essence. The recent norms abolishing the compulsory energy certification of buildings and tax allowances for energy-saving renovation run in the opposite direction to what is needed. They also reduce the demand for the related goods and services, bringing effects that are contrary to those needed to pull out of the current economic recession. Renewable sources and greater energy efficiency are the choices made by important industrialized Countries and play an important role in the proposals of economic and social rebirth made by the new US President.

Consequently:

1. Incentives to renewable energy sources are not to be seen as costs, but rather as a form of funding to technological innovation and as investments with a strategic economic and employment impact. Implementing the European package on renewables in Italy would lead to more jobs (about 150,000) for qualified staff, as well as wage increases. In the wind sector, over 50,000 new units are projected to be employed. Importantly, a share of these jobs will be secured in slow developing areas of the Country. We thus urge for the immediate enactment of the implementation decrees.

2. Investments in efficient final energy uses have great potential value both with regard to electricity and heating. The 20% saving in electricity use by 2020, to be achieved with efficient lighting systems and industrial engines, cooling systems and household appliances (technologies produced by Italy), could have a net employment impact of around 50,000 new jobs in the manufacturing sector.

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With regard to heating, investments in the building sector could create employment both in the insolation of buildings and replacement of installations. We therefore ask Parliament to withdraw the provision currently being discussed.

3. The potential of solar energy should not be exploited solely for the development of the photovoltaic sector (which is booming in Italy), but it should also be used for low, medium and high temperature heating purposes. By using solar energy for heating systems and in the industrial sector - which is being developed today - Italy can and must take part in the solar energy sector, which is still lagging behind. However, the recent positive steps forward may be may be accompanied by backward steps if substantial incentives are no longer offered.

4. With a strong commitment in the renewable sector, Italy could play a role in the Mediterranean area by promoting technological and environmental cooperation with the Countries to the South, thus boosting the industrial sector and relations with those countries.

5. In the transport sector, more efficient vehicles, support systems to local and national public transport, the development of second generation biorefineries - as well as environmental conditions - can help reduce Italy's dependence on oil products significantly, turning part of the deficit in the energy budget into added valued within the Country.

The challenge of climate change can and must be tackled by focusing on existing clean and efficient solutions, which are an opportunity for development and employment, and by promoting research on and development of new technological options. The strategic value of investments in efficiency and renewables goes beyond environmental objectives, as stated by great European Countries and the new US presidency.

AIEL Italian Association for Agro-Forest Energy
ANAB National Association for Bioecological Architecture
ANEV National Association for Wind Energy
APER Association of Energy Producers from Renweable Sources
ASSOLTERM Italian Association of Solar Thermal Energy
ASSOSOLARE Association of Solar Photovoltaic Industry
FEDERPERN Federation of RES Producers
FIPER Italian Association of Energy Producers from Renewable Sources
GIFI Group of Italian Photovoltaic Companies
GREENPEACE Italia
GSES Group for the History of Solar Energy
ISES ITALIA Italian section of the International Solar Energy Society
ITABIA Italian Biomass Association
KYOTO CLUB
LEGAMBIENTE Environment group
WWF Italia

A1.5) THE ITALIAN GOVERNMENT POSITION PAPER (SEPTEMBER 2007)

The main paragraphs on bioenergy in Italy are reported in the following excerpts.

BIOMASS. The achievable potential has been estimated to be around 5 TWh/year, mainly through the use of industrial residues. Electricity efficiency has been projected to be of 25%, assuming that the biodegradable fraction is 40% of solid urban waste. The value is given by a potential of 1.7 TWh/year given by the use of gas from controlled anaerobic fermentation, which adds to a potential of about 1.5 TWh/year mainly from landfill gas. The goal is to improve gas capture, although these waste treatment systems are expected to disappear. The goal can be achieved only by providing high incentives. The overall potental by 2020 would be of 14.50 TWh, compared to 6.16 TWh in 2005.

RESIDUE BIOMASS. The use of 5% of all untreated waste potentially available in the country for residential heating is expected and an average efficiency of 50% is estimated. Supposing that 50% of the new installed power is cogenerated and the average yield is of 70%, we estimate a potential of 389,933 TJ, or 9.32 MToe.

BIOFUELS. Given the growth in transport fuel consumption, around 40 million tons of fuel may be used by 2020. In order to produce 5.5 million tons of fuels needed to cover 10% of equivalent energy from biofuels (supposing the use of second generation biofuels), 5 million hectares of agricultural land would be needed, which corresponds to 16.7% of the country's territory and to 60% of the currently crop growing land. It is thus necessary to resort to imports if we wish to achieve such an ambitious target. Italy could produce maximum 800,000 - 1,000,000 tons a years, using 600,000 hectares of agricultural land, an not the current 260,000. This corresponds to 25,600 TJ, or 0,61 MToe. The remaining tons needed to achieve the 10% target of 46 Mton of fuel consumption, are to be imported. The possible negative impacts this approach could have on food chains, due to the reduction of agricultural land used for their needs, should be analysed. When analysing demand, the possible evolution of the road transport sector ought to be taken into account, favouring the use of increasingly efficient engines and promoting policies for more competitive public transport services. These two factors may reduce the fuel demand and thus the demand for imported biofuels. As for heating/cooling and biofuels, the maximum theoretical national potential is estimated to be 12.01 MToe. ■

2] Resources/Efficiency

RAW MATERIAL RESOURCES AND EFFICIENCY IN COLLECTION AND SUPPLY
ENERGY CONVERSION TECHNOLOGIES AND EFFICIENCY USE
ADDENDA

Bioenergy is made up of three main supply chains: the heat chain for centralized or de-centralized production of heat and/or cooling; the power chain for the production of electricity and cogeneration in small power plants, and the biofuels chain replacing fossil fuels with fuels of biological origin in the transport sector. As reported in Chapter 1, the 2007 Italian Government Position Paper already set forth some objectives for the three supply chains to be reached by 2020, which were then confirmed by the Proposal of European Directive on Renewable Energy Sources (RES) that was approved by the European Council and Parliament in December 2008 and which will soon (end 2010) enter into force. In order to assess Italy's capability to achieve these goals, the availability of raw materials and technologies for their collection, treatment, supply and conversion in the country needs to be analysed by focusing on efficiency of use.

2.1) RAW MATERIAL RESOURCES AND EFFICIENCY IN COLLECTION AND SUPPLY

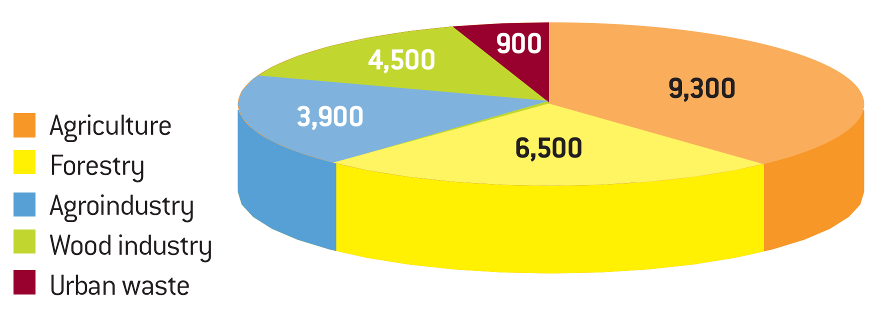
Over the past few years, public and private organisations have carried out comprehensive or partial studies to assess the availability of various biomass sources, mainly from agricultural and forest residues, firewood, and the biodegradable fraction of urban and industrial waste, to be used for energy purposes. They have also considered that more quantities of raw materials could be produced by remodernising the non-food agricultural sector, the forest sector and by re-settling marginal land that can still be cultivated with species that require low energy input and little crop maintenance. Brief mention will thus be made here on this topic, since the order of magnitude of estimates is fairly realistic and more precise data can hardly be obtained, due to the high dispersion and fragmentation of these materials in the country. The total quantity of organic residues and by-products produced in Italy every year amounts to several million tons; only a share of it can be used today due to:

1) Competition with the non-energy uses of the biogenic matter;
2) Problems with collection of materials and subsequent supply to the energy conversion plant.

2.1.1) THE AVAILABILITY OF BIOMASS AND COMPETITION

The formulation of estimates on the availability of energy biomass can give an overview of the sector's potential, but it also leaves some room for unpredictability given by the many existing variables. That is why Enea (the Italian National Agency for New Technologies, Energy and the Environment) is developing a "**Biomass Atlas**", which will be a web-accessible interactive geodatabase. The database will contain information on the annual quantity of biomass available in each Italian province. The collected data shall be georeferenced and associated with local factors that influence the management of bioenergy supply chains (transport infrastructures, geomorphology, administrative limits, environmental constraints etc.). This tool, thanks to its structure and regular updates, will help to identify the districts that encourage energy production from biomass. Since this highly detailed and reliable mapping system is not yet available, a more general overview can be obtained by referring to a recent survey carried out by ITABIA. The survey focused on organic waste deriving from the five most relevant sectors: agriculture, forestry, agro-industry, wood industry and urban waste. The data obtained result from estimates that do not take into account significant quantities of biomass, which is today inaccessible due to economic, logistical or market reasons. The estimated annual quantity of residue biomass amounts to

TOTAL BIOMASS RESIDUES (kt/anno s.s.)



2. Resources/ Efficiency

more than 25 million tons of dry matter (see graph page 17).
This quantity of available biomass, with also animal manure and potential energy crops, can be summarized with good approximation in the values of the table below, that are expressed in millions of equivalent tons of oil (Mtoe/year), so that they can be compared with the figures reported in the Position Paper mentioned in Chapter 1.

	MTEP/ANNO
1. RESIDUES FROM	
AGRICULTURE AND AGRO-INDUSTRY	5
FORESTRY AND WOOD INDUSTRY	4.3
URBAN SOLID WASTE	0.3
ANIMAL BREEDING	10-12
2. FIREWOOD	2-4
3. ENERGY CROPS (POTENTIAL)	3-5
4. TOTAL	**24-30**

This potential availability also needs to be weighted further due to technical and economic problems in the supply of raw material in the form of "biofuel" to the conversion plant (e.g. collection and transport costs, storage and pretreatment costs, etc.).

AVAILABILITY OF MAIN HERBACEOUS AND WOODY CROPS

SECTOR	TYPE OF WASTE	QUANTITY (KT/YEAR OF D.M.)
AGRICOLTURA		
SOFT WHEAT	Straw	500
HARD WHEAT	Straw	1,600
BARLEY	Straw	380
OATS	Straw	120
RICE	Straw	550
MAIZE	Stalks/Cops	3,100
TOBACCO	Stalks	10
SUNFLOWER	Stalks	350
GRAPEVINE	Shoots	880
OLIVE TREE	Wood, branches, fronds	800
APPLE TREE	Branches	90
PEAR TREE	Branches	50
PEACH TREE	Branches	150
CITRUS TREE	Branches	480
ALMOND TREE	Branches	95
HAZEL TREE	Branches	85
ACTINIDIA	Shoots	25
APRICOT, CHERRY, PLUM TREE	Branches	35
TOTAL	Straw, stalks, stems, leaves, etc.	**9,300**

BIOMASS FROM AGRICULTURAL RESIDUES

All lignocellulosic waste (straw, stalks, prunings, etc.) derived from herbaceous and woody plants that grow in Italy has been taken into account. Assessments have been made by analysing the main, recent studies performed on more or less extensive portions of land and on some biomass sources. This procedure has enabled ITABIA to assess the degree of approximation of the coefficients of residues biomass availability that have been used per surface unit and/or per main product.
The said residues are often used by the companies that produce them for various purposes (such as animal bedding, animal feeds, planting, etc.) or in some way enter the local market (paper industry and other) as reported in Addendum A2.1.
The estimated quantity of available waste (excluding the share of existing but unusable residues) amounts to approximately 9.3Mt/ year of dry matter.

FOREST BIOMASS

Estimates on the quantity of forest biomass that can be used for energy have been made by analyzing current firewood production and by identifying possible and useful measures of forest maintenance and enhancement.
Coppice woodlands are not exploited to their full potential today and therefore an increase of woodlands from 2% to 5% has been considered. Moreover, a more rational organization of forest yards, both for high forests and coppice woodlands, supported by innovative mechanization, would help exploit significant quantities of biomass (branches, tops) that today are left unused in the woods.
The woody mass derived from coppice woodlands is mainly used for energy purposes (firewood).
The figure 1 shows its production percentages.
An optimal management purely for energy purposes, based on the use of suitable working methodologies and mechanization, may significantly increase the amount of wood for energy as outlined in the figure 2.
On the other hand, **high forests** are forest formations which produce the highest quality wood that is commonly used by the wood industry and the cellulose paste sector. The figure 3 shows the percentage of woody mass that can be obtained by cutting high forests, enhancing the use of bio-

2. Resources/ Efficiency

FIGURE 1

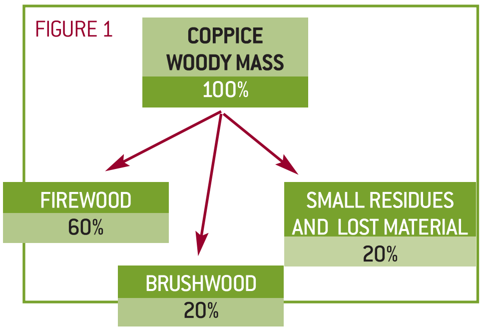


FIGURE 2

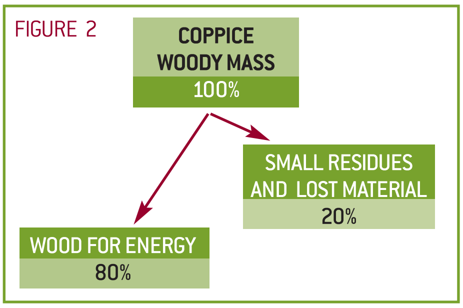
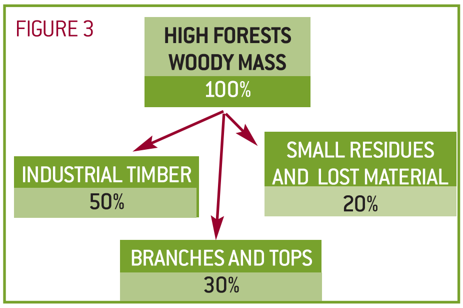


FIGURE 3



AVAILABILITY OF FOREST BIOMASS

TYPE OF WOODLAND	BIOMASS	QUANTITY (kt/year d.m.)
HIGH FORESTS (broad -leaved trees, conifers)	Branches, tops and small residues	1,800
COPPICE WOODLANDS (simple, compound)	Whole plant	4,700
TOTAL		**6,500**

mass (30% is made up of branches and tops) for energy purposes. These observations have led to estimate that the annual quantity of material that can be used for energy purposes would amount to around 13 million tons of wet matter, without reducing forest consistency which corresponds to about 6.5 millions of tons expressed in dry matter.

Firewood production in Italy today amounts to approximately 2.2. Mt/year of dry matter (4.5 million tons per year of wet matter) and firewood is used almost exclusively by a consolidated market of small consumers for their commercial activities (pizzerias, wood ovens, etc.) or, on a larger scale, for household heating. A significant increase in resources (4.3 Mt/year in d.m.) for the wood-energy supply chain would be obtained in order to reach the calculated 6.5 Mt/year from today's production. Another resource could be biomass obtained from improved management and maintenance of riverbeds, wind barriers, rows and hedges, which would also be beneficial for the environment.

BIOMASS FROM INDUSTRIAL RESIDUES

The availability of residues from the agro-industry and wood industry is significant in terms of energy content. These residues today are partly re-introduced into the production cycles of the companies that produce them (secondary products and process heat) and partly used in other market segments as second raw materials (animal feeds, soil amendments, fibres for chipboard panels or MDF, etc.) and partly disposed of as waste. Even though these residues are already employed in some way, they need to be taken into account because they may be used for the production of energy. Over the past years, the widespread development of biomass district heating, particularly in Northern Italy, has created intense competition with compressed wood or MDF panel producers for the supply of sawmill waste. This competition has become even sharper due to the recent economic crisis which has led to a drop in business for first and second wood conversion companies. Moreover, the increased demand for agro-industrial waste for biogas production, due to the ease of supply from production plants, has meant that production companies have applied the cost of up to 10-15 Euro/t for something that, up to some years ago, was supplied for free. Recent estimates by ITABIA have shown that the overall availability of

AVAILABILITY OF RESIDUES FROM AGRO-INDUSTRY AND WOOD INDUSTRY

SECTOR	TYPES OF WASTE	QUANTITY Kt/year (d.m.)
AGRO-INDUSTRY		
SUGAR REFINERY	Molasses, dry pulp, sludge	1,570
TOMATOES	Peels and seeds	135
CITRUS FRUIT	Pulp and peel	210
FRESH FRUIT	Stones	35
DRIED FRUIT	Peels	135
FLOUR MILLING	Bran	185
PASTA INDUSTRY	Part breaking off	60
RICE INDUSTRY	Husk, chaff, starch, green grains, broken parts	520
OIL	Virgin residues, exhausted residues	750
WINE	Virgin pomace, exhausted pomace, grape stalks	300
TOTAL		**3,900**
WOOD INDUSTRY		
PRIMARY WOOD PROCESSING	Barks, wane, etc.	2,500
SECONDARY WOOD PROCESSING	Sawdust, woodchips, etc	1,700
PAPER INDUSTRY	Pulp-paper, pulper	300
TOTAL		**4,500**
OVERALL TOTAL		**8,400**

2. Resources/ Efficiency

industrial residues, expressed as dry matter, amounts to around 8.4 Mt/year, of which 3.9 Mt come from agro-industry and 4.5 Mt/year from the wood industry.

BIOMASS OF URBAN ORIGIN
Urban waste, just like industrial waste, increasingly undergoes treatment to separate the recyclable fraction. There is thus uncertainty over the percentage that can be used to produce energy in the future. Today, only 8%-10% of the waste mass is used as fuel, in compliance with Legislative decree 152/06. In fact:

> **Recycling produces** almost 0.9 Mt/year of wet matter, which means about 100,000 t/year of dry matter.

> **The maintenance of public greeneries** yields over 9 Mt/year of wet matter, which mean about 380,000 t/year of dry matter.

The organic fraction of urban solid waste (FORSU) that can be obtained from waste treatment plants (existing ones and plants under construction) amounts to about 2 Mt/year, which corresponds to about 400,000 t/year of dry matter. This value may also quadruple if plants treating all national waste were developed.

ANIMAL MANURE
Is a good source of substrata for biogas production through anaerobic digestion. Biogas would be an intermediate fuel that is suitable for producing heat and/or electricity and should be given greater consideration by public and private stakeholders. Italian animal breeding produces about 330 million tons of liquid waste every year, but only a part of it is used for anaerobic digestion. Except for the limited share of liquid waste that can be spread on the fields, there are no other alternative uses that compete with their energy uses. In Germany and The Netherlands, where the sector is very well developed, there is a liquid waste stock exchange where trading rates range from 1.5 Euro/t within 5 km from the producing farm to up to 5 Euro/t beyond 5 km.

DEDICATED CROPS
Are in competition with crops planted for food or industrial purposes and are limited to a few thousand hectares of sunflower, soy and rapeseed for biodiesel and a few thousand hectares of rapid growth poplars (Short Rotation Forestry, SRF) in Northern Italy. An analysis of territory has led us to estimate that approximately 500,000 600,000 ha of arable land may be used to grow energy crops for biodiesel and first generation bioethanol, and that about 100,000 ha of marginal land may be used to grow low input energy crops that are ideal for both producing lignocellulosic biomass and biofuels (**Addendum A2.2** reports the yields per ha of some crops). Overall vegetable production (lignocellulosic, oleoplants, sugary plants, etc.) can be estimated to be about 16,000,000 t/year (as it is), corresponding to 5 Mtoe/year of primary energy.

2.1.2) COLLECTION AND SUPPLY OF BIOMASS
The collection, pretreatment and transport of agro-forest biomass relies on techniques that have been widely tested to ensure improved efficiency and safety of highly sophisticated machines. Today's levels of efficiency have been achieved owing to the joint commitment of Italian Research Institutions (CNR-IVALSA, CRA-ISMA) and National Associations of agro-forest mechanization (UNACOMA, ENAMA, UNIMA). Nonetheless, biomass supply to biomass-fuelled plants is strongly hindered by the high dispersion of these resources on the territory, particularly with regard to woody biomass or lignocellulosic residues. Italy has in fact shown to have little ability in organising company consortia or associations bringing together agricultural producers, industrial businesses and services companies for the collection and supply of these materials to the energy conversion plant. A brief description of the technical and economic features of the supply chain is provided in **Addendum A2.3**.
On the other hand, it is easier to retrieve other materials, such as for example organic liquid waste and residues; it is indeed easy to develop, in the short-range, a network channeling liquid waste to the conversion plant or organize the collection of organic residues in the long-range, which is also related to the need to deal with their final disposal.
Given these factors, ITABIA has estimated that the actual availability of biomass, regardless of collection and supply problems, is about 80% of potential availability (as seen in paragraph 2.1.1) , thus corresponding to 19-24 Mtoe/year.

2.1.3) BIOFUELS SUSTAINABILITY TOWARDS THE 2020 TARGETS
The mentioned quantities mean that bioenergy can play a role of primary importance in meeting the national target which is projected to be 17% of renewable energy by 2020 over an overall demand that today amounts to about 150 Mtoe/year of gross final energy consumption.
Should this last figure remain unvaried, by virtue of the energy saving and efficiency measures set forth in the 2008 EU Draft Directive, the RES contribution shall be around 26 Mtoe/year for the electricity, thermal and transportation sectors. With reference to the present situation and to the foreseen uptake for the other RES (solar, wind, hydro, etc.), bioenergy contribution should be of about 16-18 Mtoe/year, available from the national biomass resources.

2. Resources/ Efficiency

Even though the share of bioenergy needed to meet the 2020 target may be obtained according to raw material availability, the criteria for sustainable biofuel production set forth in the draft RES directive ought to be respected.
From this viewpoint, the sector of biofuels for transport is in a critical situation, since biofuels are to give the greatest contribution by replacing fossil fuels by 10% by 2020. The Position Paper (Chapter 1) estimates the use of 4.2 Mtoe of biofuels, which can only be obtained by importing raw materials and by granting incentives and significant support measures for research (second generation biofuels). ITABIA has indeed estimated that, by respecting the Directive's new criteria, first generation biofuels (if produced from national crops) would help produce maximum 2 Mtoe, but demand in 2020 will be (realistically) above 5 Mtoe, due to the need to incorporate 10% of biofuels in fossil fuel consumption.

The sector of solid, liquid and gaseous biocombustibles for the production of heat and electricity is not in such a critical situation, because no strict sustainability criteria are to be met. However, biomass supply systems and energy conversion efficiency need to be improved by reducing the radius of supply (less emission for transport) and resorting to high-yield technologies (cogeneration). Nowadays, a significant share of primary energy contained in lignocellulosic biomass used for household heating is dispersed due to the use of obsolete and low-yield technologies (30%-35%). By replacing these technologies with high-efficiency equipment (70%-80%), further primary bioenergy resources, estimated to amount to 2 million equivalent tons of oil (2 Mtoe), may become available in 2020. Such resources may be used for the production of second generation biofuels, if the related technology were to become technically mature, cost-effective and sustainable by 2020.

Moreover, the use of quality biofuels is fundamental particularly for large plants. It is thus necessary to set the standards for these biofuels (See Chapter 4), so as to prevent uncertain interpretations of existing laws and avoid "administrative misunderstandings" in the path to achieving the ambitious EU objectives and the projected "macroscopic" developments in the bioenergy sector.

Today's projections clearly show that a predominant role shall be played by "solid biofuels" not only for heat production (firewood, chipped wood and pellets) and electricity/cogeneration (chipped wood), but also for the production of "second " generation biofuels (chipped wood).
Definitions, production features and technical specifications of solid "biofuels" are provided in detail in Addendum A2.4.

2.2) ENERGY CONVERSION TECHNOLOGIES AND EFFICIENCY OF USE

A wide range of technically and economically mature technologies for biomass conversion into energy is available in Italy today. Some of these technologies produce heat and electricity independently or through co- and trigeneration; others produce intermediate energy carriers mainly for transport. Innovative technologies with the same end use are at an advanced stage of development. Brief mention is made hereinafter of the conversion technologies used in Italy; for a detailed description of the said technologies reference can be made to specialised publications. However, efficiency of use can be assessed by taking account of the entire supply chains, rather than single technologies. Biomass types and their conversion processes can be summarised as reported in the figure (page 22).

The outlined picture shows that in the future it may be convenient, for instance, to produce bioethanol from the bacterial degradation of sugars contained in woody biomass in the form of cellulose and hemicellulose, or (which is already being done) generate electricity from vegetable oil combustion, etc.

The activation of any kind of supply chain for biomass energy production requires an in-depth study of the local context where the chain is to operate. The features of the biomass supply chain system determine the choices to be made for the correct management and integration of the entire production process, which ranges from biomass supply (cultivation and/or harvesting, transport, storage), to transformation (chipped wood, pellet, vegetable oil, biodiesel, bioethanol, biogas, etc.) up to energy conversion (heat, electricity, transport, etc.).

A distinct feature of bioenergy supply chains is their degree of complexity. There are the so-called "farm supply chains" and "industry supply chains".
The farm supply chains can be developed in the agro-forest sector, at farm or small district level. Today's most developed farm supply chains (which are easier to set up because they require smaller investments) are those based on small- and medium-scale production of electricity, heating or biofuels by agricultural companies. This means that a step further beyond traditional agro-forest productions has been made by developing agro-energy companies that can supply heat, produce electricity, etc. Owing to the deep interest that these chains have raised, the following technologies have reached high levels of maturity:

> small domestic heating boilers from solid biofuels;
> district heating from solid biofuels;

2. Resources/ Efficiency

TYPES OF BIOMASS AND THEIR ENERGY CONVERSION

TYPE BIOMASS	CONVERSION PROCESS	PRODUCT	USAGE
WOODY MATERIAL and dry fraction of urban solid waste $H_2O \leq 35\%$ C/N>30	Combustion	Heat	Heating Electricity
LIQUID WASTE and wet fraction of municipal solid waste $H_2O > 35\%$ $20 \leq C/N \leq 30$	Anaerobic digestion	biogas 60% methane	Heating Electricity
SUGARY, STARCHY and cellulosic materials urban solid waste $15 \leq H_2O \leq 90\%$ ANY C/N ratio	Fermentation of sugars in ethylic alcohol	Bioethanol and by-products	Petrol-fuelled engines
OLEOPLANTS $H_2O > 35\%$	Oil estherification	biodiesel	Diesel-fuelled engines

> electricity from solid biofuels;
> electricity from liquid and gaseous biofuels;
> electricity and co-generation from solid biofuels ;
> electricity and co-generation from liquid and gaseous biofuels;
> trigeneration from solid biofuels;
> trigeneration from liquid and gaseous biofuels.

Industry supply chains are, on the other hand, based on a close relation between the agriculture/forest sector and the industrial sector and require greater levels of organisation, and also the strong involvement of administrations. These chains, which are wanted by policymakers and stakeholders, often fail to develop because of the lack (up to the present day) of practical, widespread national energy planning. These supply chains can hardly grow or develop if they are not supported by significant and reliable financial aid, at least in the kick-off phase. A clear example of the current situation is given by the quantity of biodiesel that is exempt from the excise tax: the quota changes every year according to the financial law that is passed, thus hindering the industrial production of a biofuel that is technically mature for the market. Despite the mentioned difficulties, the main agro-industrial supply chains in Italy today focus on:

> industrial-scale production of electricity from solid and liquid biofuels;
> production of biodiesel;
> production of bioethanol.

Second and third generation biofuels may become available in the near future:

> ethanol from lignocellulosic biomass;
> biomass hydrogen;
> BTL (Biomass to Liquid);
> BTG (Biomass to Gas).

The assessment of the efficiency of use of supply chains leads to the considerations that are reported hereinafter.

2.2.1) THERMAL SUPPLY CHAINS

They are the most common supply chains and are usually considered as "farm supply chains". They are mainly related to solid biofuels (firewood, pruning, chipped wood, pellet), and marginally use gaseous biofuels (biogas) and liquid biofuels (vegetable oils). Biogas and vegetable oils are today more suitably developed (due to their many energy options) through combined energy generation (cogeneration) and for the mechanical energy sector (transport). This concept can be further clarified by saying that the "added value" biogas and vegetable oils acquire during their conversion processes from biomass qualifies them for more noble uses, such as electricity and/or mechanical (transport) production. Hence, this added value should not be "wasted" for mere heat production. That is why this paragraph shall not deal with supply chains producing heat from biogas and vegetable oils, even though their use for heating purposes is in some cases cost-effective, such as in the case of biogas plants annexed to cheese factories.

Despite the already widespread development of wood and pellet fuelled heating equipment, it is very important to underline their efficiency. Woody biomass is an endless energy resource that needs to be exploited in the best way possible. It has also been noticed that its cost is in some way related to fossil fuel prices. Its "cost-effective" use thus requires maximum "supply chain" efficiency from biomass growth, collection and transport to end use (plant yield, final user management).

With regard to the efficiency of use, the heating sector (household, industrial and district heating systems) is the most heterogeneous sector not only for the widespread distribution network across the country, but also for their good yields and reliability.

2. Resources/ Efficiency

Clearly, small systems, despite being significant in terms of quantity, have on average relatively low yields (30-35%). Such values clash with the advanced technological development of modern inverse flame boilers, chipped wood and pellet fuelled boilers that have very high yields (up to 90%).
Nonetheless, in Italy there are about 6 million low-efficiency or even obsolete heating devices (old stoves, fire places, cheap kitchens, etc), with an overall installed power of about 30,000 MW th (Source: ITABIA, European Project K4 RES-Heat).
The installation of modern biomass boilers should be strongly promoted also through incentives for replacing old wood-fired boilers, which today give the highest contribution in terms of primary energy (approx. 4 Mtoe) over the total consumption of primary energy in Italy (approx. 200 Mtoe).
Biomass district heating installations, on the other hand, are made up of highly technological and innovative systems that offer high energy yields and remarkable savings both for the cost of the raw material used and for the management and maintenance of the system.
To date, district heating systems have been installed mainly in Northern Italy, but interest on these systems has recently started to grow in Central and Southern Italy.
The following paragraphs provide an outline on the efficiency of technologies used in heat supply chains.

HEATING

Manual feed biomass boilers (firewood, pellet) for household heating (thermal output up to 100 kW)
Small biomass boilers today are guaranteed by the manufacturer for a nominal efficiency value (heating yield) of up to 80%- 90%.
The actual energy yield (annual average) depends on several factors, such as correct boiler size and the conditions under which it is used.
The actual energy yield differs from the nominal yield if the boiler output is significantly lower than the nominal yield for long periods of time, or if the fuel used is not homogeneous and/or has a relative moisture content above 50%. The actual (annual average) yield must not be lower than 60-70%.
Automatic feed biomass boilers (pellet or chipped wood) for household/district heating/production (thermal output up to several MW).
Automatic feed boilers today can be guaranteed by the manufacturer for a nominal yield that is not lower than 85-90%.
Boilers with an output above 100 kWt are usually fed automatically using chipped wood that is obtained from the mechanical grinding of wood residues that have to be stored indoor for better drying. The actual (annual average) yield of these boilers should not be lower than 80-85%.
The overall actual yield of district heating systems (boiler + network) should not be lower than 75%-80%, on account of the heat that may be lost along the heat distribution network.

HEATING AND COOLING

Manual or automatic feed biomass boilers and absorption machine for domestic heating/cooling (output from 35 kW up to several MW).
A heating and cooling system using solid biomass is made up of two main components:
> Hot water boiler.
> Lithium bromide refrigerating absorption machine.

The biomass boiler that is used for heating in winter is turned on in summer to power the refrigerating absorption machine.
The reason why lithium bromide machines are mentioned (rather than ammonia machines) is because their process cycle does not require high temperatures (steam or diathermic oil boilers) but can be powered by standard hot water boilers.
Hot water temperatures in the absorption cycle in fact ranges between 75°C and 95°C.
The refrigerated water produced from the evaporator has a temperature of 7°C, which is particularly suitable for air cooling processes.
Lithium bromide refrigerating absorption machines available on the market vary in size and output, ranging from a minimum output of 20 kW to up to 200 kW (greater outputs are usually achieved by installing more machines in parallel , powered by one centralized biomass boiler).
These machines work correctly if coupled with a biomass boiler with a heating output that is 1.6 times higher. The overall actual efficiency of the heating/cooling system depends on the number of operation hours in summer and winter: if the system runs for the same number of hours in summer and in winter, its annual actual efficiency is about 15% lower than the efficiency of a boiler that is solely used for heating. This is due to the heat loss that occurs in the absorption machine's refrigerating tower.
The ratio between the refrigerating output produced by the machine and the heat input from the boiler quantifies the machine's performance: the efficiency value, known as COP (Coefficient of Performance) is usually 0.7 and indicates that 1.43 kWh of heat are needed to produce 1 kWh of cool air.

2.2.2) ELECTRICITY SUPPLY CHAINS, COGENERATION AND TRIGENERATION

While thermal supply chains are almost all considered as "farm chains, electricity and/or cogeneration supply chains are "farm chains" for small plants (electricity output < 1 MW) and "industry-based chains" for plants with greater output capacities. Effi-

2. Resources/ Efficiency

ciency of conversion processes and supply chains is as important in the production of electricity as it is in thermal production. Combined thermal and electricity production is preferable, because it favours an optimal use of biomass, it is eco-friendly and cost-effective, despite the higher initial investment costs.
With regard to the supply of electricity, the larger plants (>1 MW), most of which were set up in line with provision CIP 6/92, favoured the production of electricity alone and achieved a primary energy conversion efficiency of no more than 20-25%, based on Rankine cycle technologies (water steam). The average biomass (relative moisture 35-45%) consumption of these plants amounts to approximately 1.3-1.5 t for produced MWhe .
Following the expiry of CIP6 and the introduction of Green Certificates, the "rush" towards the exclusive production of electricity has waned and awareness of the potential offered by cogeneration has been growing, also with a view to improve the cost-effectiveness of initiatives.
The use of cogeneration should be pursued with resolve, in order to increase the amount of useful final energy (electricity + heat) and overall conversion efficiency: this would mean respecting the principle that biomass is not an endless resource and must therefore be used as efficiently as possible.
The following paragraphs report on the technological resources of the electricity/cogeneration supply chain and the various conversion processes.

ELECTRICITY

This paragraph takes account of the supply chains for the production of electricity from solid, liquid and gaseous biofuels.

Generation of electricity from solid biofuels

The production of electricity from solid biofuels is based on two consolidated technologies:

- > Boiler for steam production.
- > Turbine coupled with alternator.

Steam production occurs through two main conversion processes that vary according to plant size.

» **Small plants** (< 1 MWe): diathermic oil boiler using ORC cycle (Organic Rankine Cycle)
Today's preferred technology for the production of electricity in small/medium-sized plants is the one offered by the Italian company Turboden which combines a diathermic oil boiler with an organic fluid turbogenerator. The output capacity available on the market ranges between 200 kWe and 2000 kWe.
In the ORC, the turbogenerator uses the hot diathermic oil to pre-heat and vaporise an organic fluid that activates the turbine, which is coupled with the electrical alternator.
The electrical efficiency of these systems ranges between 15% and 18%, depending on size. These systems, if not operated in cogeneration, can only be cost-effective and thermodynamically efficient if installed in decentralised areas, that are close to the national electricity grid and where large quantities of biomass are available. Given the high, initial investment costs of these plants, it is important to rely on the state incentives granted per kWhe produced (GC or all-inclusive tariff), in order to achieve an economic return.
There are also other technological resources, which are still being developed, for small electricity production plants (< 200 kWe): they are based on Stirling engines and on the gasification of solid biofuels whereby gas combustion occurs in micro-gasturbines.

» **Medium and large plants** (> 1 MWe) : Water steam boilers.
Medium and large electrical power plants exploit long-established technological resources. This process is used by the main power plants (from 1 MWe up to 40 MWe) where the simultaneous application of cogeneration rarely occurs, because there is not a sufficient number of users who would make use of the significant quantities of residual heat that is wasted from the electricity production process.
The cycle's electrical efficiency is much higher than that of ORC plants and given that plants are larger in size, remarkable economies of scale can be achieved on investment unit costs.
Economic profitability strictly depends on the cost of the biofuel (which is not always available locally) and national incentives.
The most common combustion technology used today in water steam generators (boilers) is the mobile grid, which, compared to fluidized bed boilers, is more reliable in terms of operation, but is less efficient in terms of combustion and emission control (NOx, CO, etc.).
These plants need to achieve maximum net electricity yields, due to their high investment costs and the use of large quantities of biomass (they operate on a continuous all-year-round production cycle). Since fuels are never completely homogeneous, balanced process solutions (e.g. steam at 450°C and 50 bars) need to be implemented, so that plants can even work for 8000 hours/year with a 25% electricity yield, and biomass types other than chipped wood (e.g. olive residues, grapeseed flour, husk, etc.) can be used, without posing any risk to plant operation. More "extreme" process parameters (e.g. steam at 520 °C and 90 bars) provide higher yields (up to 30%) but also entail greater risks, because plant operation may have to be stopped to perform maintenance work due to corrosion or excessive fouling.

2. Resources/ Efficiency

Generation of electricity from liquid and gaseous biofuels

A plant producing electricity from liquid biofuels (vegetable oils) or gaseous biofuels (biogas) is made up of the following main components:

> Internal combustion engine.
> Alternator.

Depending on plant size, power outputs range between 50 kWe to about 20 MWe. Small output plants usually work at high speeds (1,500 spins/min), while bigger output plants work at average-low speeds. Flue-gas contain high NOx and CO levels. However, according to current laws, the flue-gas emitted by engines with an output of <1 MWt (350 kWe) are not significant, whilst treatment processes need to be implemented when bigger engines are used, so as to prevent emissions from exceeding allowed limits (legislative decree 152/2006).

Small and medium plant supply chains are interesting and their main features are:

- integration of both field and farm activities;
- proximity to the electricity grid and to users who have significant and varied electricity demands, and constant improvements aimed to enhance district energy self-sufficiency and, in general, rationalize energy supply and management;
- availability of land (used or usable in the short term) for dedicated crop growth.

Generally, these plants produce electricity using their own "home-produced" biofuels. For the plants, this means developing other interesting activities which can be mainly carried out during period of low field work (cold seasons) and help improve the use of farm resources.

These supply chains are efficient and their electricity efficiency is definitely higher than that of solid biofuel supply chains.

Their yield can be summarized as follows, in relation to their size range:

From **50 kWe** to **350 kWe**	32%
From **350 kWe** to **1 MWe**	36%
From **1 Mwe** to **10 MWe**	40%
>10 MWe	45%

These supply chains are also cost-effective not only because they have a higher electricity yield, but also because their plant unit investment cost (per kWe of installed power) is definitely lower. However, the cost of vegetable oils used to fuel the engine is about three times higher (in terms of primary energy content) than the cost of solid biofuels (chipped wood).

COGENERATION

Decision AEEG 42/02 and legislative decree 20/2007 set the parameters of fossil fuel "cogeneration" plants:

> Thermal Limit (TL) - the ratio between useful thermal energy produced and the sum of useful thermal and electrical production. It expresses the amount of useful thermal energy produced over total useful production (electricity + heat).

> Energy Saving Index (ESI) - the ratio between total primary energy consumed and the sum of specific primary energies related to useful electricity and heat production. ESI expresses the percentage of energy saving that is achieved by producing the same amounts of useful electricity and heat using one single process (cogeneration) instead of two distinct processes.

The said norms state that a new thermal-electrical plant, fed by fossil fuels, can benefit from the advantages granted to cogeneration if:

> LT > 30%
> IRE > 10%

There are, as yet, no similar rules for biomass cogeneration plants, but it would be reasonable to develop future bioenergy incentives in line with the above-mentioned parameters.

It is important to point out that the TL and ESI parameters do not concern the overall energy efficiency of conversion processes, but are useful in determining whether a cogeneration or trigeneration process can be considered as such and can thus benefit from financial incentives. The most common cogeneration supply chains concern solid, liquid and gaseous biofuels.

Cogeneration from solid biofuels

An electricity plant fuelled by solid biofuels is composed of three main

EXAMPLE: PLANT WITH 5 MW PRIMARY ENERGY (ORC TURBOGENERATOR - 20% ELECTRICAL EFFICIENCY)

FEATURES:
1 MWe available output (electrical power) for grid connection.
3 MWt available output (thermal power) for heat users.
1 MW (losses and self-consumption).
On-grid electricity production with yearly operation of 7,500 hours: 7,500 MWhe.
Potential heat production with yearly operation of 7,500 hours: 22,500 MWht
Hypothesis of actual annual production of useful thermal energy for 1100 hours: 3,300 MWht.
TL = 3,300/(7,500 + 3,300) = 30.5%
ESI = 10%
Clearly, even a limited thermal exploitation of 1,100 hours/year has a TL > 30%.
If all potential thermal energy was exploited, the TL would be 70% and ESI 43%, which are the maximum values of both parameters that can be achieved with ORC.

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components:
> Steam boiler.
> Turbine coupled with alternator .
> Heat recovery circuit. from the turbine condenser.

A biomass-fuelled cogeneration plant is made up of the same elements of a plant producing only electricity , plus the heat recovery circuit which is, in practical terms, a second boiler.
Hereinafter is an analysis of the TL and ESI values of a cogeneration plant that has an all-year-round continuous electricity production.
The overall efficiency of ORC cogeneration strictly depends on the number of annual hours in which useful thermal energy is used, and can range between a minimum of 30% and a maximum of 70%.

Cogeneration from liquid and gaseous biofuels

An electricity plant using liquid biofuels (vegetable oils) and/or gas biofuels (biogas) comprises the following main components:
> Internal combustion engine (Diesel cycle).
> Alternator.
> Heat recovery circuit from exhaust gases and cooling water.

The overall efficiency of cogeneration using a Diesel cycle, strictly depends on the number of annual hours in which useful thermal energy is used, and can range between a minimum of 50% and a maximum of 85%.

The reason why TL and ESI values obtained with the Diesel cycle are lower is due to a higher electrical yield and a lower amount of residual heat.

TRIGENERATION

The supply chains for the combined production of electricity, heat and cooling from solid, liquid and gaseous biofuels are not as yet very common, but the technology is consolidated.
The installation of a trigeneration plant is an excellent solution to meet the strong demand of thermal energy both in winter (heat) and in summer (cooling). The Thermal Limit (TL), the Energy Saving Index (ESI) and overall efficiency of trigeneration plants are by far better than those achieved with cogeneration only.
Trigeneration overall efficiency and cost-effectiveness increases (compared to cogeneration) with the increase in the number of operation hours of the absorption machine during the summer months .
The largest plant size is 5MW primary power: it is relatively easy to find users that require this power output of thermal/cooling energy that is obtained after the plant's production of electricity, which is in any case supplied to the national grid.
Using the heat/cold produced is a very important eco-friendly move, because it allows to make the most of the energy content of the biomass used for the same amount of emitted CO_2.

Trigeneration from solid biofuels

This type of plant comprises:
> Steam boiler.
> Turbine coupled with alternator.
> Heat recovery circuit from the turbine condenser.
> Absorption machine.

This type of plant has the same components that are found in a cogeneration plant, plus a refrigerating absorption machine. The considerations made in the paragraph on "Heating and cooling" (2.1.1) also apply to this technology, for the output range available on the market (from minimum 20 kW to up to about 200 kW) and for their correct operation which requires the use of a co-generator (turbine coupled with alternator) with an available thermal power output that is at least 1.6 times the nominal refrigerating power of the absorption machine.
In this case too, overall efficiency of the heating/cooling system depends on operation hours in summer compared to winter: with the same working hours in summer and winter the

EXAMPLE: PLANT WITH 5 MW PRIMARY ENERGY (DIESEL ENGINE WITH ALTERNATOR)

FEATURES:

2 MWe available electrical power output for grid connection.
2,5 MWt available thermal power output for heat users.
0,5 MW (losses and self-consumption).
On-grid electricity production with yearly operation of 7,500 hours: 15,000 MWhe.
Potential heat production with yearly operation of 7,500 hours: 18,750 MWht.
Hypothesis of actual annual production of useful thermal energy for 1,100 hours: 2,750 MWht
TL = 2,750 / (15,000 + 2,750) = 15.5%
ESI = 8%
It is worth remarking that cogeneration plants operating with liquid/gaseous biofuels ((Diesel cycle) and having the same cogeneration structure (installed power and annual hours of useful heat production), obtain a TL value of 15.5% as opposed to 30% achieved with solid biofuel cogeneration, and an ESI value of 8% against 10% of solid biofuels. If all the potential thermal energy was exploited, the achieved TL would be 55% and ESI 40%, which are the maximum values of both parameters that can be achieved with a Diesel cycle.

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actual overall annual efficiency is about 15% less,, due to the heat loss that occurs at the refrigerating tower during the summer months.

Trigeneration from liquid and gaseous biofuels
The main components of this type of plant are:
> Internal combustion engine.
> Alternator.
> Heat recovery circuit from exhaust gases and cooling water.
> Absorption machine.

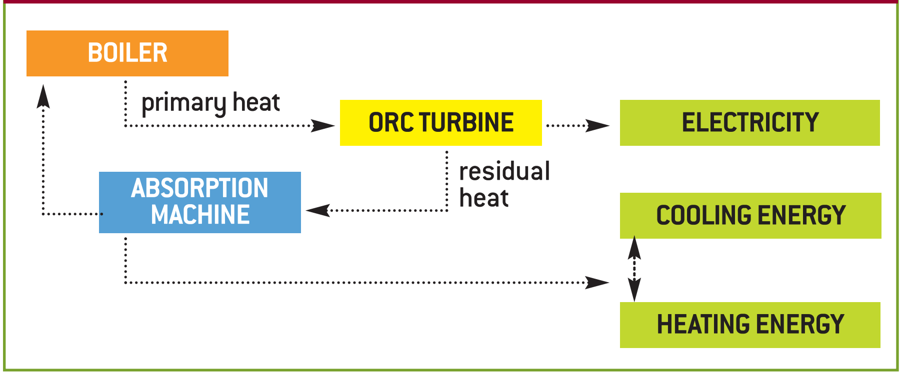
This type of plant is made up of the same components that are found in a cogeneration plant from liquid and gaseous biofuels, plus a refrigerating absorption machine. The latter has the same features outlined in the paragraph above, both with regard to machine size available and their correct operation, which requires the use of a co-generator (turbine coupled with alternator) with an available thermal power that is at least 1.6 times the nominal refrigerating power of the absorption machine. In this case too, overall efficiency of the heating/cooling system depends on operation hours in summer compared to winter, as described above for solid biofuel trigeneration.

2.2.3) BIOFUEL SUPPLY CHAIN

The main biofuels that can also be used in the transport sector, as laid down in Directive 2003/30/CE, are:
> Bioethanol and bio-ETBE
> Biomethanol and bio-MTBE
> Biodiesel
> Biogas
> Biohydrogen

Recent studies and analyses have shown that bioethanol for ETBE production and biodiesel are the biofuels that rely on the most mature production technology for their industrial and market exploitation in the short-medium term.

SIMPLIFIED SCHEME OF TRIGENERATION PLANT FROM SOLID BIOFUELS



BIOETHANOL
Ethanol can be produced by chemical synthesis from a fossil source or by fermentation from biomass materials. The latter process leads to the production of the so-called bioethanol. The raw materials used for ethanol production belong to the following categories:
> Agricultural crop residues.
> Forest residues.
> Temporary and occasional agricultural excess.
> Processing residues from agro-industry and agro-food industries.
> Dedicated crops.
> Urban waste.

Depending on their nature, the raw materials can be classified into three separate groups:
> Sugary materials: substances rich in saccharose, such as sugar cane, beet, sugary sorghum, fruits, etc.
> Starchy materials: substances rich in starch such as wheat, maize, barley, grain sorghum, potato, etc.
> Lignocellulosic materials: substances rich in cellulose, such as straw, maize stalks, woody residues, etc.

The most widely tested and used dedicated crops are sugar cane (see the brazilian experience), wheat and maize.

The raw materials that are currently used in Italy for bioethanol production (only occasionally addressed to the energy market) are dregs of pressed grapes, excess wine, fruit and vegetables that have been withdrawn from the market.
In the absence of a real market for dedicated crops, other types of crops such as beet, sugary sorghum and topinambur have been tested with interesting results.
Many expectations in terms of cost-effectiveness and energy-efficiency are placed on the production of second-generation bioethanol from lignocellulosic materials, which would reduce the cost of the raw material to 20-30% over the total process cost, compared to the 60-70% that is achieved with the other materials. Moreover, agricultural, forest and agro-industry residues, together with the highly productive yields of lignocellulosic crops, would require the exploitation of remarkably lower portions of agricultural land, thus avoiding any competition between food and energy crops.

The use of these raw materials is not yet widespread, because complex and expensive technologies are needed. In fact, bioethanol production from these materials is more complex than that obtained from sugary materials. The substances containing lignin, cellulose and hemicellulose need to be pretreated before fermentation and this can be achieved through different processes: a chemical process (basic or

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acid hydrolysis) or a microbiological process. Detoxification is the next step which removes the hemicellulose, organic acids and phenolic compounds that are produced during the previous phase. The final phase is hydrolysis, which separates the complex lignocellulosic structure into monosaccharides that provide a good substrate for alcoholic fermentation, which is followed by distillation and finally bioethanol is obtained.
The efficiency and economic convenience of the process described needs to be improved and the industrial sector is focusing its attention on this. Many large companies (especially in the USA) are working on experimental projects. The European Commission has projected that by 2020 about 30% of biofuels will be second-generation biofuels.

BIODIESEL

Biodiesel is a methyl ester of fatty acids of vegetable and/or animal oils, produced via transesterification, whereby vegetable oils react with excess methyl alcohol, in the presence of an alkaline catalyst.
The final product is a mixture of some (6-7) methyl esters, which does not contain sulphur and aromatic compounds, but contains large quantities of oxygen (no less than 10%) and can be used as fuel for transport and heating, either alone or mixed with diesel fuel.
Biodiesel mixed with diesel can be used in diesel engines in volumes comprised between 2 and 30% , without the need to modify the engines.
Pure biodiesel used as fuel for transport may require engine modification, due to its lower calorific value.
The by-product of the transesterification process is glycerol (commonly known as glycerine), which, once refined, is sold to pharmaceutical and cosmetic industries.
The raw materials used for biodiesel production can be divided into two main categories:
a) Oils from widespread crops with high content of oleic and/or erucic acid (e.g. soy oil, rapeseed oil, sunflower oil, palm oil, coconut oil and castor oil);
b) Exhausted vegetable oils and/or other waste or recovered fatty materials.
The category b) materials are not currently being used on an industrial scale, but some experimental or demonstrative applications are being tested.
The main raw material used worldwide is rapeseed oil. This is due to several reasons: other raw materials are more expensive and have limited availability; diesel engine manufacturers are sceptical about the use of biodiesel produced from vegetable oil with high iodine content and from exhausted and fatty oils.
This situation has been "ratified" by the standards set by the European Committee for Standardization. To meet such standards, biodiesel producers must use rapeseed oil or a blend of oils containing at least 50-60% in weight of rapeseed oil. The simplified mass balance equation of the whole process is as follows: 1,000 kg of refined oil and 100 kg of methanol produce 1,000 kg of biodiesel and 100 kg of glycerine.
Since a high rate of conversion into methyl ester is generally obtained (if possible above 97%), phospholipids and mucilage need to be eliminated and oil acidity levels need to be kept as low as possible.
Efficient biodiesel supply chains (just like bioethanol) focus greatly on innovative technologies, also with the aim of limiting the portions of agricultural land to be dedicated to the cultivation of energy crops. Europe would need 24 million hectares of land cultivated with rapeseed, or 18 million hectares cultivated with sunflower, to be able to produce the quantity of biodiesel needed to replace 10% of diesel fuel used for transport. Only 4 million hectares of land would be needed if cultivated with Arundo donax (common cane) for biofuels that can be obtained via innovative "biomass to liquid" processes. Algae are another highly promising material: experiments have shown that their oil yield can be of about 50% of the biomass of origin and they can have a potential annual production capacity that is 10 to 20 times higher than that of traditional oleoplants.

BIOGAS

Over the past ten years anaerobic digestion has become one of the most extensively treatments used in many European Countries, including Italy, to produce renewable energy in the form of biogas. The main raw materials used in biogas production are:
- Animal manure.
- Agricultural residues.
- Agro-industry waste.
- Dedicated crops.
- Organic fraction of urban solid waste (FORSU).
- Sewage sludges.

In the agricultural sector, anaerobic digestion is particularly important in the treatment of animal manure because it reduces odour emissions and achieves a balanced nitrogen load in the biomass, prior to its agronomic use. Today, perspectives for the agricultural world have become broader, because biogas can also be conveniently produced from vegetable biomass that is cultivated for this purpose.
The recovered biogas has a lower calorific value ranging between 4,000 and 6,000 kcal/Nm^3 and can be used for several purposes:
- Production of electricity and/or heating, both for self-consumption and distribution, generally using internal combustion engines, fed by biogas and coupled with electrical alternators and heat recovery circuits.
- Use in gas-fuelled engines for transport, after purification and upgrading to biomethane.

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> Use of synthesis and/or hydrogen gases, through catalyzed processes similar to those used for methane (partial catalytic oxidation).

In Italy, the first category is extensively widespread, whereas the other two are at a testing or demonstration stage.

The use of biogas upgraded to purified methane (95-98%), which is biomethane, is widely used in many European countries in the transport sector to fuel vehicles that run on natural gas or fossil methane. Biomethane is an energy-efficient fuel that burns in engines in an efficient way, reducing direct CO_2 emissions by 20% compared to petrol and by 5% compared to diesel.

However, the beneficial environmental impact of biomethane on greenhouse gas emissions needs to be assessed over the entire lifecycle of biomethane. Firstly, it is a renewable fuel and secondly its CO_2 emissions over its lifecycle are very low; finally, it eliminates methane dispersion due to natural decomposition, since it derives from organic matter. These effects, combined together, favour a more than 100%-reduction of CO_2 equivalent compounds. Depending on the basic substrate that is used for biomethane production, the reduction of CO_2eq emissions ranges between 75 and 200%. Biomethane emissions meet air quality standards. Biomethane combustion produces low particulate levels and its NO_x levels are also acceptable if flue gases are treated with specific devices. Biomethane vehicles generally meet the strictest European legal emission limits (Euro V and EEV for Bi-Fuel vehicles, Euro IV for dual-fuel vehicles). Recent technological developments are expected to bring better environmental performances.

Economically speaking, the most reliable data regarding the cost of biomethane come from the Swedish market where biomethane is widely used in the transport sector and costs vary between 0.65 and 0.75 €/l excluding tax. The unitary production cost amounts to 0.47-0.57 €/litre of diesel equivalent, compared to a fossil diesel cost of 0.75 €/litre (excluding tax). Taxes on bimoethane are lower than traditional fuels, so its use can be cost-effective. Nonetheless, biomethane vehicles are still more expensive than conventional vehicles, but prices are expected to drop with their expansion on the market.

2.2.4) SOME CONCLUSIVE REMARKS ON THE CHOICE OF SUPPLY CHAIN

Briefly, the efficiency of biomass to energy conversion can be summarized as in table below. In most cases, it is difficult to say a priori which is the best supply chain to be used for a specific kind of energy conversion. It is much easier to do it if the plant site, geoclimatic area and district in which the supply chain has to be operated are known. These aspects are mainly related to the following variables:

> availability of biomass and thus agricultural and forest production (affected by orography, climate, soil, water availability, average size of farms, etc.);

> harvesting, transport and storage costs (which vary according to conversion plant size, level of mechanization, degree of third-party contractorship, existing infrastructures, etc);

> existence of heating and/or electricity users and their annual demand (load curves);

> factors affecting energy conversion (yields, size and type of plant, etc.);

> factors influencing emission control and management (climate, biomass type, conversion process, technologies for flue gases treatment, ashes, etc.).

The next chapter will outline the situation of operational bioenergy plants in Italy today, providing an indication of economic estimates and some remarks on possible future trends.

EFFICIENCY OF BIOMASS TO ENERGY CONVERSION	
Single heating households	70-85 %
District heating	75-90%
Heating and cooling	55-70%
Bioelectricity from solid biofuels	15-30%
Bioelectricity from liquid and gaseous biofuels	32-45%
Co-generation from solid biofuels	30-70%
Co-generation from liquid and gaseous biofuels	50-85%
Tri-generation from solid biofuels	15-55%
Tri-generations from liquid and gaseous biofuels	35-70%

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A2.1] CURRENT USE OF RESIDUES FROM AGRICULTURAL CROPS AND RELATED INDUSTRIES

CROPS	RESIDUES	USE	PERCENTAGE OF USE
HARD AND	Straw	> Animal bedding	40-50 %
SOFT WHEAT		> Animal food	5-10 %
		> Paper industry and other	5-10 %
		> Burnt in the field	30-40 %
BARLEY	Straw	> Animal bedding	40-50 %
		> Burnt in the field	50-60 %
OATS	Straw	> Animal food	40-60 %
		> Burnt in the field	40-60 %
RICE	Straw	> Animal bedding	20-30 %
		> Burnt in the field	70-80%
GRAIN MAIZE	Stalks (stems);	> Animal bedding (stalks)	40-50 %
	Cobs (ear axes)	> Animal food (stalks)	10-20 %
		> Ploughing (cobs)	70-80 %
SUGAR BEETROOT	Leaves	> Animal food	10-20 %
		> Ploughing	90-80%
TOBACCO	Stalks	> Ploughing	100%
SUNFLOWER	Stalks	> Ploughing	100%
VINE	Shoots (Branches)	> Ploughing	30-40 %
for wine and grapefruit		> Burnt in the field	30-40 %
		> Fascine da ardere	20-40 %
OLIVE TREES	Wood, branches,	> Energy (wood);	90-100 %
	fronds	> Burnt in the field (branches)	90-100 %
FRUIT TREES	Branches	> Ploughed (on lowland)	10-20 %
(apple, pear, peach trees, etc.)	> Burnt in the field	80-90%	
CITRUS TREES	Branches	> Burnt in the field	90-100 %
(orange, lemon trees, etc.)			
NUT TREES	Branches	> Burnt in the field	90-100 %
(almond, hazel, walnut trees)			

A2.2] YIELD BY HECTARE OF SOME AGRO-ENERGY CROPS

MAIN CARBOHYDRATE CROPS

CROPS	t/ha OF SUGARS Current	t/ha OF SUGARS In 5/10 years time	AREA	PROBLEMS
MAIZE	5-8	8-12	Irrigated lowland	Food competition
WHEAT	4-7	7-10	Dry lowland/hills	Food competition
SUGARY SORGHUM	7-12	12-20	Irrigated lowland	Short harvesting period
BEET	5-10	10-15	Irrigated lowland	Short harvesting period, costs
TOPINAMBUR	5-8	8-15	Dry hills	Difficult rotation

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A2.2) YIELD BY HECTARE OF SOME AGRO-ENERGY CROPS

MAIN OILSEED CROPS

CROPS	t/ha OF OIL		AREA	PROBLEMATICHE
	Current	In 5/10 years time		
SUNFLOWER	0,8-1,2	1,2-1,8	Clayey soils	Choice of varieties
RAPE	0,6-0,9	0,8-1,5	Centre-north	Adaptation, choice of varieties
SAFFLOWER	0,5-0,8	1,0-1,6	Centre-south	Adaptation, mechanization

Source: ITABIA elaboration from INEA data

MAIN LIGNO-CELLULOSIC CROPS

ANNUAL			
Fibre sorghum	15-20	20-30	Soil exploitation
PERENNIAL			
Arundo donax	20-22	30-35	Limited tests
Miscanthus	15-20	20-30	Limited tests
Broom	6-8	8-12	Harvesting
Cynara card.	10-12	12-20	Variable yields
SRF	10-16	15-25	Tehcniques to be developed, transplantation costs

Source: ITABIA elaboration from INEA data

A2.3) TECHNOLOGIES FOR BIOMASS COLLECTION, PRE-TREATMENT AND TRANSPORT

Woody biomass can be obtained from different sources, such as residues from first conversion wood industry (sawmills, furniture factories and joineries), woods, agricultural crop residues and dedicated woody crops.

COLLECTION AND PRE-TREATMENT**

Industrial waste collection is the simplest way of collecting residues, because waste simply needs to be chipped and transported to the energy conversion plant. These two operations can also be performed in reversed order, that is by transporting wood to the conversion plant where it is then chipped. The latter operation is often carried out in special intermediate transfer stations, so the material is transported twice: in bulk from the site of origin to the transfer stations and in the form of chips from the transfer stations to the plant. Regardless of the place where the material is processed, chipping is the main operation in both cases , which is done with either a chipper or a grinder. The main difference between the two machines is the chipping device, which are sharp blades (knives) in the chippers and non-sharp rounded tools (hammers) in the grinders. Chippers produce higher quality material and consume less energy, but their blades are very sensitive to stones, metal and soil particles. If the wood to be chipped contains these elements, it is best to opt for a grinder, despite the lower quality end product.

Collecting residues from **woods** is a much more complex operation, because working conditions can vary greatly and woods also offer a very vast array of materials - firewood and chipped wood - with highly different features and costs. With regard to the supply of wood for energy, woods can be divided into two great categories: those directly producing wood for energy and those producing other wooden primary products from which wood for energy can be obtained as a process by-product .

The former category comprises young woods, mainly **coppices** and young plantations, where a correct forest management requires their thinning in order to ensure good development and more resistance to adverse conditions. This practice can be performed in different ways, according to available working conditions. Short-wood operations involve the cutting of trees, their conversion into logs and successive transportation to the truck road. These operations can be carried out either by hand with chain saws and tractors or by some mechanized processor such as harvesters and forwarders. On the other hand, whole-tree operations log trees on the truck road, which means whole trees are to be transported to the road. The transportation can be done using different types of machines, the most mechanized being fellers and skidders. Advanced machines are available in different sizes and

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are not necessarily big and heavy. There are mini-fellers and mini-processors that rely on the best technology from Scandinavia or North-America and are very light and cheap. Their weight and cost are less than half of those of the most common commercial models.

In woods with greater value (**higth forests**), that is those exploited for hardwood log production, there are large quantities of residues, such as branches and tops, that are left over from tree cutting and can be a source of energy biomass. Residue collection is usually carried out in two phases: firstly, trees are cut into logs which are then transported out of the woodland; secondly, the branches and tops left over on the ground are collected. During the second phase, the material is chipped either on site or on the banking ground. On-site chipping requires the use of a self-propelled chipper, which may have an built-in container or may be flanked by a tractor with a large container with high sides. When the container is full, the machine returns to the banking ground and unloads the material on the ground or in a truck road container. The reverse order is followed when the branches are loaded on a container and carried to the banking ground to be chipped and then loaded directly onto a truck. A third option consists in compressing and tying the branches in cylindrical packages, which have similar shapes and sizes than the logs. This operation allows to transport residues with the same machines used to transport logs, without having to use too many machines.

Residues can also be collected in another way, that is by hauling whole trees and cutting them on the banking ground, where the wood for industry and residues for energy purposes are separated - the former is loaded onto trucks and transported to the wood factory, the latter is chipped and transported to the energy conversion plant. Integrated collection is a cost-effective operation and it is often the only way to obtain the residues from mountain woods, where it would be too complicated and expensive to transport out of the woods branches and tops separately. The integrated system is becoming widespread in the Alps, because operations are mechanized through a processor. In this way, the cost of wood for industry is reduced by 30% and at the same time large quantities of biomass can be recovered, which will bring further gains.

Agricultural residues are another important source of woody biomass: fruit tree and vine pruning produces between 1 and 3 tons of dry matter per hectare every year, which are to be multiplied by the enormous stretches of land that are cultivated with these crops. After pruning, residues are first collected and chipped and then packed. For the first operations, the material can be heaped in the headland using a front-bladed tractor, and then chipped using a grinder. There are also some machines that carry out the operation in one step only: they are shoot cutters carrying a container where the cuttings are collected. These machines are available in various versions, there are light and industrial models, the latter being heavier and more expensive, but also more productive. As an alternative, various balers can be used to form bales of various shapes and sizes. Bales are easier to handle than cuttings, but they require a double processing because the bale has to be cut up before being transported to the boiler.

Agriculture can also contribute to biomass production with the cultivation of **dedicated crops** - mainly poplars and locust trees - which are now also being successfully planted in Italy. There are two systems for the collection of these crops. One system is based on the biomass being cut, collected, chipped in continuous succession: the whole operation is carried out by one machine and the material is unloaded on the edge of the field in the form of chips. The other system is based on separated cutting, collection and chipping phases, which can be performed with different machines and at different times. The first system is generally more productive and simpler to organize, but it does not offer great flexibility and may rely on the use of cumbersome machines. The second system is more flexible, it can be performed using conventional equipment and the cutting operation can be "delayed" until stem moisture reaches optimal levels. Both systems and the related equipment are known in Italy, but the one-step collection is the most common system that is carried out with very powerful harvesters. They are equipped with special collection spikes and their hourly productivity can be over 40 tons/hour. Similar collection spikes are used to equip tractors, but their performance and reliability are lower than harvesters.

In summary, the sector is vast and articulate and offer very interesting opportunities for those who work in the agricultural and forest sectors. One must not take fright of the sector's complexity, because Italy has the knowledge and equipment to deal with any type of work: this information has been widely provided at BiomasseEima 2008, where UNACOMA, ITABIA and CNR have informed the public, through info-points, workshops and practical demonstrations, in close cooperation with the main manufacturers of agricultural and forest machines.

***Contribution by Raffaele Spinelli (CNR-IVALSA)*

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TRANSPORT

The supply of biomass or "final biofuels" to the energy conversion plants is a critical issue because of the need to reduce supply costs and fossil CO_2 emissions during the transport phase. That is why, efficient means need to be used at all times and there should always be a correct ratio between quantity of transported biomass and the distance to be run. Excessive CO_2 emissions resulting from badly managed transport would adversely affect the carbon-neutral balance that biomass combustion is known to produce. This adverse effect however is not relevant if distances are short or if long distances are covered by transporting large quantities of biomass (ship transport). ITABIA has calculated that even long-distance road transport (up to 1,000 km) with 25t lorries and/or lorries with trailer has a negative effect on the carbon balance of only up to 10%.

With regard to environmental transport costs, ITABIA has estimated that the average fuel consumption of small trucks that are suitable for local biomass transport (3.5 gross t, 1.5 net t) amounts to about 0.125 l/km, that is a fossil CO_2 emission of 0.33 kg/km, which corresponds to 0.22 kg/km of CO_2 every t of transported biomass.

The unit fuel consumption of large lorries (40 gross t, 27 net t) amounts to 0.42 l/km, that is a fossil CO_2 emission of 1 kg/km, which corresponds to 0.037 kg/km of CO_2 every t of transported biomass.

This shows that a 50 km trip on a 3.5 t small truck corresponds to 300 km trip on a 27 t lorry in terms of fuel consumption and CO_2 emissions.

By absurdity and before talking of zero CO_2 benefits from transported biomass, it can be easily calculated that a 1.5 t small truck could travel for about 5500 km, while a 27 t lorry could travel for about 36000 km, before drawing down to zero the CO_2 balance between fossil transport emissions and transported biomass.

If the same consideration is made for sea transport, one can say that the advantages in terms of savings on fossil fuels and reduced CO_2 emissions are even greater, bearing in mind, however, that biomass would have to be transported to the port of departure and from the port of arrival.

What has been stated above is not intended to encourage transatlantic or long-distance transport, but rather to underline that even the efficiency of supply systems needs to be assessed because it can greatly affect environmental sustainability and efficiency of the entire supply chain.

A2.4) DEFINITIONS OF BIOMASS, BIOMASS FOR FUEL AND BIOFUELS

The biomass types mentioned at the beginning of the chapter need to be further clarified by providing a definition of "biomass as a renewable energy source", "biomass for fuel" and "biofuels".

"Biomass" is a heterogeneous group of organic and renewable materials and is an atypical energy source characterised by:

> Multiple energy options.
> Strong embeddedness in the ecosystem.
> Multiple extra-energy uses.
> Wide social implications.

That is why biomass can be defined in a number of ways and it is difficult to find one single definition that is both brief and comprehensive. For ease of comprehension, reference can be made to what has been established by some European Directives that have been transposed into Italian laws .

THE DEFINITION OF "BIOMASS AS A RENEWABLE ENERGY SOURCE"

Biomass for energy can be defined as reported below, in line with Legislative Decree 29/12/03, n. 387 - "Implementation of directive 2001/77/CE on the promotion of electricity produced from renewable energy sources in the internal electricity market ", as:

"The biodegradable part of products, waste and residues from agriculture (including vegetable and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste".

THE DEFINITION OF "BIOMASS FOR FUEL"

According to Legislative Decree 152/2006 (Part V, Annexe X, part II, section 4, n. 1), the following materials are defined as "biomass for fuel":

a) Vegetable material produced from dedicated crops.

b) Vegetable material exclusively produced from the mechanical treatment of non-dedicated agricultural crops.

c) Vegetable material from forest activities, management and pruning.

d) Vegetable material exclusively produced from the mechanical processing of virgin wood, including bark, sawdust, shavings, chips, virgin wood wane and rounds, virgin wood granules and waste, virgin cork granules and waste, rounds, that are not contaminated by pollutants.

e) Vegetable material exclusively produced from mechanical processing of agricultural products.

f) Oil-free olive residues ...(omissis).

g) Black liquor obtained in paper factories during leaching of wood and evaporated in order to increase the solid residue ...(omissis).

The energy products from "biomass for fuel" can be used in a variety of ways as solid, liquid and gaseous biofuels.

THE DEFINITION OF "BIOFUEL"

Biofuels derive from the transformation of "biomass for fuel" and they shall have to meet well established product features and comply with

Addenda to Chapter 2

BIOFUEL IS PRODUCED FROM BIOMASS TRANSFORMATION

BIOMASS

> Woody (SRF, woodland management, urban greeneries)
> Herbaceous (beetroot, sugar cane, potato, wheat, maize, sorghum)
> Seeds and fruits (sunflower, rape, soy)
> Blends and mixtures of the above

TRANSFORMATION PROCESS

Cutting of trunks and branches → Firewood
Sawdust pelletting → Pellets
Chipping of trunks, branches and faggots → Chipped wood
Cold mechanical pressing of oilseeds → Vegetable oil
Esterification of vegetable oils with methyl alcohol → Biodiesel
Fermentation of starchy and sugary biomass → Bioethanol
Anaerobic fermentation of animal manure, silage and vegetable waste → Biogas

BIOFUEL

SOLID BIOFUELS
> Firewood
> Pellets
> Chipped wood

LIQUID BIOFUELS
> Vegetable oil
> Biodiesel
> Bioethanol

GAS BIOFUELS
> Biogas

specific national and international technical and certification norms (UNI, CEN, etc.).
In "biofuel" production a major role is played by the mechanical transformation of original woody biomass into firewood, pellets and chipped wood (solid fuels), the pressing of oilseed biomass into vegetable oil (liquid fuels), the fermentation of starchy-sugary biomass into ethanol (liquid fuels) and anaerobic digestion of liquid animal manure and moist herbaceous productions into biogas (gaseous fuels).
Thus, "biofuel" is not the raw material it originates from, but rather the specific end product that is obtained, which has to be technically suitable for the demands of final conversion technologies (boilers, endothermal engines to generate electricity or for transport, etc.).

The technologies available for the various final energy conversion processes require the biofuels used to meet set quality standards, that is why scores, standards and technical norms are currently being developed for all types of biofuels , taking into account the specific conversion plants and their end use.
This activity is very important not only to censure energy and environmental efficiency, but also to widen their use on the market, control their quality, certify their origin and protect the final consumer.
Follow a brief list of the norms on "biofuels" that are being promoted:
With regard to liquid biofuels, the "EU Directive on Fuel Quality" has been recently approved, which provides a detailed technical description of the features fuels need to have to enter the market of transport fuels.

NORMS ON BIOMASS

> CTIR 03/1 Recommendation - Solid Biofuels - Technical specifications and classification
> CTIR 04/5 Recommendation - Solid Biofuels - Pellet characterization for energy purposes
> Norms of CEN/TC 335 - Solid biofuels
> Norms of CENTC 343 - Solid Recovered Fuels
> National CTI documents on pellets, oils, dregs of pressed grapes
> CEN's activity on biomass plants:
stoves, fireplaces, barbeques, wood and pellet- fuelled boilers
> UNI Norms of BIOEDIESEL, OILS AND FAT

3] Market/Good practices

CRITERIA FOR PINPOINTING GOOD PRACTICES ECONOMIC ASSESSMENT
REMARKS ON MAIN DEVELOPMENT OPPORTUNITIES
ADDENDA

The biomass market is based on the equilibrium between demand, offer and compatibility with the local environment. Singling out the successful supply chains by choosing the ones that adopt "good practices", helps the market, favouring the increase and marketability of resources, technology, as well as ecologically and socially-economically sustainable products.

3.1) CRITERIA FOR PINPOINTING GOOD PRACTICES

In Italy today there are numerous initiatives that enhance the use of biomass for energy purposes. It has been remarked that when these are planned with a correct supply chain approach, they are effective and long-lasting, reaching the expected energy, economic and environmental objectives.
With the aim of cataloguing and assessing the characteristics and quality of such initiatives, ITABIA has developed an original survey plan structured in three "macro" areas (technical, legal and economic) containing various "survey keys" (concerning energy conversion process, collection-storage-transport, agricultural practices, etc.) and many other evaluation parameters (performance of conversion process, supply chain energy assessment, CO_2 balance, repeatibility, etc.). An example of this survey plan is described in **Addendum A3.1**. The analysis criteria of the plan have already been used in the European project Bites, coordinated by ITABIA, for supply chains producing transport biofuel and have also partly been used (at the end of 2008) in some of Italy's biomass plants: the survey plan has been useful to pinpoint, amongst the cases analysed, those that are considered examples of "good practices" for their technology and plant system as well as for their management and financial organisation.

3.1.1) SOLID BIOFUEL PLANTS

At present the operators and plants that use solid biomass of different origin as fuel to produce thermal energy and/or electricity can be subdivided into three large categories:
a) Small household systems (using wood chunks, pellets and chips) which have been, up until now, the leading sector in national bioenergy .
b) District heating plants using woody virgin biomass (chipped wood) mainly for the production and distribution of thermal energy for household use (district heating) and often combined with cogeneration.
c) Thermoelectric power plants fuelled only by wood biomass of agricultural, and / or industrial origin (wood chips) or a mix of biomass and fuel coming from RDF (Refuse Derived Fuel) for the exclusive production and transfer of produced electricity to the national electrical grid.

Small household systems
This first category is of great importance for the potentiality it currently has in terms of use and future development. However, it will not be dealt with in this report, as it would be difficult to classify it in a survey. Therefore, please refer back to what has been said in the previous chapter.

District heating plants
The 2008 survey has brought to light the existence of about 130 district heating plants using virgin biomass in Italy, supplying heat to a number of users over the territory, which are managed by a variety of operators, namely firms providing municipal services, cooperatives or private companies and also by some non-profit associations.
Obviously, the survey did not take account of the boilers used by single households, such as private blocks of flats or detached houses, that use biomass fuel but do not have any collective heat distribution network.
The capacity of the surveyed plants reaches altogether about 370 MWt; they have 172 boilers that supply a network covering 700 km and a number of consumers that is over 14,000 units.
The total consumption of biomass, according to available data, is about 300,000 t/year; this data is however an underestimation as final data on the 2007-2008 winter season were not collected from many plants.
The surveyed plants are mainly situated in the north of Italy for obvious climatic reasons and they are especially concentrated in the following regions: Valle D'Aosta and Piedmont (13 plants), Lombardy (12 plants) and Trentino-Alto Adige (73 plants) and Friuli -Venezia Giulia (15 plants), while the remaining 15 plants are located in the Regions of Veneto, Liguria, Emilia Romagna, Tuscany, Marche, Campania and Basilicata. In particular, 35 district heating plants in the Alto Adige area belong to the Alto Adige Biomass Fuel Consortium, while another 12 plants are operational in provincial areas, according to the latest data updated to September 2008. **Addendum A3.2** reports a list of all the plants included in the sur-

3. Market/ Good practices

vey as well as information on their location and the names of the managing companies, their thermal potential, number of boilers installed, the size of their heat distribution networks, the number of consumers connected to the system, the quantity of thermal energy produced and, lastly, the quantity of biomass used (websites can be accessed to gain more knowledge on the technical - management aspects of the 128 district heating plants which are operating regularly and continually at the present moment).

The data collected have pinpointed the existence of some "energy districts" where eco-friendly, energy-efficient and cost-effective systems/plants are able to satisfy the energy needs of the public and private buildings of a whole town which is supplied with household heating and hot water for hygienic/ sanitary usage.

The leading "energy districts" are from Alto Adige-Trentino, Lombardy-Valtellina and Piedmont - Val D'Aosta. They are all characterised by an excellent level of organisation, a high level of social approval and noteworthy level of success, as shown by the data collected through a questionnaire that was elaborated by ITABIA and filled in by the main FIPER companies (Fiper is the Federation of Renewable Energy Producers).

The questionnaires used for the survey have been elaborated by the companies SEA of Aosta, TCVVV of Tirano and Azienda Pubbliservizi Brunico and the cooperative FTI of Dobbiaco - San Candido.

The main operational data of the three energy areas are summarised in the following paragraphs.

ALTOATESINO-TRENTINO DISTRICT

This district was created by the Alto-Adige - Trentino Region in the mid nineties and by the end of 2008 had more than seventy units with 73 working plants having 102 boilers with a total thermal capacity of 220 MW.

Worthy of a special mention for their high level of success, are the two plants in Brunico e Dobbiaco-San Candido, respectively managed by Azienda Pubblisevizi and the FTI Cooperative, which are the leading plants in Val Pusteria and, together with the other 33 plants, are characterised by the following technical and operational data:

> Management body: Consorzio Biomasse Alto Adige (Biomasseverband Südtirol).
> 35 plants with 53 boilers with the capacity of 217 MWt, equal to 58.6% of the total installed capacity.
> 35 town councils supplied by the network distributing energy and water for sanitary use.
> About 500 km of distribution network.
> Over 6,500 consumers connected to the system, the equivalent of 19,000 inhabitants.

LOMBARDO-VALTELLINESE DISTRICT

This is the second Italian district in order of importance for biomass district heating plants that were built in Lombardy as from the end of the nineties. By 2008 the district had more than 10 units with 12 working plants having 17 boilers with a total heating capacity of over 75MW.

Worthy of a mention for their high level of success are the three plants in Tirano, Sondalo and Santa Caterina Valfurva by the company Teleriscaldamento Cogenerazione Valtellina Valchiavenna Valcamonica SpA, which are characterised by the following technical and operational data:

> Management body: TCVVV SpA.
> Plants with 7 boilers with the capacity of 42 MWt, equal to 11.3% of the total installed capacity.
> 3 town councils supplied by the network distributing energy and water for sanitary use.
> Over 50 km of distribution network.
> Over 1,000 consumers connected to the system, the equivalent of 15,000 inhabitants.

PIEMONTESE-VALDOSTANO DISTRICT

The third Italian district, in order of importance for its biomass district heating plants, comprises several units that were installed in Piedmont and Valle d'Aosta in early 2000, and by the end of 2008 had more than ten units with 13 working plants with 21 boilers with a total energy capacity of over 50 MW.

Worthy of a mention for their level of success are the three plants of Morgex, Pollein and Pré -Saint-Didier located in Val D'Aosta and managed by SEA Srl: they are the leading plants in the Val d'Aosta region and are characterised by the following technical and operational data:

> Management body: SEA Srl (Società Energetica Aostana).
> 3 plants with 6 boilers with the capacity of 16. 1 MWt, equal to 4.3% of the total installed capacity.
> 3 town councils supplied by the network distributing energy and water for sanitary use.
> About 20 km of distribution network.
> Over 300 consumers connected to the system, equivalent to 2,300 inhabitants.

Besides the three energy districts described above, the biomass district heating plants in Friuli - Venezia Giulia must also be mentioned: in 2004 and 2005 over 15 collective district heating plants and over 50 biomass individual boilers supplying private households were installed, which, as already mentioned, have not been taken into account in this survey.In

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the other Italian regions, there are only a few scattered collective district heating plants, some of which have only recently become operational, such as: the plants in Treviso, Ponte San Nicola (PD), Valdastico (VI), the plant in Vidiciatico in the town council of Lizzano in Belvedere (BO), the plants in Campo Ligure and Rossiglione in the Province of Genoa; the plants in Tuscany at Camporgiano (LU), Castel San Niccolò and Loro Ciuffenna both in the Province of Arezzo, the plants in Casole d'Elsa and Monticano in the province of Siena; the plant in Apiro in the province of Macerata (which opened in March 2008); the plant at Eboli in the Province of Salerno and lastly the plant in Calvello in the Province of Potenza.

Thermo-electric power plants

The biomass thermoelectric power plants that have been taken into account and surveyed as at 30th September 2008, are those that mostly deal with the production of electricity which is fed into the national network. There are 25 such plants in Italy today, mainly producing electricity, of which 19 are exclusively electricity producers, while the other 6 plants are cogeneration plants offering a combined production of electricity and steam, the latter being used in industry and in district heating plants. The above-mentioned plants are fuelled only by biomass of agricultural and/or industrial origin or by a mixture of biomass and quality RDF; besides the previously mentioned plants two other biomass thermoelectric plants are at an advanced stage of construction and other projects are being developed by multi-service companies and private energy supply companies.

The functioning plants have plants with a potential output ranging from 2.5 to 40 MWe, which have been built in different parts of Italy depending on the availability of biogenic resources, the consent of the local people and the ability to get through all the complicated administrative paperwork which enables the company to get authorisation. In several cases the plants have been created by reconverting existing abandoned industrial sites and using the already existing logistic infrastructure (such as access roads, storage areas, auxiliary services etc).

ITABIA's survey has identified some examples of "excellence" among which it is worth to mention the plant in Ospitale di Cadore (SICET) and particularly the plants in Crotone (20 MWe) and Strongoli (40 MWe) owned by the company BiomasseItalia, which received a special mention in 2008 for the Eco-Friendly Company Award for being "an excellent example of a sustainable Company developed in a disadvantaged territory, having a good environmental management system and a capacity to employ a specialised workforce in a province like Crotone which has been going through a phase of rapid de-industrialisation."

The Eco-friendly Company Award was promoted by the Italian Ministry for the Environment, Land and Sea, the Economic Development Ministry, Unioncamere (Union of Chambers of Commerce) and the Chambers of Commerce of Rome and Milan.

ITABIA has directly acknowledged that BiomasseItalia is engaged in creating local infrastructures for the cultivation and harvesting of raw materials necessary for producing biofuel to be used in the plants (about 800,000 t/year between the plant in Crotone and the one in Strongoli).

Addendum A 3.3 lists the 25 plants, their location, their management companies, their electrical potential, the quantity of useable biomass, the combustion technology they adopt and the type of energy recovery. The list also includes the third line of the MSW waste- to-energy plant in Brescia, which treated 289,000 tons of biomass throughout 2007, producing in one year about 190,000 MWht used to supply the city's district heating.

A close examination of the 25 functioning plants, contained in the above mentioned Table, showed the following technical and operational data:

a. Technologies adopted:
   14 combustion chambers with mobile grid;
   6 combustion chambers with fluidized bed;
   4 combustion chambers with vibrating grid;
   1 combustion chamber with fixed grill.

b. Treatment Capacity: about 3,000,000 t/ year of various biomass types.

C. Net Power transferable to GSE: 285.8 MWe.

The operational data reported herein have been collected according to treatment capacity and production of net electricity transferable to the national grid and are to be intended as referring to maximum potentiality; they are not the result of a final annual statement, which can vary according to particular technical situations or programming (break-downs, accidents, interruption of operation due to maintenance work, etc.) or for market reasons related to the supply of biomass or RDF, when the latter has been authorised for co-combustion with biomass.

With the aim of supplying a reference framework at a European level, we consider it useful to convey the most significant experiences of energy usage of biomass that have been widespread in the countries of Northern Europe such a Sweden, Germany, Denmark, The Netherlands and Austria as well as Spain.

Addendum A3.4 contains the list of the major thermo-electric plants in Europe, their location, their management companies, their useable biomass capacity, their electricity potential and the combustion technology adopted. All the plants listed adopt a cogenerative system for the production of electricity and thermal energy for town district heating as well as industrial use.

Municipal solid waste plants (MSW)

This paragraph shall deal with solid municipal waste and waste-to energy plants.

The waste-to-energy process should be intended as the final phase of an integrated system of waste management, which allows us to exploit its calorific potential and transform the heat produced by its combustion into electricity and/or thermal energy.

These types of plant are therefore to be considered proper thermo-electric power plants that use municipal solid waste as fuel, adequately pretreated and / or left over from recycling, and/or RDF as fuels that can replace fossil sources.

In particular, European Union policies no longer view dumps as the main means to deal with waste disposal, and rather aim at the re-use of secondary materials and the energy recovery of otherwise unrecyclable residues.

At present there are in fact over 400 waste-to-energy plants in Europe (another hundred will be started-up by 2012), which every year treat about 50 million tons of municipal solid waste; this type of waste management is widespread even outside Europe, in countries like USA, Canada, Japan and South-East Asia.

The "most virtuous " European Countries are France and Germany, but also Sweden, Denmark and The Netherlands are among the leading countries with waste-to-energy plants (between 55% and 60% of the waste they produce).

France has the highest number of waste-to-energy plants, namely 123. Germany is, on the other hand, the state that converts the largest quantity of waste into energy (about 12 million tons every year) with 58 operational plants. There are however European states like Austria, Spain, England, Finland, Ireland and Greece that make a limited use or no use at all of their refuse.

As far as Italy is concerned, waste-to-energy management has developed between 1960 and 1970, undergoing a rapid slowdown during the 1970s and 80s. Since the mid 1990s, there have been weak but continuous signs of revival, owing to technological developments in this sector and changes in the laws governing the environment, which have led to acknowledge the vital role played by energy recovery in the implementation of an integrated waste management system.

The national situation has therefore slowly gained ground through a constant increase in the number of operational plants, first of all in the Northern regions of Italy and only in the last few years has there been an increase also in the Central-Southern areas of the country, which however are still lagging behind. At the same time, the annual quantities of treated refuse has grown from about 1.6 million tons in 1996 to about 6 million tons in 2007.

With regard to energy recovery, over the years there has been a considerable reduction in the number of plants with no energy recovery system, in favour of those with energy (mainly electricity) production systems.

The 2007 Waste Report by APAT (Agency for Environmental Protection and Technical Services) describes clearly the Italian situation in 2007; the data published in the Report show that dumps were still the most common form of municipal waste management (47.9%), in spite of a growing national production of municipal waste (32.5 million tons in 2006, 2.7% more than 2005) and widespread waste recycling (25.8% of total municipal waste production, against 24.2% of 2005).

The use of other forms of waste management seemed to remain fairly steady: compared to 10.1% in 2006, combustion processes increasingly exploited the potential of incinerated waste, which rose to about 20% of the urban refuse produced at national level, due to the construction of new plants.

Based on the APAT data, there were 50 waste-to-energy plants in Italy in 2006, of which 48 were fully operational; about 60% of these were located in the North of Italy (29) and over 70% of the plants located in the northern regions were situated in just two regions: Lombardy (13) and Emilia Romagna (8).

In central Italy there were 13 operational plants, of which 8 were located in Tuscany; in the South of Italy there were fewer plants (only 8): 2 in Apulia, 2 in Basilicata, 1 in Calabria, 1 in Sicily and 2 in Sardinia.

The total number of waste incinerating plants indicated in the report included also the plant in Potenza, even though it was in a testing phase, and the plant near Taranto, at Statte, which however was operational only for a short period of time.

On the other hand, 8 plants are operated with cogeneration cycles producing both electricity and thermal energy (Bolzano, Cremona, Milan, Brescia, Ferrara, Reggio Emilia, Granarolo dell'Emilia and Forlì), which had treated 1.7 million tons of waste, recovering 1.3 million MWh of electricity and 689,000 MWh of thermal energy.

Finally, the remaining 38 plants relied on systems for the sole recovery of electricity and had treated over 2.7 million tons of municipal waste and RDF, recovering 1.6 million MWh of electricity; in total about 2.9 million MWh of electricity and 689,000 MWh of thermal energy were recovered in 2006.

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Moreover, according to the APAT Report, waste treated in plants dedicated to municipal solid waste treatment, amounted to about 4.5 million tons, divided as follows: 3.3 million tons of municipal waste, 687,000 tons of RDF, 500,000 tons of other special refuse and 52,000 tons of sanitary refuse.

Treated hazardous waste amounted to more than 72,000 tons, and was mainly made up of refuse from the sanitary and hospital sector.

Considering the territorial distribution of the plants, the largest amount of waste was treated in the northern regions of Italy in 2006: the Lombardy region (39%) ranked first for the energy recovery of municipal solid waste, in relation to its regional production, followed by the Regions of Friuli-Venezia Giulia (22.7%), Emilia Romagna (22.2 %), Sardinia (18.3 %), Trentino-Alto Adige 13.2%), Calabria (12.5 %), Basilicata (11.6%) and Veneto (6.7%).

An update of the data, through information gathered during 2008 and as at the date of this report, shows that in Italy there are 54 waste-to-energy (MSW, RDF and biomass) plants which are either operational, or undergoing renovation and/or testing or under construction. Overall, they have 102 lines of combustion having a treatment capacity of about 22,000 tons per day and a total energy recovery system of over 800 MWe (installed power).

However, such a treatment capacity does not represent the quantity of waste that can be actually treated every day by the above-mentioned 54 plants, as the operational activity of each plant may vary according to seasonal variations in the quality and quantity of collected municipal solid waste and if plants are undergoing maintenance and thus are not operational.

The geographical position, the main technical characteristics and the Internet websites of the Italian plants can be found in **Addendum A3.5** - List of waste-to-energy plants with energy recovery, both operational and under construction, as at 31 October 2008.

In conclusion, the Italian integrated municipal solid waste treatment system still appears to be inadequate and insufficient; in particular, waste incinerating plants in many regions of Central and Southern Italy are obsolete; even large cities such as Genoa, Florence, Rome, Naples, Bari, Palermo and Catania are still without these essential structures, which are necessary for the efficient management of the whole process of municipal solid waste management, from recycling to disposal through energy recovery of the remaining fractions.

The reason for this imbalance might lie in sociological rather than technical causes. Nonetheless, the situation is at a deadlock and in a state of permanent environmental emergency, even in the Regions of Campania, Apulia and Sicily, where contracts were awarded by the Special Commissioners for Environmental Policies for the construction of an integrated municipal waste-to-energy processing and management.

These contracts, each being of a different nature, were based on the development and management of a system made up of several plants for the mechanical pre-treatment (more or less advanced) of non-recycled municipal solid waste or of the remaining fractions of recycled municipal solid waste, and also by several waste-to-energy plants capable of absorbing as much product as such plants can take in the form of the so-called RDF, and finally by a series of controlled dumps for collecting residual products, such as pre-treatment residues and ashes waste.

The significant delay in building two large waste-to-energy plants in Campania, encompassing 5 lines each having a treatment capacity of 650 tons/day, has brought about several environmental crises, which have been denounced by the general public and by the press, and which finally led to the well-known serious hygiene-health emergency.

Even in Sicily the building of 4 waste-to-energy plants (in Augusta, Siracusa, Palermo and Catania) is being delayed. They are designed to have a total of 11 combustion lines that will be capable of treating about 500 tons of municipal solid waste per day.

As for 2009, the Lazio region has planned to start the bureaucratic procedure required for authorising the installation of an adequate and modern waste-to-energy plant in Rome, and to upgrade the plant at S.Vittore del Lazio by installing a second line. By 2009, the plant at Valmadrera in the province of Lecco shall be upgraded with a third line and the “famous” waste incinerating plant at Acerra in Campania should be completed and become operational.

Finally, the bid for the building of a new waste incinerating plant in Turin, serving the area south of the city and its province, was awarded on 11th March 2009 to the firm TRM of Turin.

3.1.2) BIOGAS AND BIOFUEL PLANTS

Biogas

The biogas sector in Italy is evolving rapidly: new plants are being constructed, new businesses are being set up and also new business sectors are developing for the construction of plants and/or components.

The zootechnical sector can become the driving force for the large-scale development of anaerobic digestion, like in Germany, Denmark, Sweden and Austria. The many incentives that can motivate are: improvement of livestock “environmental sustainability”, additional income “from green

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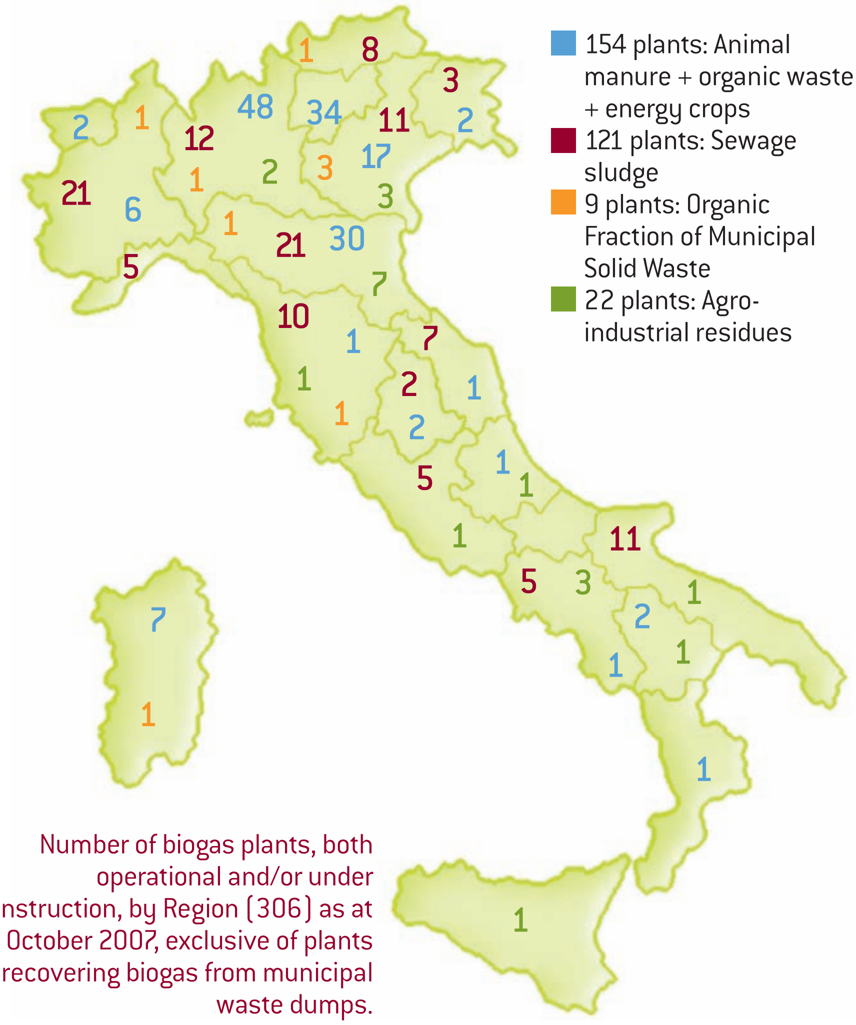
energy", reduction of environmental problems related to emissions in the atmosphere and odours, a better agronomic use of fertilizing elements that are found in liquid manure.
According to estimates by EurObserv'ER, Italy's biogas production in 2007 amounted to about 406.2 ktep (about 4.7 TWh); of which over 85% derives from urban waste dumps. The GSE (Gestore Sistema Elettrico, national public responsible of the electrical grid) reported for 2007 a gross production of electricity from biogas of 1.45 TWh, of which about 86% is obtained from biogas from municipal waste dumps.
A more detailed national scenario is given by the survey that was performed by CRPA on behalf of the Emilia-Romagna Region on anaerobic digestion plants operating in the animal and agro-industrial sector.

At the beginning of 2008, there were about 306 small-medium sized plants (see **Addendum A3.6**) including:

>154 plants fuelled with animal manure + organic waste + energy crops;
>121 plants fuelled with sewage sludge;
> 9 plants fuelled with the organic fraction of municipal solid waste;
> 22 plants fuelled with agro-industrial residues.

There are also about 140 plants that recover biogas from municipal solid waste dumps (about 210 MWe installed capacity) which to date represent the main source of biogas obtained from biomass.

The overall potential of biogas-fuelled electrical generators is estimates to amount to about 250-300 MWe installed capacity.
The survey has demonstrated that almost all of these plants are located in Northern Italy, mainly in the regions of Lombardy, Emilia-Romagna and Veneto, where there is a greater concentration of animal farms. Some plants are being built in areas where there are significant quantities of organic waste and by-products deriving from the agro-industrial sector, which can be used in the co-digestion process. These plants offer a solution to the recovery and management of these types of waste.
There are many plants in the Province of Bolzano, owing to its proximity with Austria and Germany and to the incentives granted by the Province's administration. The number of operational plants is by far lower in Central and Southern Italy.
Most of the **154** plants, which treat animal manure, agricultural and agro-industrial waste and energy crops, have (each) an installed electrical capacity that is lower than 100 kWe, while 14 have (each) an electricity capacity that is higher than 1 MWe. The total installed capacity amounts to about 50 MWe (see **Addendum A3.7**). Out of the 154 plants, 115 use (almost exclusively) animal manure. Compared to a 1999 survey, the number of these plants has increased by 43 units (+60%) and by 78 units (+108%) if plants under construction are also taken into account. These data confirm the intensive development of anaerobic digestion in Italy. The end use of the biogas produced in these plants is the combined generation of electricity and heat. Only a few plants, especially those that are annexed to cheese factories, use biogas for process heat by



Number of biogas plants, both operational and/or under construction, by Region (306) as at October 2007, exclusive of plants recovering biogas from municipal waste dumps.

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burning it directly in boilers.
The **121** anaerobic digestion plants treating civil and industrial sewage sludge are mainly located inside large urban plants for the depuration of civil and industrial wastewater.
Among the **9** plants that treat the preselected organic fraction of recycled waste (Organic Fraction of Municipal Solid Waste), some do so by mixing the fractions with sewage sludge. Four of the plants using animal residues, treat the organic fraction of municipal solid waste together with liquid residues, chicken manure, agro-industrial sludge and energy crops. CRPA is now updating this survey and preliminary data show the intense evolution of the biogas sector in Italy: only one year later (December 2008) the number of plants has risen to 237 (against the previous 185) that operate on animal residues, energy crops, organic residues, agro-industrial waste and organic fraction of municipal waste.

Biodiesel and vegetable oils *

In 2007, almost 6 million tons of biodiesel were produced in Europe, despite an estimated production capacity as at 2008 of almost 17 million tons. About 80% of the biodiesel produced derives from rapeseed cultivated in Central-Northern Europe, the remainder derives from oleoplants (mainly sunflower and soy) that grow more in southern countries.
Italy, with its production capacity of about 470,000 tons per year, is the third European biodiesel producer after Germany (2,890,000 t) and France (872,000 t). Germany alone produces about 50% of European biodiesel and is the first world producer.
In Italy today there are 15 plants with a production capacity of about 2,250,000 t/year of biofuel, which are members of the Union of Biodiesel Producers of Assocostieri. Another 4 plants are under construction (table 1, page 42).

PRODUCTION 2007		PRODUCTION CAPACITY 2008	
COUNTRY	Kt	COUNTRY	Kt
GERMANY	2,890	GERMANY	5,302
FRANCE	872	FRANCE	1,980
ITALY	469	ITALY	1,916
AUSTRIA	267	SPAIN	1,267
PORTUGAL	175	UNITED KINGDOM	726
SPAIN	168	BELGIUM	665
BELGIUM	166	THE NETHERLANDS	571
UNITED KINGDOM	150	GREECE	565
GREECE	100	AUSTRIA	485
THE NETHERLANDS	85	POLAND	450
DENMARK	85	PORTUGAL	406
POLAND	80	BULGARIA	215
SWEDEN	63	SWEDEN	212
CZECH REPUBLIC	61	SLOVAKIA	206
SLOVAKIA	46	CZECH REPUBLIC	203
FINLAND	39	HUNGARY	186
ROMANIA	36	FINLAND	170
LITHUANIA	26	LITHUANIA	147
SLOVENIA	11	DENMARK	140
BULGARIA	9	ESTONIA	135
LETONIA	9	LETONIA	130
HUNGARY	7	ROMANIA	111
IRELAND	3	IRELAND	80
CYPRUS	1	SLOVENIA	67
MALTA	1	MALTA	8
ESTONIA	0	CYPRUS	6
LUXEMBOURG	0	LUXEMBROUG	0
TOTAL	**5,819**	TOTAL	**16,949**

Most of these plants are located in the Lombardy Region and they have an overall production capacity of 670,000 t/year, which corresponds to 33% of total national production.
Biodiesel trade in Italy is regulated by Decree of the Ministry of Economy and Finance n. 256 of 25 July 2003 that sets the quota of reduced excise duty, which is reviewed every year according to the Financial law, and lays down how biodiesel is to be used (blends with up to 5% of biodiesel can be used for consumption on and off fuel service network; blends with up to 25% of biodiesel can be used for consumption by off-network users; blends above 25% are not regulated by law). Quantities set in this way are in line with the productive capacity of plants across Italy, which clearly export a good share of their production to Germany, France and Austria.
In Italy there are 7 large oil producing plants (table 2, page 43); six of them are members of Assitol (Associazione Italiana dell'Industria Olearia, Italian Association of Oil Industry). Other small sized oil producing plants supply local markets and show little interest in supplying the biofuel market with raw material.
Oil producing plants are mainly located in Central and Northern Italy, with the larger number being concentrated in the regions of Emilia Romagna and Veneto (figure 1). Among the mentioned plants, those more adequate

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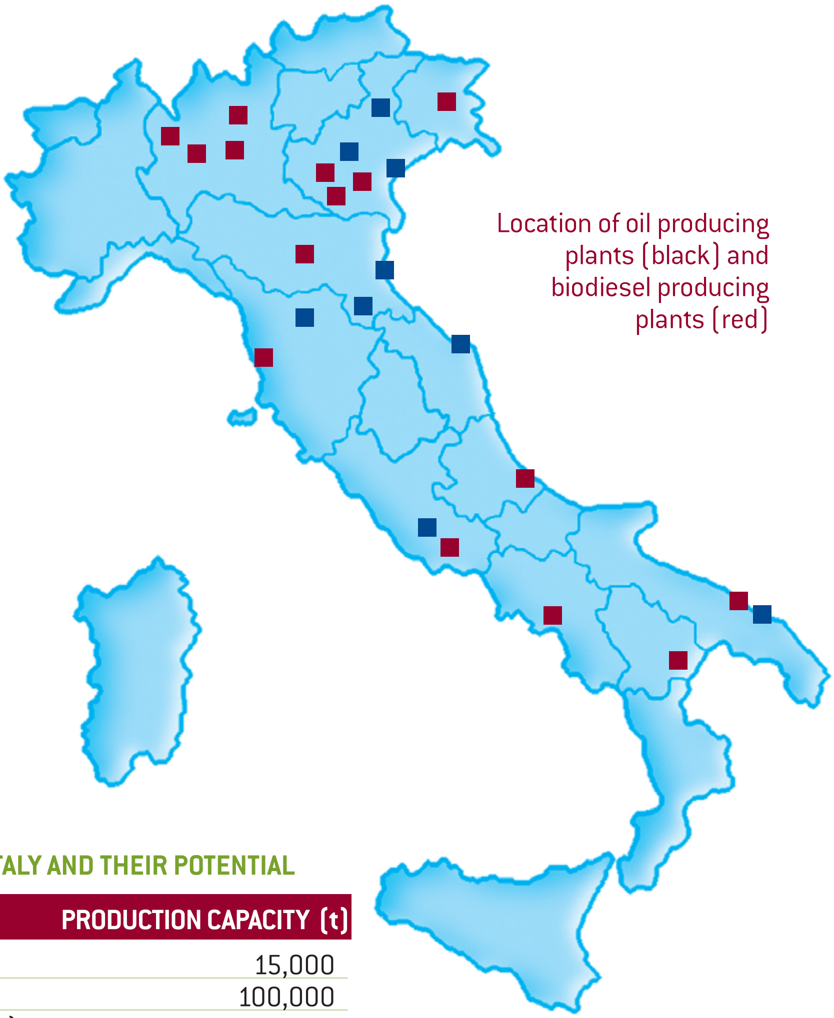
towards biodiesel production are plants 1, 2 and 3,in the figure, which have their own esterification system. Besides industries producing seed oil, there are industries in Italy that only deal with refining and/or packaging and/or distribution (table 3, page 43). The only strong feature in the supply chain in Italy today is the biodiesel production phase. Most of the raw material used is in fact imported from both European countries (France, Spain, Germany) and non-European countries (Argentina, Brazil, South America and Canada). Sixty percent of the biodiesel that is produced is exported to European countries. The esterification by-product, glycerine, is in part exported to Asian countries. Italian biodiesel producers resort to "foreign oil" because biofuel production costs depend on the cost of the raw material, which is high in Italy. If, for example, we take a blend of Italian raw oil made up of 30% of soy and 70% of rape, respectively costing 565 €/t and 665 €/t, and we assume refining and esterification cost 50 €/t and 100 €/t respectively, the final biodiesel production cost would amount to 785 €/t. Clearly, the cost of the raw material has a strong impact (80%) on the final biodiesel production cost (Assocostieri 2007). Moreover, 60% of biodiesel is marketed outside Italy because in Italy, as already said, there are many constraints, especially of a legal nature, that hinder its widespread use: limited annual concessions on excise duties; limit of 5% of biodiesel in the blend for on- fuel-network sale; "compulsory" blending of traditional fuels for producers/traders with sanctions having been only



Location of oil producing plants (black) and biodiesel producing plants (red)

TABLE 1 - BIODIESEL PRODUCTION PLANTS IN ITALY AND THEIR POTENTIAL

COMPANY	LOCATION	PRODUCTION CAPACITY (t)
ALCHEMIA ITALIA SRL	Rovigo	15,000
BIO-VE-OIL OLIMPO SRL*	Corato (BA)	100,000
CAFFARO BIOFUEL SRL	Torviscosa (UD)	60,000
CAFFARO BIOFUEL SRL*	Torviscosa (UD)	100,000
CEREAL DOCKS SPA	Vicenza (VI)	150,000
COMLUBE SRL	Castenedolo (BS)	120,000
DP LUBRIFICANTI SRL	Aprilia (LT)	155,520
ECOIL*	Priolo (SR)	200,000
F.A.R. Spa Divisione Polioli	Cologno Monzese (MI)	100,000
FOREDBIO SPA	Nola Marigliano (NA)	70,000
ECO FOX SRL	Vasto (CH)	131,370
ITAL BI OIL SRL	Monopoli (BA)	190,300
ITAL GREEN OIL SRL	San Pietro di Morubio (VR)	365,000
GDR BIOCARBURANTI	Cernusco sul Naviglio (MI)	50,000
MYTHEN SPA	Ferrandina (MT)	200,000
NOVAOL SRL	Livorno (LI)	250,000
NOVAOL SRL*	Ravenna (RA)	200,000
OIL.B SRL	Solbiate Olona (VA)	200,000
OXEM S.p.A.	Mezzana Bigli (PV)	200,000
TOTAL		2,257,190**

* Plants to be built
** The total does not include the plants to be built
Source-www.assocostieribiodiesel.com (2009)

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TAB. 2 - MAIN OIL INDUSTRIES IN ITALY

OIL PRODUCING PLANT	LOCATION	TREATED SEEDS	OPERATION
1	San Pietro di Morubio (BA)	Soy	Pressing, refining ,
		Sunflower	packaging
2	Camisano Vicentino (VI)	Soy	Pressing
3	Porto Marghera (VE)	Rape, sunflower	Pressing, refining ,
	Porto Corsini (RA)	Soy, maize	packaging,
	Porto di Ancona (AN)	Peanut (no pressing)	distribution
4	Castelfiorentino (FI)	Sunflower	Pressing
5	Fontanelle (TV)	Soy, grapeseed,	Pressing, refining ,
		maize, rape (no pressing)	packaging,
		Sunflower (no pressing)	distribution
		Peanut (no pressing)	
6	Cisterna di Latina (LT)	Sunflower, rape, soy	Pressing, refining
7	Faenza (FC)	Sunflower, high oleic	Pressing, refining,
		Grapeseed, maize	distribution
			(tankers or ships)

TAB. 3 - MAIN OIL REFINING INDUSTRIES IN ITALY

OIL PRODUCING PLANT	LOCATION	OPERATION	TREATED SEEDS
8	Silea (TV)	Refining, packaging	Maize, soy,
		Distribution	sunflower
9	Viareggio (LU)	Refining, packaging	Rape, sunflower, soy,
		Distribution	grapeseed, maize, peanut
10	Inveruno	Refining, packaging	Rape, sunflower, soy,
		Distribution	grapeseed, maize, peanut

recently introduced.
In conclusion, existing laws in Italy show that the development of the whole supply chain across Italy may depend on the last link of the chain, that is on the fossil fuel companies who should respect the obligation of blending traditional fuels with biodiesel. This would increase the biodiesel demand made to biodiesel producers, who can today benefit from special concessions for the share of raw material coming from local supply chains, developed through agreements among the various stakeholders. The aim of these agreements is to create a direct connection between the first and last link of the chain, improving logistics and benefits of the whole production chain and giving the opportunity to agricultural firms to develop their businesses beyond food production.

** Contribution by V. Scrosta and R. Cerioni - Sistemi Innovativi Biomasse Energetiche - Spin-off of the Politechnic University of Marche*

Bioethanol
The development of the bioethanol supply chain for the energy market in Italy has only been based on demonstrative and experimental projects which have, up to now, mainly used ethanol deriving from the compulsory distillation of wine and other excess vegetable and fruit products. About 150 Italian firms produce ethyl alcohol from agricultural products or residues. Most of them are small distilleries or wine producing firms, but there are also some modern plants with high production capacity such as IMA of the Bertolino Group (Trapani), Caviro Sca (Faenza), Alc.Este. SpA (Ferrara), Sedamyl of the Amylum Group - Tate & Lyle (Saluzzo) and Silcompa SpA (Correggio). The mentioned companies, which are among the main alcohol producers in Europe, are members of the Italian Bioethanol Society (Società Italiana BioEtanolo, Sibe) and thus share a common strategy for the production of ethyl alcohol for biofuel. Italian distilleries are versatile in their use of various fermentable raw materials. In 2007, the agricultural alcohol produced derived from molasses (5%), wine (34%), vinous material (36%), cereals (23%) fruit (2%), for an amount of 117.5 million litres of pure alcohol (1,175,000 hn).

ALCOHOL PRODUCED AND RAW MATERIALS USED (YEAR 2007)

RAW MATERIAL OF ORIGIN	TONS USED	ALCOHOL PRODUCED (in hn)
MOLASSES	19,000	61,000
WINE*	360,000	400,000
VINOUS MATERIALS	975,000	421,000
FRUIT	50,000	22,000
CEREALS	66,000	271,000
TOTAL	1,470,000	1,175,000

** 1,000 litres*
Source: AssoDistil

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This ethanol of agricultural origin is mainly produced for uses other than energy, such as for the alcoholic drinks market, the food and pharmaceutical industries, etc., while bioethanol as fuel is not marketed at all in Italy. The compulsory distillation of wines and other excess vegetable and fruit products has generated significant stores of agricultural ethyl alcohol, that are estimated to be millions of hectanydres. The new wine CMO (august 2008) sets out that the distillation of by-products (lees and pomace) and unsold wine (crisis distillation) should be maintained, but under certain conditions that differ completely from the old 1493/99 regulation: there will no longer be the imposed minimum price, the aid to transformation and transport will be maintained, alcohol will no longer have to be stored or purchased through intervention bodies. Alcohol will thus be managed by the distiller, who will be the sole person in charge of marketing it exclusively for industrial / energy uses.

The national situation for ETBE is different: Italy's short-term national production capacity amount to 300 kt/year of ETBE (that is slightly less than 150 kt/year of ethanol).

The new prospects that have been opened up by the reduction of aromatic compounds in petrol triple the market share that will be available in the short term: the use of a minimum amount of 5% of ETBE in all the petrol consumed in Italy would require about 800 kt/year of bioethanol (after all, today's MTBE market amounts to around 430-450 kt/year).

For years, the development of this market has been conditioned by muddled and incomplete legal processes for the definition of support measures for bioethanol to be used as biofuel (tax exemption, usage constraints, etc.). However, in line with law 81/2006, the 2007 Financial Law set out the following usage obligations: 1% in 2006, 2% in 2007 and provides a non-binding objective of 5.75% for 2010. The same law confirms the annual financial support of Euro 73 million for the partial tax relief of excise duties on bioethanol for the 2007-2010 period. This financial support had already been introduced with the Financial laws of 2001 and 2005, but was never put into practice. Finally, in April 2008 two decrees, setting out application obligations, were published (n.100 of 23 April 2008 - n.110 of 29 April 2008): they contain provisions that will favour the birth of a national biofuel market.

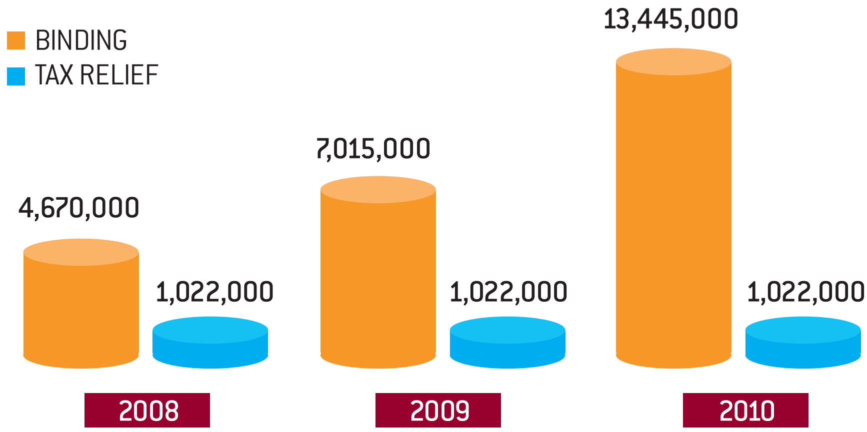
Clearly, Industrial distillers are the ones who are mainly interested in the tax relief set out in the Financial Law, since a litre of ethanol still costs two-three times more than petrol. Tax relief on bioethanol production means that the potential of bioethanol production could exceed the potential ETBE market in Italy (and also the ETBE production capacity of Italian industries) and this could cause further amounts of bioethanol stocks, unless exports are increased.

With regard to ETBE production, in fact, the only plant in Italy is an MTBE-producing plant owned by Ecofuel in Ravenna (ENI); their technology (SNAMPROGETTI/ECOFUEL) allows to alternate the production of MTBE and ETBE through slight changes to the plant configuration. This alternation between MTBE and ETBE production can be decided depending on the availability and price of ehtanol.

In the near future new plants could be realized in other italian refineries.

In the meantime, supply agreements have been reached among the main companies producing bioethanol and Ecofuel for the production of some tenths of thousands tons of ETBE. under the National Program on Bioethanol /ETBE In accordance with the mentioned usage obligations for 2008-2010, Assodistil has estimated the potential Italian market for bioethanol/ ETBE and projected that petrol shall be replaced by 2% in 2008, 3% in 2009 and 5.75% in 2010.

BINDING QUANTITIES OF BIOETHANOL TO BE USED VS TAX-RELIEVED QUANTITIES (2008-2010 - IN HECTANYDRES)



3.2) ECONOMIC ASSESSMENT

The economic assessment of bioenergy supply chains is as fundamental as the assessment of their environmental and social sustainability, in order to forecast their developments in view of achieving the 2020 targets. The economic assessment should obviously take

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into account the respective BAT (Best Available Technologies) for each supply chain, in terms of energy conversion efficiency and technical reliability of plants. That is why the remarks contained in this chapter concern exclusively those technologies that have already achieved technical, economical and market effectiveness. Briefly, they are:

- Thermal energy production (heating, cooling and district heating for domestic use and/or heat / cooling for process uses).
- Electricity production.
- Thermal and electricity cogeneration/trigeneration (heating, cooling and district heating for domestic use and/or heat/ cooling for process uses).
- Supply chain for biofuel for transport .

This chapter will briefly describe the main technologies and plants available for these supply chains and their cost-effectiveness in order to show their potential to enter the national market.

First, it is important to state that the economic assessment of any bioenergy supply chain cannot be determined univocally, but it is dependent upon specific local situations (in terms of available resources, climatic conditions, proximity of users requiring heat and electricity, local support and incentives, number of operational hours per year, etc.).

With regard to incentives, some supply chains in Italy, especially those providing domestic heating and district heating from solid biofuels, are already economically sustainable and do not require state aid. However, for many other supply chains, incentives (such as in the case of production of electricity only) or tax relief measures (such as for the production of biofuels) are extremely important and necessary for their development.

For all bioenergy supply chains, however, the number of annual operational hours of each plant is equally important: the higher the number, the better the payback. The "escalator" factor is also equally important for all the chains: investment costs on plants (per unit of installed power) decrease as plant size increases.

Any economic assessment of the bioenergy sector needs to be compared with reference parameters on the cost of fossil energy: it is in fact the use of biofuels (rather than fossil fuels) that offers savings and thus a payback (over either a short or long period of time) of the greater investment costs that need to be made to build bioenergy conversion plants.

In summary, the main data and reference parameters to be used for a correct economic assessment need to take the following into account:

- Cost of fossil fuels (price of oil).
- Cost and rates of electricity
- Cost of currency (interest rates).
- National and local incentives (GC-Green Certificates, TEE-Energy Efficiency Titles, tax relief measures).

The indexes that are usually employed to perform the economic assessment are the amount of time needed to equal investment costs (Payback) and the Internal Rate of Return (IRR).

Payback estimates the numbers of years required to cover the invested capital with the net gains generated by the investment.

The IRR is the interest rate that should be obtained by investing that capital in the bank throughout the lifespan of the initiative (usually 15 years).

The assessment of initial investment costs and subsequent annual net gains are the starting point of any economic assessment.

Some general data on investment costs for biomass boilers are briefly reported in Addendum A3.8.

ITABIA has recently developed, in cooperation with UNACOMA, a programme that calculates which are the most cost-effective energy conversion technologies according to type, quantity and cost of available biomass. The median data and parameters calculated by this programme for 2008 (e.g. cost of fossil fuels, cost and rates of electricity, interest rates, incentives, etc.) have shown some interesting "economic" peculiarities regarding the IRR of the various technological supply chains, which we report hereafter. This calculation takes into account the supply chains that have greater potential for development in Italy.

SMALL BOILERS FOR DOMESTIC HEATING FROM SOLID BIOFUELS

The main driver for their economic assessment is the location of users and the duration of daily and annual operation as set out in Decree of the President of the Republic (D.P.R.) 412/93. The main climatic zones of the Italian Provinces are reported in Addendum A3.9.

For example, the payback for a chip-fuelled boiler (wood chips at the cost of 70 €/t) supplying heat to users with the same specific structural features (volume, type of construction, etc.) will vary remarkably according to the climatic zone where the boiler is installed. The table below shows that the amount of time needed to recover investment costs decreases as we move from warmer to colder zones, in spite of the higher cost of boilers where more thermal power is needed.

LOCATION	PAYBACK
Climatic Zone A	13 years
Climatic Zone B	7 years
Climatic Zone C	5 years
Climatic Zone D	2.5 years
Climatic Zone E	1.5 years
Climatic Zone F	1 year

Calculations do not include the economic incentives (mainly tax relief measures) granted by national law, which are nonetheless inadequate in regulating thermal renewable energy.

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CLIMATIC ZONE	PERIOD OF USE	ALLOWED HOURS OF USE
A	1 December - 15 March	6 hours daily
B	1 December - 31 March	8 hours daily
C	15 November - 31 March	10 hours daily
D	1 November - 15 April	12 hours daily
F	15 October r - 15 April	14 hours daily
G	No limitation	No limitation

These assessments apply to both small automatic-feed boilers (chips) and manual-feed boilers (pellet and/or firewood): their payback is similar because for manual-feed boilers the cost of the biofuel used is higher, but their investment costs are lower, since these small boilers do not have all the expensive components that are needed in automatic-feed boilers.

DISTRICT HEATING FROM SOLID BIOFUELS

The same remarks made above on climatic zones apply to district heating. Compared to small individual boilers, the payback of district heating systems is "slowed down" by the cost of the heat distribution network. However, installations are bigger and this can have a positive effect on both investment and operation costs.
The following payback values are obtained when supplying heat to the same type of users having similar volumes, using similar distribution networks and a biofuel that has the same cost (wood chips at 70 €/t):

LOCATION	PAYBACK
Climatic Zone A	14 years
Climatic Zone B	8 years
Climatic Zone C	6 years
Climatic Zone D	3 years
Climatic Zone E	2 years
Climatic Zone F	1.5 years

ELECTRICITY (< 1MWE) FROM SOLID BIOFUELS

Unlike heat supply chains, where location and features of various users are the main reference parameters used for their economic assessment, in electricity supply chains the exclusive user is the national public grid which is obliged, by law, to buy renewable electricity produced by IAFR (RES Plants) qualified plants at incentivated rates.
The two main drivers for their assessment are:
> the cost of the biofuel used (wood chips),
> the incentive granted per kWh of electricity produced.
Due to the high investment costs, these thermo-electric plants are employed for the maximum number of annual operational hours (excluding interruptions for planned maintenance work), in order to achieve a more rapid payback.
The incentive that is taken into account per kWh produced amounts to 0.30 €/kWh, as set out in Financial Law 2008.
The incidence of fuel cost (wood chips) is reported in the table below:

COST OF BIOFUEL €/t	PAYBACK
40	6 years
70	8 years

Interestingly, payback values would change if the incentive per kWh produced was lowered to 0.20 €/kWh:

COST OF BIOFUEL €/t	PAYBACK
40	15 years
70	>100 years

This strong payback variation shows the importance of incentives for the future development of this technology.
Investment costs for these small electricity plants fuelled with solid biofuels amount to about € 5,000 per kW of gross electric installed power.

ELECTRICITY (< 1MWe) FROM LIQUID AND GASEOUS BIOFUELS

The economic assessment of plants producing electricity from liquid biofuels (vegetable oils) differs from the economic assessment of electricity production from gaseous biofuels (biogas). Production costs vary greatly and, therefore, different approaches are required for their preliminary economic assessment.
Interestingly, the costs of investing in technologies converting energy from liquid biofuels are 5 times lower than investments on technologies exploiting solid biofuels. However, the unit cost of vegetable oil is 10 times higher than chip wood, even though its energy content is only 3 times higher.
In this case too, the main drivers for their economic assessment are:
> the cost of the vegetable oil used,
> the incentive granted per kWh of electricity produced.
The incentive that is taken into account per kWh produced amounts to 0.30 €/kWh, as set out in Financial Law 2008.
The incidence of fuel (vegetable oil) cost is reported in the table below:

COST OF BIOFUEL €/t	PAYBACK
600	2.8 years
800	4.0 years

Interestingly, payback values would change if the incentive per kWh produced was lowered to 0.20 €/kWh:

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COST OF BIOFUEL €/t	PAYBACK
600	15 years
800	never

Investment costs for these small electricity plants fuelled with liquid biofuels amount to about € 1,500 per kW of gross electric installed power.
The final conversion of biogas into electricity exploits the same process used for vegetable oils (combustion in endothermic engine) and the payback mainly depends on investment and management costs for biogas production, which, however, vary remarkably and can hardly be estimated.
Investment costs for small biogas plants for electricity may be estimated to stand in a variable range between € 2,500 and 5,000 per kW of gross electric installed power, depending on plant size, complexity and efficiency.
Their economic assessment not only depends on investment costs, but also on type and cost of the substrate that is supplied to the anaerobic digester and on the number of plant operational hours.
The incentive that is taken into account per kWh produced for biogas of agro-animal origin amounts to 0.30 €/kWh, as set out in Financial Law 2008: with an incentive of this kind, payback would be achieved within 3 to 6 years.
Important opportunities related to the use of biogas can be developed only if licensing procedures are streamlined and made clearer than existing procedures, in particular with regard to plant construction, connection to national electricity grid, handling and storage of the various matrices that can be used for its production as by-products and not as waste.

ELECTRICITY (< 1 MWe) AND COGENERATION FROM SOLID BIOFUELS

Cogeneration is highly cost-effective when residual heat is recovered throughout the year and recovery is simultaneous and proportional to the production of electricity. This exploitation can only occur through industrial processes and if the demand of low temperature heat is constant, and not only seasonal. This case, however, is not so diffused in Italy.
That is why the economic assessment is here limited to the most common users, that is domestic households and their seasonal heating demand.
For cogeneration too, the climatic zones are of upmost importance, as explained above for domestic heating and district heating.
The table below shows the most interesting climatic zones in terms of residential cogeneration applications, where the heating installation is likely to be operational under the conditions and at the times set out in the above-mentioned Decree of the President of the Republic (D.P.R.) 412.
The incentive that is taken into account per kWh produced amounts to 0.30 €/kWh, as set out in Financial Law 2008.
The following payback values have been calculated for supplying heat to users having similar features (same volume and type of construction), using similar distribution networks and a biofuel that has the same cost (wood chips at 70 €/t):

CLIMATIC ZONE	THERMAL LIMIT	PAYBACK
C	17%	6.7 years
D	28%	5.6 years
E	41%	4.4 years

Interstingly, the Thermal Limit (TL) and payback values improve remarkaby as we move towards colder zones. Moreover, the payback achieved is more interesting than the payback that is reached with the production of electricity only, even if the cost of the biofuel used is the same.

ELECTRICITY (< 1MWe) AND COGENERATION FROM LIQUID AND GASEOUS BIOFUELS

The same remarks made on the cost-effectiveness of cogeneration from solid biofuels apply to this type of cogeneration.
Compared to solid biofuels, liquid biofuels are more cost-effective for the production of electricity and thus for cogeneration. The climatic zone where the plant is installed always affects outcomes. The table below shows the influence of climatic zones on TL and payback for electricity supplied to the same type of users, having the same volume, using similar distribution grids and by estimating the cost of vegetable oil to be 600 €/t.

CLIMATIC ZONE	THERMAL LIMIT	PAYBACK
C	16%	2.5 years
D	27%	2.3 years
E	35%	2.0 years

Interestingly, the Thermal Limit (TL) and payback values reached with cogeneration from liquid biofuels improve remarkably in colder zones: the improvement is however less marked compared to cogeneration from solid biofuels, due to the higher electrical yield and the subsequent lower quantity of residual heat available for heating.

ELECTRICITY (< 1 MWe) AND TRIGENERATION FROM SOLID BIOFUELS

Contrary to cogeneration, the economic assessment of trigeneration is strictly dependent upon the projected number of hours of air conditioning during the summer months: no law whatsoever regulates this number of hours (while D.P.R. 412 regulates winter heating) and the economic assessment is therefore highly hypothetical. Climatic zones do not play an equally important part, simply because the hotter the climatic zone, the less the air conditioning needed in

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summer, and viceversa. The independence of trigeneration from climatic zones in terms of cost-effectiveness is confirmed by the table below, which has been developed by hypothizing different numbers of cooling hours in the summer months for each climatic zone:

CLIMATIC ZONE	AIR CONDITIONING
C	1.000 hours
D	700 hours
E	400 hours

The same hypotheses applied to cogeneration have been applied to trigeneration in terms of volume and type of users, features of distribution grid and cost of biofuel used (chipped wood at 70 €/t):

CLIMATIC ZONE	THERMAL LIMIT	PAYBACK
C	37%	7.0 years
D	39%	6.3 years
E	43%	5.6 years

The table above shows that the effectiveness of trigeneration lies mainly in the high LT value, which in turn means greater energy and environmental efficiency of the entire system.
The payback of trigeneration provided to the same users and for the number of hours in summer mentioned above, does not improve the cogeneration payback, due to the high additional investment cost sustained to install the absorption machine. A significant increase in the number of operational hours in summer would entail a better payback.

ELECTRICITY (< 1 MWe) AND TRIGENERATION FROM LIQUID AND GASEOUS BIOFUELS

The same remarks and the same hypotheses concerning hours of operation in summer, volume and type of users, features of the distribution grid and cost of biofuel used (vegetable oil at 600 €/t) also apply to trigeneration from liquid biofuels:

CLIMATIC ZONE	THERMAL LIMIT	PAYBACK
C	29%	3.5 years
D	32%	3.3 years
E	37%	3.0 years

System effectiveness lies in the high TL value and the subsequent energy and environmental efficiency of the entire system. With regard to payback, the same remarks made for trigeneration from solid biofuels apply.

PRODUCTION OF ELECTRICITY FROM SOLID, LIQUID AND GASEOUS BIOFUELS (INDUSTRAL PLANTS)

The pros of this production are that large plants are cost-effective, be them fuelled with solid or liquid or gaseous biofuels:
> The unit investment cost is lower than that of plants with an electrical capacity < 1 MWe, thanks to the "escalator" effect, and can be estimated to range between 3 and 4 Meuro / MW for solid biofuels and 1 Meuro / MW for liquid biofuels.
> The biofuel usually costs less (because large quantities are purchased in the framework of multi-annual more favourable supply contracts).
> Fixed operation costs in €/kWh (management, maintenance, financial costs, etc.) are lower because they are spread over a large number of kWh that are produced during the lifespan of the plant.

The cons are:
> Low electrical efficiency (25%) of plants fuelled with solid biofuels.
> Difficulty in finding users for the large quantities of residual heat.
> Dependence on the market value of Green Certificates and temporal instability of legislation on the matter.
> Difficulty of investors in obtaining the necessary licenses and authorizations.

The main drivers for their economic assessment are: cost of biofuel and incentive per kWh produced.
Due to the high initial investment costs, plants are likely to work for the maximum number of operational hours per year, excluding any interruptions for planned maintenance work.
The incentive granted per kWh produced is based on the mechanism of Green Certificates, as set out in 2008 Financial Law, for plants with an installed electrical capacity > 1 MWe.
The following payback values are obtained with "short" or local supply chains (supply of biomass within 70 km from the power plant):

COST OF BIOFUEL	PAYBACK
40	4 years
70	6 years

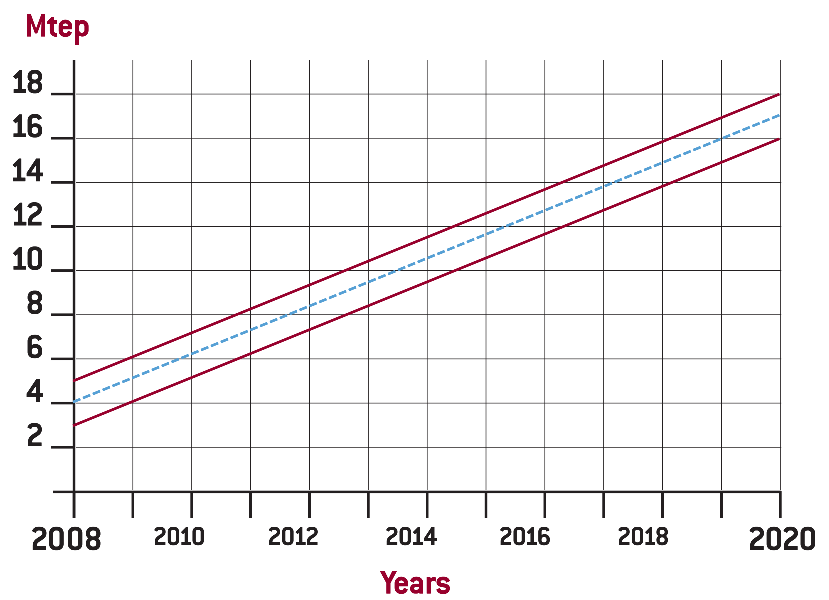
This assessment is however influenced by dependence on the market value of Green Certificates and the lack of clear legislation on the so-called "short" supply chain.

3.3) REMARKS ON MAIN DEVELOPMENT OPPORTUNITIES

In light of the above-mentioned considerations and in order to achieve the targets of the European Directive on RES, projections of possible development scenarios can be made for the various bioenergy supply chains. As stated in Chapter 2, the quantity of bioenergy to be used to cover final gross consumption should amount to about 16-18 Mtoe by 2020, in order to reach the Directive's targets.
These projections also take into account the hypotheses put forward by the Position Paper (see Chapter 1) which sets forth that, in line with the mentioned Directive, the following quantities of primary fossil energy are to be

3. Market/ Good practices

BIOENERGY: TREND OF GROSS FINAL CONSUMPTION

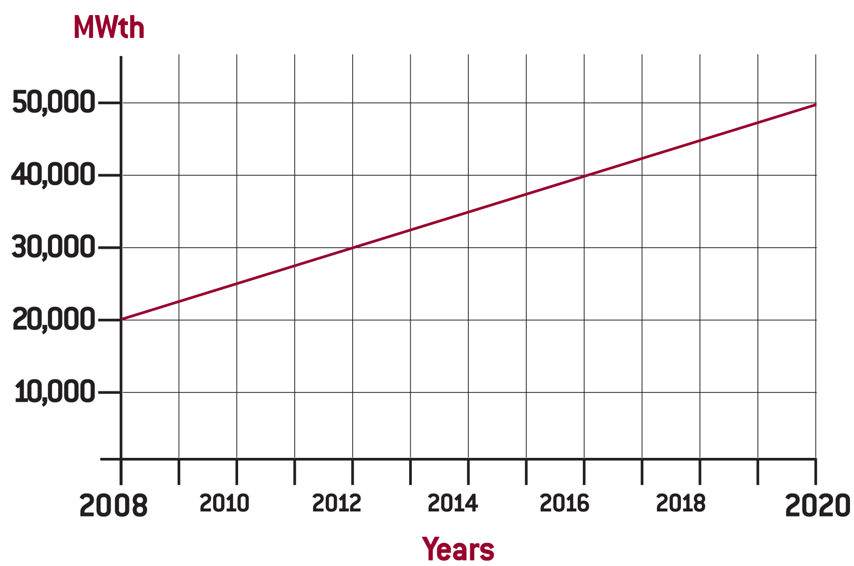


replaced with bioenergy by 2020:
HEAT: 9.3 Mtoe, which will lead to a useful heat production of 80 TWh, with an average actual heat yield (70%).
ELECTRICITY: 2.9 Mtoe which, with a conventional average electrical yield (50%), equal a production of 14.5 TWh, and a corresponding consumption of primary bioenergy of 6 Mtoe, according to the lowest average energy yield of biomass to electricity conversion (25%).
BIOFUELS: 0.6 Mtoe (against the 4.2 Mtoe needed by 2020 to fulfil the obligation to cover 10% of fuel consumption for transport).

The Position Paper, which was drawn up in 2007, could not foresee the objectives that were later set by the Directive on RES (2008). It will be thus necessary to await the enactment of the National "Action Plans" to be issued by Member States by 2010, in order to trace detailed trend curves.
Annex 1 to the Directive provides the indicative trajectories to be followed, in order to monitor whether National targets are actually being achieved.
Italy's indicative trajectory for bioenergy final consumption is represented in the figure below.
More detailed trend curves for the single technologies can only be developed when the National Action Plan has been issued. However, some more general considerations can be made today on the basis of the Position Paper, particularly with regard to investment costs that will have to be made by 2020.

3.3.1) THERMAL ENERGY
Producing 80 TWh/year of thermal energy from biomass (2007 Position Paper) means that by 2020 Italy should have an overall installed capacity of about 50,000 MW, hypothizing an average operation time of 2000 hours a year (including both civil and industrial users).
Today's national installed capacity of biomass fed equipment is of 16000 MW thermal for civil users and 5000 MW thermal for industrial users (see ITABIA - K4 RES Heating EU Project). Most of the boilers installed in Italy are obsolete, and those used in households have very low efficiency outputs. Therefore, they need to be replaced by 2020, which means that at least 40,000 MW of the 50,000 MW needed will have to be replaced through new installations that need to be built. A significant part of thermal energy can, however, be supplied by cogeneration plants which may have a residual, use-

THERMAL ENERGY: TREND OF NEW CROSS POWER INSTALLED



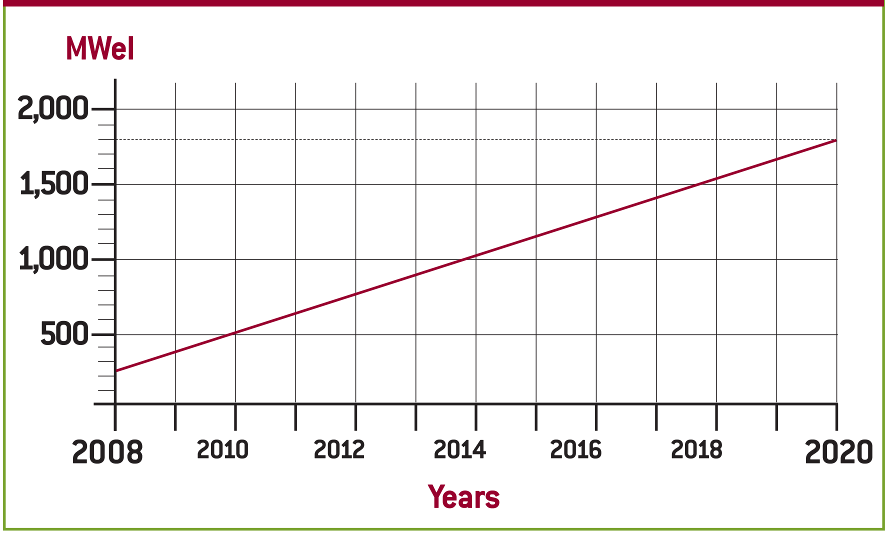
3. Market/ Good practices

ful thermal capacity of at least 3000 MW. This assessment reduces to 37,000 MW the thermal capacity needed, through the construction of new plants, by 2020.
A first estimate of the necessary investment costs is based on the fact that the new capacity will be mainly made up of small household boilers, even if district heating has recently started to develop and is expected to grow, owing to its cost-effectiveness and favourable environmental and social impact. It can be estimated that the unit investment cost of new boilers will amount to € 400/kW, inclusive of new district heating networks: the total investment needed by 2020 can be so far estimated to be about Euro 15 billion.
The expected development trend for biomass heating systems can be hypothesized to be as shown in the figure below.
Statistics do not include an additional 14,000 MW thermal capacity supplied by very small systems which have a power output that is lower than 10 kW , namely fireplaces, thermo-fireplaces, stoves, hobs, etc. Estimates by the Italian Pellets Association show that in Italy there about 740,000 modern stoves fuelled with wood pellets.

3.3.2) ELECTRICITY

Producing 14.5 TWh/year from biomass (2007 Position Paper) means using (average electricity yield amounts to 25%) about 6 Mtoe/year of primary bioenergy and having by 2020 an installed electrical capacity of about 2,000 MWe (estimating an average operational hours of 7,000 hours/year).
The current installed electricity capacity (including the contribution given by urban solid waste) is of about 1,300 MWe, but at least 80% of these plants are likely to be closed (because they are obsolete, or because the CIP6 and other national incentives are near to expire) and be subject to modernisation.
This assessment brings the electrical capacity of new plants to be installed by 2020 to 1,800 MWe.
Investment costs can be estimated by taking into account that this new capacity will be mainly produced by small/medium-sized cogeneration electricity plants (<1MWe) fuelled with solid, liquid and gaseous biofuels. Investment costs for each of these units can be estimated to be ? 3,000/kWe (average). The overall investment needed from now until 2020 can thus be estimated to amount to around 5 billion euros.
By installing cogeneration systems in these new plants, a significant amount of thermal capacity (at least 3,000 MW) will be available, favouring a reduction of investment costs needed to install new boilers, as explained in the

ELECTRICITY: TREND OF NEW GROSS POWER INSTALLED



3. Market/ Good practices

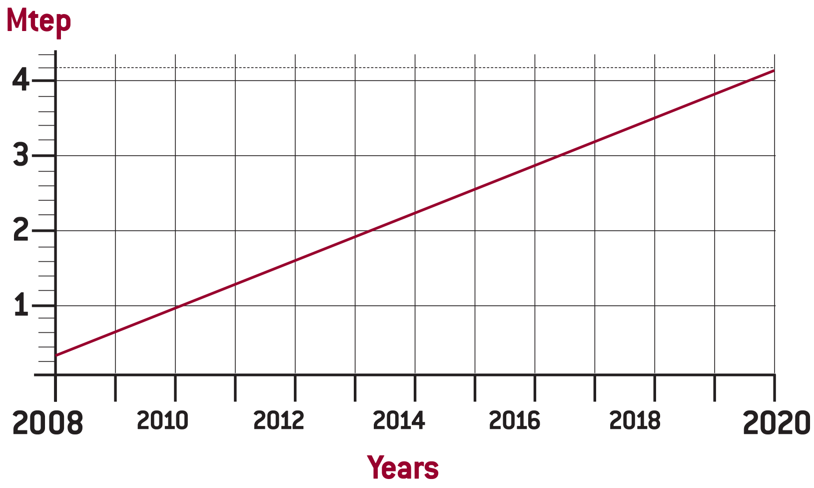
previous paragraph on thermal energy. The positive economic analyses of electrical production and cogeneration from solid, liquid and gaseous biofuels (see excellent payback of plants) suggest the trend projection that is reported in the table below.

3.3.3) BIOFUELS FOR TRANSPORT

By 2020, to fulfil the requirement to include 10% of biofuels in fuel consumption for transport , 4.2 renewable Mtoe will be necessary. This amount corresponds to about 5.5 million tons of biofuels, most of which produced by second-generation technologies. Nonetheless, in any case, Italy will have to resort to imports.

Recent studies and analyses have shown that the biofuels market will invest over Euro 20 billion by 2020, in order to comply with the targets of the EU Directive. These analyses exclude investments on first and second generation plants for the production of biofuels, which cannot be easily estimated yet.

BIOFUELS FOR TRANSPORT: TREND OF FINAL CONSUMPTION



3.3.4) CONCLUSION

The supply of solid, liquid and gaseous biofuels to the various technological conversion plants will amount to approximately Euro 10 billion.

The above-mentioned National Action Plans, to be enacted by 2010, will allow to analyse the market projections that are being presented in this chapter. In the meantime, while waiting for the National Plans issue, it is important to acknowledge that there are some difficulties in achieving the Directive's targets and the necessary actions to overcome such difficulties need to be immediately envisaged.

These actions are summarized in a document by APER (Association of Producers of Renewable Energy) and hereafter we report an excerpt:

"1. *Definition, to be agreed between National Government and Regions, of the targets to be achieved in terms of quantity of energy source and regional distribution: the national target must be the result of the sum of the realistic regional targets.*

2. *Setting of mechanisms of awards and sanctions for the achievement of regional targets, by applying "flexible mechanisms" so as to guarantee economic returns for "virtuous" Regions.*

3. *Definition of clear licensing and authorizing criteria that are reliable over time and non-discriminatory, that favour the harmonization of regional regulations and the elimination of possible local hostilities.*

4. *Establishing a body with executive powers to monitor the achievement of RES targets in Italy, also by strengthening the role of the National Observatory for Renewable Sources and energy efficiency, set up under Legislative Decree 387/03, whose duties and tasks should be further implemented.*

5. *Strengthening and developing the role of CNR (National Research Centre), ENEA (National Agency for New Technologies, Energy and the Environment), CESI (Italian Experimental Electro-technical Centre) in the planning and spreading of information for basic research (and also applied research) in the renewable sector.*

6. *Full implementation of laws 222/07 and 244/07 through applicative decrees to be enacted by the competent Ministries, in coordination with the AEEG - Authority for electricity and gas."*

3] Addenda

A3.1) PARAMETERS FOR ASSESSING THE DEGREE OF SUCCESS OF BIOMASS PLANTS

COMPANY: Azienda Pubbliservizi Brunico - Stadtwerke Bruneck
REGION/CITY: TN-AA, 39031 Brunico (BZ)
PERIOD CONSIDERATED: 2007
PLANT CAPACITY: 7,306 MW
BIOMASS USED: Chipped wood, bark, forest wood shaving

1 TECHNICAL ISSUES	TOPIC	DESCRIPTION
1.1 Dedicated crops and/or biomass sources of origin	Cultivated and/or harvested species	larch, fir
	Method of cultivation and/or harvesting	n.a.
	Productivity rates in terms of ton/ha	n.a.
	Unit cost of harvesting (euro/ha)	n.a.
	Geographical sources of origin	direct suppliers: approx. 75 km
	Suppliers	sawmills, woods owners
	Type of supply contract	m^3 steres
1.2 Supply, transport and storage of biomass	Ways and means of transport	trucks / lorries
	Type of transport contract	included in the price of biomass
	Storage facilities	open-air outdoor facility
	Duration of storage	6 months
1.3 Plant management	Process of energy conversion	biomass boilers
	Type of energy recovery	boilers: exhaust fumes (950°C) hot water (95°C)
	Quantity of biomass used (ton/year)	43,320
	Output capacity of installed thermal power (MWt)	73,6
	energy yields (% kJin/kJout)	85%
	Technology for cutting emissions	electrostatic filters and condensation systems
1.4 End uses of energy produced	Population and users served (N. of inhabitants and N. of buildings)	approx. 13,000 inhabitants - approx. 2,200 buildings
	Heated volume (m^3)	n.a.
	Energy produced (kJ/year)	129 MWh - 467 TJ
	Distributed energy (kJ/year)	109 MWh
	Pro-capita energy/inhabitant ratio (kJ/person)	n. disp.
1.5 Energy and environmental sustainability	Saved fossil fuels (ton/year)	11,000
	Saved CO_2 emissions (ton/year)	27,000
	Avoided HCl, NOx, and other emissions (ton/year)	n.a.
1.6 Residues produced	Waste and/or recovered material (ton/year)	
	Process ashes (ton/year)	140
	Destination of waste and ashes	dump

Addenda to Chapter 3

2 LEGAL ISSUES	TOPIC	DESCRIPTION
2.1 Dedicated crops and/or biomass sources of origin	Regional and/or national legal requirements	
	Stability and duration of legal requirements	
	Other information:	
2.2 Supply, transport and storage of biomass	Regional and/or national legal requirements	V.I.A. - Provincial Association for Crafts (APA) in Bolzano
	Stability and duration of legal requirements	
2.3 Plant management	Operation licences and their duration	Autonomous Province of Bolzano Office for Air and Noise (rip. 29.2)
	Rules for plant operators	
2.4 End uses of energy produced	Regional and/or national requirements and/or constraints to transfer of energy produced	
	Regional and/or national contracts for transfer of energy produced	
2.5 Energy and environmental sustainability	Legal requirements/limitations to energy production	Autonomous Province of Bolzano Office for Air and Noise (rip. 29.2)
	Legal requirements/limitations to emissions into the atmosphere	Autonomous Province of Bolzano Office for Air and Noise (rip. 29.2)
2.5 Residues produced	Legal requirements/limitations to residue disposal	Legislative decree 22/1997, Ministerial Decree 145/1998, Decision 27.07.1984

3 ECONOMIC ISSUES	TOPIC	DESCRIPTION
3.1 Dedicated crops and/or biomass sources of origin	Regional and/or national economic-financial incentives	
	Stability and duration of economic-financial incentives	
	Support measures for farmers/producers	Woods owners: market price + 40%
	Specific economic assessments (ROI, PBT, etc.)	
	Effects and advantages for employment	
	Political and/or social acceptance	Very high
3.2 Supply, transport and storage of biomass	Supply and transport costs(€/ton)	not defined (included in the price of biomass - carriage paid)
	Storage costs (€/ton)	n.a.
3.3 Plant management	Specific economic assessment (ROI, PBT, etc.)	
	Types of support measures (ex-CIP 6, green certificates, etc.)	provincial capital account contribution (LP 4/1993)
	Unit management costs (€/ton)	
	Unit investment costs (M€/ton)	
3.4 End uses of energy produced	Contracts of energy transfer	Yes
	Unit energy enhancement (€/kJ)	0.095 / kWh
3.5 Energy and environmental sustainability	Economic savings of fossil fuels (€/year)	
	Energy savings in TEP (Tep/year)	
3.6 Residues produced	Cost of residue disposal (€/ton)	
	Cost of disposal of ashes (€/ton)	approx. 130 €/t
	Alternatives to disposal and/or recovery of residues	

Addenda to Chapter 3

A3.2) BIOMASS DISCRICT HEATING PLANTS

REGION Municipality, Province and Company	POWER MWt-MWe	BOILERS N°	NETWORK Km	USERS N°	ENERGY production MWh/year	BIOMASS consumption t/year
VALLE D'AOSTA						
1 **Pollein (AO)** S.E.A. Srl	5	2	2.5	21	2,600	1,800
2 **Morgex (AO)** Le Brasier Srl	7	2	10	200	8,500	5,700
3 **Pré-Saint-Didier** S.E.A. Srl	4.1- 0.205	2	5	80	9,500	5,500
PIEMONTE						
4 **Leinì (TO)** Provana Calore Srl	10	2	10	67	14,790	6,788
5 **Castellamonte (TO)** A.S.A. Srl	9	2	13.75	152	12,729	8,600
6 **Chivasso (TO)** Comune di Chivasso	1.2	1	n.a.	240	Recent start-up	
7 **Vico Canavese (TO)** Vico Energia Srl	3.5	2	3	78	Recent start-up	
8 **Vinovo (TO)** Comune di Vinovo	1.65	1	n.a.	5	Recent start-up	
9 **Verzuolo (CN)** ETS Srl	5.8	2	3.8	31	7,755	2,995
10 **Ormea (CN)** Calore Verde Srl	3.9	2	5.5	152	4,520	3,240
11 **Arquata Scrivia (AL)** B.E.A. Scarl	1	1	n.a.	n.a.	1,220	567
12 **Serravalle Scrivia (AL)** B.E.A. Scarl	1	1	0.55	4	2,130	1,054
13 **Casale Monferrato (AL)** Comune	0.2	1	n.a.	3	Recent start-up	
LOMBARDIA						
1 **Collio (BS)** F.R. Alta Val Trompia Srl	12.5	1	18	320	n.a.	n.a.
2 **Corte Franca (BS)** IS.PA.RO. Onlus	0.25	1	0.07	3	Self consumption	
3 **Ospitaletto (BS)** Fraternità Agricola Onlus	0.9	1	0.5	2	772	98
4 **Piancogno (BS)** Integra Srl	5.5	2	12.5	200	n.a.	n.a.
5 **Sellero Novelle (BS)** T.S.N. Srl	12.9	1	14	415	n.a.	n.a.
6 **Sondalo (SO)** T.C.V.V.V. SpA	10	2	17.3	339	28,982	8,600
7 **Tirano (SO)** T.C.V.V.V. SpA	20	3	30.4	641	66,882	25,500
8 **S. Caterina Valfurva (SO)** T.C.V.V.V. SpA	12	2	3.6	38	Start-up 2007	
9 **Marchirolo (VA)** Energia Legno Varese Srl	1	1	0.36	8	Start-up 2008	
10 **Gerosa (BG)** Wood factory	0.65	1	n.a.	4	Recent start-up	n.a.
11 **Peghera di Taleggio (BG)** Wood factory	0.5	1	n.a.	4	Recent start-up	n.a.
12 **Gargnano (BS)** Hotel	0.65	1	n.a.	3	Recent start-up	n.a.
PROVINCIA AUTONOMA DI TRENTO						
1 **Cavalese** Bioenergia Fiemme SpA	8	2	20	475	24.609	10,125
2 **Fiera di Primiero** Ecotermica S. Martino Srl	8	2	12.6	218	n.a.	n.a.
3 **Fondo** Bioenergy Anaunia SpA	5	2	6,5	144	5,932	7,285
4 **Pieve di Ledro** Foletto Snc	0.55	1	0.08	6	Start-up 2007	
5 **Predazzo** Eneco Energia Ecologica Srl	2.32	1	16	40	6,700	2,160
6 **S. Martino di Castrozza** n.a.	8.8	2	13	230	23,952	9,140
7 **Malosco** n.a.	0.9	1	n.a.	n.a.	n.a.	n.a.
8 **Tres** n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
9 **Grumes** n.a.	0.6	1	n.a.	n.a.	n.a.	n.a.
10 **Cloz** n.a.	0.8	1	n.a.	n.a.	n.a.	n.a.
11 **Coredo** n.a.	6	1	n.a.	n.a.	n.a.	n.a.
12 **Pellizzano** n.a.	n.a.	1	n.a.	n.a.	n.a.	n.a.
PROVINCIA AUTONOMA DI BOLZANO						
1 **Resia** Bioenergia Resia Scrl	1.6	1	5	31	n.a.	n.a.
2 **Slingia** Bioenergiegenossenschaft Scrl	0.3	1	n.a.	15	n.a.	n.a.
3 **San Valentino alla Muta** Bioenergie Scrl	1.6	1	n.a.	81	460	n.a.

Addenda to Chapter 3

REGION Municipality, Province and Company	POWER MWt-MWe	BOILERS N°	NETWORK Km	USERS N°	ENERGY production MWh/year	BIOMASS consumption t/year
4 **Siusi** Bio Heizwerk Srl	0.85	1	n.a.	15	680	n.a.
5 **San Pietro-Funes** Azienda Elettrica Scrl	1,1	1	n.a.	90	n.a.	n.a.
6 **Laces** Energetica Laces Scrl	8,4	2	n.a.	373	n.a.	n.a.
7 **Solda** Coop. di Energia Solda Scrl	4	2	17.1	111	9,847	6,070
8 **Vandoies** Energiegenoss. Vintl Scrl	2.5	1	9.4	145	6,772	n.a.
9 **Valles** Fonti Energetiche Valles Scrl	4	2	8.2	132	6,306	3,610
10 **Obereggen** Energia e Teler. Scrl	2.65	2	1.8	12	4.000	n.a.
11 **Varna-Bressanone** Ener-Team Srl	0,7	2	n.a.	7	440	830
12 **Prato allo Stelvio** Az. Energetica Scrl	2.8	2	17	347	7,416	3,495
13 **Lutago-Lutago di Sopra-Gisse** Feichter Holz Sas	2.95	3	5	162	4,881	1.840
14 **Dobbiaco-San Candido** FTI Scrl	18-1,5 (ORC)	3	87	680	44,096	34,430
15 **Colle Isarco** Teleriscald. Colle Isarco Scrl	3.5	1	n.a.	117	3,499	n.a.
16 **Racines di Dentro** teleris. Racines Srl	1.2	1	n.a.	29	n.a.	n.d
17 **Chiusa** Teleriscaldamento Chiusa Srl	3	1	n.a.	450	n.a.	n.a.
18 **Lazfons** Teleriscaldamento Chiusa Srl	1	1	n.a.	94	1,528	n.a.
19 **Valdaora di Sot. Mez. e Sop.** Centr. Teleris.	8	2	19	488	17,106	13,350
20 **Sorafurcia** Centr. Teleris. Valdaora SpA	1.1	1	n.a.	22	n.a.	n.a.
21 **Sesto** Teleriscaldamento Sesto Srl	9	2	17.4	335	17,520	n.a.
22 **Verano** Termocentrale Verano Scrl	1.6	2	5	90	1,929	1,050
23 **Monguelfo-Villabassa** Telerisc. Scrl	6	2	23.5	430	19,578	8,180
24 **Prato alla Drava** Telerisc. Rainer Srl	0.55	1	0.58	18	706	n.a.
25 **Tiso-Funes** Teleriscaldamento Tiso Scrl	0.85	1	n.a.	51	302	n.a.
26 **San Nicolò** Coop. Prom. Ultimo Scrl	0.7	1	n.a.	26	1,171	n.a.
27 **San Pancrazio** Coop. Prom. Ultimo Scrl	0.7	1	n.a.	49	1,866	n.a.
28 **S. Valpurga-Pracupola** Coop. Prom. Ult.	1.4	1	n.a.	130	5,147	n.a.
29 **San Giovanni-Riepe Com. Valle Aurina**	0.55	1	n.a.	16	182	n.a.
30 **Laion** Comune di Laion	1.3	1	n.a.	110	3,165	n.a.
31 **Luson** Comune di Luson	1.4	1	n.a.	94	n.a.	n.a.
32 **Malles** Comune di Malles	1.2	1	n.a.	49	2,648	n.a.
33 **Martello** Comune di Martello	0.55	1	n.a.	5	437	n.a.
34 **Naturno** Comune di Naturno	1,4	1	1.05	10	2,608	n.a.
35 **Terento** Comune di Terento	1	1	n.a.	68	3,015	n.a.
36 **Terlano** Comune di Terlano	1.2	1	n.a.	15	n.a.	n.a.
37 **Velturno** Centrale Termica Velturno Scrl	2.1	1	n.a.	120	3,229	n.a.
38 **Sarentino-Villa** Telerisc. Sarentino Scrl	3	1	n.a.	199	6,794	3,400
39 **Nova Ponente** Holz & Ko Srl	0.84	1	0.96	12	791	1,050
40 **Lasa-Oris** Laser Eyrser Energie. Scrl Laser Eyrser Energie. Scrl	6.2	2	23	470	15,262	6,420
41 **La Villa-Funtanacia** Ligna Calor SpA	5	2	17	264	12,640	6,780
42 **Plan, Moso in Passiria** Pfelderer Genossenschaft Scrl	1.2	1	1.7	42	1,456	675
43 **Prato allo Stelvio** Polyfaser Srl e Az. En. Prato Scrl	3.2	2	n.a.	15	2,228	n.a.
44 **Sluderno-Glorenza** Schluderns Glurns Energieg. Scrl	4.5	2	19.4	447	11,369	10,270

Addenda to Chapter 3

REGION Municipality, Province and Company	POWER MWt-MWe	BOILERS N°	NETWORK Km	USERS N°	ENERGY production MWh/year	BIOMASS consumption t/year
45 **Malles** Impianti Sportivi Malles SpA	2.45	2	n.a.	64	4,323	n.a.
46 **Brunico-Perca** Az. Pubbliser. Brunico	20-4.5	3	110	1,884	109,429	43,320
47 **Versciaco** Sulzenbacher Otto & Co. Snc	1.1	1	n.a.	45	2,266	n.a.
48 **San Pietro-Laion** Telfholz Srl	0.55	1	n.a.	16	319	n.a.
49 **Antermoia** Termo Antermoia Scrl	1.2	1	2.4	50	1,445	n.a.
50 **Vipiteno-Prati-Casateia** Thermo Wipptal SpA	17.3	2	66.4	584	31,000	15,740
51 **Burgusio** Wood factory Telser Snc	1.2	2	n.a.	50	477	n.a.
52 **S. Giovanni-Cadipietra** **S. Giacomo-Valle Aurina** Wärme und Energie. Ahrntal Scrl	1.6	1	n.a.	122	n.a.	n.a.
53 **Anterselva di Mezzo** Termocen. Scrl	3.4	2	n.a.	127	3,447	n.a.
54 **Rasun** Wärmewerke Rasen SpA	5	2	16	306	9,574	5,770
55 **Lappago** Az. Elet. Selva dei Mulini SpA	0.35	1	n.a.	24	n.a.	n.a.
56 **Selva dei Mulini** Az. Elettrica SpA	1.4	1	n.a.	90	2,110	275
57 **San Martino-Sarentino** Cons. Centr. F.lli Gruber	0.37	2	0.9	10	1,058	n.a.
58 **Castelrotto** Private company	n.a.	1	n.a.	n.a.	n.a.	n.a.
59 **Lana** Comune di Lana	0.65	1	n.a.	82	n.a.	n.a.
60 **Lana** Comune di Lana	0.30	1	n.a.	4	n.a.	n.a.
61 **S. Martino in Passiria** Comune	0.19	1	n.a.	4	n.a.	n.a.
VENETO						
1 **Ponte S. Nicolò (PD)** Biomasse Europa Srl	0.58	1	0.3	3	n.a.	n.a.
2 **Treviso** Comune di Treviso	1.3	2	n.a.	8	Recent start-up	n.a.
3 **Valdastico (VI)** Industria agroalimentare	0.3	1	n.a.	3	Recent start-up	n.a.
FRIULI VENEZIA GIULIA						
1 **Buttrio, Caminetto (UD)** private company	0.17	1	n.a.	1	204	25
2 **Capriva del Friuli (GO)** civil buildings	0.11	1	n.a.	1	132	n.a.
3 **Chiusaforte (UD)** private company	0.20	2	n.a.	3	300	180
4 **Cividale del Friuli (UD)** Farm solida	0.10	1	n.a.	3	120	80
FRIULI VENEZIA GIULIA						
5 **Forni di Sopra (UD)** private company	0.54	1	n.a.	3	810	400
6 **Malborghetto Valbruna Ugovizza (UD)** civil buildings	0.15	1	n.a.	2	225	150
7 **Ovaro (UD)** Hotel and civil buildings	0.50	1	0.22	4	750	290
8 **Pontebba (UD)** private company	0.68	1	n.a.	1	1.020	n.a.
9 **Romans d'Isonzo** private company	0.465	1	n.a.	1	558	n.a.
10 **San Giorgio della Richinvelda, Rauscedo (PN)** Azienda sperimentale	0.70	1	n.a.	3	840	300
11 **San Giorgio di Nogaro (UD)** civil buildings	0.40	1	n.a.	1	480	400
12 **Sgonico (TS)** Farm solida and civil buildings	0.10	1	n.a.	4	149	50
13 **Treppo Carnico (UD)** C. M. della Carnia	0.55	1	0.7	17	1,069	n.a.
14 **Villa Santina (UD)** Hotel and civil buildings	0.10	1	n.a.	1	150	55
15 **Villa Vicentina (UD)** public administration	0.30	1	n.a.	3	360	n.a.
LIGURIA						
1 **Campo Ligure (GE)** C. M. Valli Stura e Orba	0.7	1	n.a.	n.a.	n.a.	n.a.
2 **Rossiglione (GE)** C. M. Valli Stura e Orba	1.2	1	n.a.	n.a.	n.a.	n.a.
3 **Carcare (SV)** n.a.	1	1	n.a.	n.a.	n.a.	n.a.

Addenda to Chapter 3

REGION Municipality, Province and Company	POWER MWt-MWe	BOILERS N°	NETWORK Km	USERS N°	ENERGY production MWh/year	BIOMASS consumption t/year
EMILIA ROMAGNA						
1 **Lizzano in Belvedere, Vidiciatico (BO)** Warmwood Srl	3	1	20	235	3,868	1,840
TOSCANA						
1 **Campogiano (LU)** Comune	0.54	1	0.3	3	n.a.	150
2 **Castel San Niccolò (AR)** C. M. del Casentino	0.35	1	0.6	17	n.a.	220
3 **Loro Ciuffenna (AR)** Comune	0.5	1	0.3	6	n.a.	266
4 **Casole d'Elsa (SI)** Comune	0.54	1	0.1	4	n.a.	211
5 **Monticiano (SI)** Comune	0.50	1	0.1	2	n.a.	50
MARCHE						
1 **Apiro (MC)** Comune	1.2	1	n.a.	n.a.	n.a.	n.a.
CAMPANIA						
1 **Eboli (SA)** Azienda Improsta	0.29	1	0.1	5	110	60
BASILICATA						
1 **Calvello (PZ)** Centro Polifunzionale	0.22	1	0.1	3	85	120
TOTAL 128 Plants	**370**	**172**	**716**	**14,388**	**620,000**	**280,000**

Source: Segreteria Generale Itabia, Segreteria Nazionale Fiper, Consorzio Biomassa Alto Adige, Provincia Autonoma di Bolzano e Provincia Autonoma di Trento - Agenzia provinciale per l'energia.

A3.3) BIOMASS POWER PLANTS IN ITALY

REGION Municipality, Province and Company	POWER MWe	BIOMASS consumpt. (t/year)	TECNOLOGY	ENERGY generation	WEB SITES
PIEMONTE					
Airasca (TO) STC - ATEL Srl	14.6	120,000	Mobile grid	Cogeneration	stcgroup.com
Crova (VC) Idroblins Srl	6.7	64,000	Mobile grid	Electricity	n.a.
Verzuolo (CN) Cartiere Burgo SpA	5.5	95,000	Fluidized bed	Cogeneration	burgo.com
LOMBARDIA					
Brescia ASM (III linea)	20.0	289,000	Mobile grid	Cogeneration	a2a.eu
Sustinente (MN) Gruppo Saviola	8.0	110,000	Mobile grid	Electricity	grupposaviola.com
Pavia Riso Scotti Energia Srl	7,6	80,000	Mobile grid	Cogeneration	risoscotti.it
Valle Lomellina (PV) Curti Riso SpA	4.5	42,000	Mobile grid	Electricity	regioneambiente.it
Lomello (PV) Riso Ticino Scrl	3.6	2,000	Fixed grid	Electricity	calorsrl.com
Castiraga Vidardo (LO) Ecowatt Srl	3.6	40,000	Mobile grid	Electricity	cti2000.it
VENETO					
Ospitale di Cadore (BL) SICET Srl	20.0	200,000	Fluidized bed	Electricity	cti2000.it
Castellavazzo (BL) CEB SpA	5.0	39,000	Mobile grid	Electricity	protoimprese.it
FRIULI VENEZIA GIULIA					
Manzano (UD) Nuova Romano Bolzicco	2.5	21,000	Mobile grid	Cogeneration	premioinnovazione.
EMILIA ROMAGNA					
Bando d'Argenta (FE) S. Marco Bioenergie SpA	20.0	280,000	Vibrating grid	Electricity	bioenergiespa.it

Addenda to Chapter 3

REGION Municipality, Province and Company	POWER MWe	BIOMASS consumpt. (t/year)	TECNOLOGY	ENERGY generation	WEB SITES
Faenza (RA) Cavino Energia Scrl	3.2	33,000	Mobile grid	Cogeneration	distilleria.caviro.it
TOSCANA					
Scarlino (GR) Scarlino Energia Srl	19.5	120,000	Fluidized bed	Electricity	marsegliagroup.com
UMBRIA					
Terni ENA Srl	10.0	90,000	Mobile grid	Electricity	enertad.it
MOLISE					
Termoli (CB) Ecoenergy Srl	14.6	120,000	Mobile grid	Electricity	stcgroup.com
Pozzilli (IS) Energonut Srl	11.4	85,000	Mobile grid	Electricity	e-gazette.it
PUGLIE					
Monopoli (BA) Ital Green Energy Srl	12.0	110,000	Mobile grid	Electricity	marsegliagroup.com
Maglie (LE) CoperSalento SpA	3.0	18,000	Mobile grid	Electricity	protoimprese.it
CALABRIA					
Strongoli (KR) Biomasse Italia SpA	40.0	400,000	Fluidized bed	Electricity	biomasseitalia.it
Crotone Biomasse Italia SpA	20.0	250,000	Vibrating grid	Electricity	biomasseitalia.it
Cutro (KR) E.T.A. SpA	14.0	190,000	Fluidized bed	Electricity	etacutro.com
Rende (CS) Ecosesto SpA	12.3	150,000	Vibrating grid	Electricity	actelios.it
Rossano Calabro (CS) Rossano Energia Srl	4.2	36,000	Vibrating grid	Electricity	icqholding.it
TOTAL 25	**285.8**	**3,009,000**	**14 Mobile grid 4 Vibrating grid 1 Fixed grid 6 Fluidized bed**	**19 Electricity 6 Cogeneration**	

A3.4) MAIN BIOMASS PLANTS IN EUROPE

COUNTRY AND MUNICIPALITY	COMPANY	BIOMASS CONSUMPTION (t/year)	POWER	TECNOLOGY
SVEZIA				
Örebro	Örebro Energi AB	260,000	165 MWt	Fluidized bed CFB
Västeras	Mälarenergi AB	250,000	60 MWe	Fluidized bed CFB
Perstorp	Perstorp AB	90,000	55 MWt	Fluidized bed CFB
Lidköping	Lidköping Värmeverk AB	50,000	30 MWt	Fluidized bed BFB
Sala	Heby Energi AB	50,000	30 MWt	Fluidized bed BFB
Norrsundet	Norrsundet Bruk AB	45,000	27 MWt	Gassificatore BFB
FINLANDIA				
Lahti	Kymijärvi Power Station	80,000	50 MWt	Gassificatore CFB
Pietarsaari	Oy Wisaforest AB	55,000	35 MWt	Gassificatore BFB
Pieksämäki	Pieksämäki D. H. AB	35,000	20 MWt	Fluidized bed BFB
GERMANIA				
Bertenrath	n.a.	240,000	150 MWt	Gassificatore HTW
Rüdersdorfer	Rüdersdorfer Zement AG	160,000	100 MWt	Gassificatore CFB
Schwedt	Haindl Papier GmbH	55,000	34 MWt	Fluidized bed BFB

Addenda to Chapter 3

NAZIONE E LOCALITÀ	SOCIETÀ di gestione	CONSUMI BIOMASSA (t/anno)	POTENZA	TECNOLOGIA adottata
DANIMARCA				
Køge	Junckers Industrier AS	105,000	65 MWt	Vibrating grid
Rudkøbing	Rudkøbing Kraftvarm AS	25,000	16 MWt	Vibrating grid
OLANDA				
EVZ AV	135,000	84 MWt		Gassificatore CFB
AUSTRIA				
Sankt Veit	Funder GmbH	50,000	32 MWt	Fluidized bed FICB
SPAGNA				
Villanuevadel Arzobispo	Energia de la Loma SA	150,000	16 MWe	Mobile grid

A3.5) MSW AND RDF THERMOVALORIZATION PLANTS

REGION Municipality (Province)	TREATMENT capacity (n. lines x t/d)	FUEL	COMBUSTION technology	FLUE-GAS treatment technology	ELECTRIC power (MW)
PIEMONTE					
Mergozzo (VB)	2 x 60	MSW	ACG - Fonsar (I)	DeNOx + CR + BF + WET	5
Vercelli (VC)	3 x 75	MSW	ACG - DBA (D)	BF + WET	4
Torino, Gerbido	3 x 540	MSW	A/WCG - Von Roll (CH)	DeNOx + ESP + BF	65
LOMBARDIA					
Bergamo (BG)	1 x 200	RDF	BFB - EPI (USA)	1BF + CR + 2BF + DeNOx	11,5
Brescia (BS)	3 x 750	MSW + Biomas.	ACG - Martin (D)	CR + BF	84,4
Busto Arsizio (VA)	2 x 200	MSW	ACG - W+E (CH)	DeNOx + BF + WET	9,2
Como, loc. La Guzza (CO) (revamping)	1x120 + 1x150	MSW	ACG - De Bartolomeis (I)	ESP+CR+BF+DeNOx+WET	6
Corteolona (PV)	1 x 180	RDF	BFB - Kvaerner (S)	DeNOx + CR + BF	8,7
Cremona (CR)	2 x 125	MSW	ACG - Steinmüeller (D)	CR + BF + WET	6
Dalmine (BG)	2 x 200	RDF	WCG - NoyVallesina (I)	ESP + CR + BF + DeNOx	15,6
Desio (MI)	2 x 120	MSW	ACG - De Bartolomeis (I)	DeNOx + ESP + CR + BF	5,7
Parona Lomellina (PV)	1x 620 + 1x580	RDF	CFB - Foster Wheeler (USA)	DeNOx + CR + BF	38
Milano, Silla 2	3 x 485	MSW	A/WCG - ABB W+E (CH)	ESP + BF + DeNOx	59
Sesto San Giovanni (MI)	3 x 80	MSW	ACG - De Bartolomeis (I)	DeNOx + ESP + WET + BF	5,5
Trezzo sull'Adda (MI)	2 x 300	MSW	WCG - Von Roll (CH)	DeNOx + CR + BF + WET	20,2
Valmadrera (LC) (revamping)	1x120 + 1x160	MSW	ACG - TM.E. (I)	DeNOx + CR + BF + WET	10,5
TRENTINO ALTO ADIGE					
Bolzano	1x150 + 1x200	MSW	ACG - DBA/Lentjes (D)	BF + WET + DeNOx	6.05
FRIULI					
Trieste	3 x 204	MSW	A/WCG - W+E (CH)	DeNOx + CR + BF + WET	14.9
VENETO					
Padova	2 x 150	MSW	ACG - Von Roll (I)	DeNOx + CR + BF + WET	6.6
(third line: construction)	1 x 300	MSW	WCG - Martin (D)	1 BF + CR + 2 BF + DeNOx	7
Schio (VI)	1 x 36+60+100	MSW	ACG - DBA (D)	DeNOx + ESP + CR + BF	6.9

Addenda to Chapter 3

REGION Municipality (Province)	TREATMENT capacity (n. lines x t/d)	FUEL	COMBUSTION technology	FLUE-GAS treatment technology	ELECTRIC power (MW)
Venezia, loc. Fusina	1 x 150	MSW	ACG - W+E (CH)	DeNOx + CR + BF + WET	2.15
Verona	2 x 180	RDF	BFB - Thyssen (D)	DeNOx + CR + BF	21.8
EMILIA ROMAGNA					
Granarolo dell'Emilia (BO)	2 x 300	MSW	A/WCG - Von Roll (CH)	CR + BF + WET + DeNOx	22
Coriano (RN) (revamping)	2 x 280	MSW	ACG - Von Roll (CH)	ESP + CR + BF + DeNOx	15.7
Ferrara, loc. Canal Bianco	2 x 215	MSW	ACG - De Bartolomeis (I)	CR + BF + DeNOx	12.9
Forlì	1 x 380	MSW	ACG - Von Roll (CH)	CR + BF + DeNOx	10.6
Modena	2 x 140+1x 250	MSW	ACG - Von Roll (CH)	ESP + BF + DeNOx	32
Piacenza	2 x 180	MSW	ACG - Martin (D)	DeNOx + ESP + BF	11.6
Ravenna	1 x 150	RDF	BFB - EPI (USA)	DeNOx + BF + WET	6.5
Reggio nell'Emilia	2 x 100	MSW	ACG - De Bartolomeis (I)	DeNOx + ESP + BF	4.3
TOSCANA					
Arezzo, loc. San Zeno	1 x 120	MSW	ACG - Volund (DK)	DeNOx + CR + BF	2.9
Castelnuovo di G. (LU)	1 x 36	MSW	ACG - Fonsar (I)	CR + BF	0.5
Livorno	2 x 90	MSW	WCG - Nöell (D)	DeNOx + CR + BF	6.7
Montale (PT) (revamping)	2 x 75	MSW	RK - Tecnitalia (I)	DeNOx + ESP + CR + BF	4.8
Pisa, loc. Ospedaletto	2 x 100	MSW	ACG - De Bartolomeis (I)	DeNOx + CR + BF + WET	4.5
Pietrasanta (LU)	2 x 120	RDF	BFB - Kvaerner (S)	DeNOx + CR + BF + WET	5.7
Poggibonsi (SI)	2 x 30	MSW	ACG - De Bartolomeis (I)	DeNOx + CR + BF	-
(third line: construction)	1 x 170	MSW	WCG - De Bartolomeis (I)	CR + BF + DeNOx	8.4
Rufina (FI)	1 x 30	MSW	ACG - n.a.	DeNOx + CR + BF	n.a.
Scarlino (GR) (revamping)	1 x 96+2 x 144	RDF + Biomas.	BFB - Ex-Dorr Oliver (USA)	DeNOx+WET1+ESP+WET2	19.5
MARCHE					
Tolentino (MC)	1 x 70	MSW	ACG - DBA (D)	CR + ESP + BF + WET	1.2
UMBRIA					
Terni	2 x 75	MSW	ACG - Von Roll (CH)	CR + BF + WET	2.5
LAZIO					
Colleferro, Mobilservice (Roma)	1 x 300	RDF	WCG - Lurgi (D)	CR + BF + DeNOx	13.5
Colleferro, E.P. Sistemi (Roma)	1 x 300	RDF	WCG - Lurgi (D)	CR + BF + DeNOx	13.5
San Vittore del Lazio (FR)	1 x 300	RDF	WCG - Lurgi (D)	CR + BF + DeNOx	13.5
CAMPANIA					
Acerra (NA) costruction	3 x 650	RDF (Downgrad. to FSC)	WCG - DBA (D)	CR + 1 BF + 2 BF + DeNOx	106
PUGLIA					
Taranto, Com. di Statte (revamping)	2 x 100	MSW	ACG - Von Roll (CH)	DeNOx + ESP + BF + WET	3.5
Massafra (TA)	1 x 300	RDF	BFB - EPI (USA)	DeNOx + CR + BF	12.25
Modugno (BA) (under costruction)	1 x 300	RDF	BFB - EPI (USA)	DeNOx + CR + BF	12.25
BASILICATA					
Melfi (PZ)	1 x 100	MSW	ACG - DBA (D)	CR + BF + WET + DeNOx	4.0
Potenza (revamping)	2 x 50	MSW	ACG - De Bartolomeis (I)	DeNOx + WET + CR + BF	1.2

Addenda to Chapter 3

REGIONE Comune (Provincia)	POTENZIALITÀ nominale (n. linee x t/d)	TIPOLOGIA del combust.	TECNOLOGIA di combust.	TRATTAMENTO depurazione fumi	POTENZA elettrica (MW)
CALABRIA					
Gioia Tauro (RC)	2 x 190	RDF	BFB - Kvaerner (S)	CR + BF + DeNOx	17
SICILIA					
Messina, loc. Pace	2 x 100	MSW	ACG - Fonsar (I)	CR + BF + WET	n.a.
SARDEGNA					
Cagliari, loc. Capoterra	2 x 160	MSW	ACG - W+E (CH)	DeNOx + CR + BF	9.4
	1 x 180	MSW	ACG - Kawasaki (J)	CR + BF + DeNOx	4.5
Macomer, loc. Tossilo (NU)	2 x 72	RDF	BFB - Ebara (J)	CR + BF + DeNOx	2

SUMMARY DATA

Total Plants:54	**Total treatment capacity:** 22,272 t/d 6,960,000 t/y (average 7,500 h/year)	**37 MSW Plants:** 15,034 t/d (67.5%) **17 RDF Plants:** 7,238 t/d (32.5%)	ACG: 34 plants (63%) WCG: 9 plants (16.5%) BFB: 9 plants (16.5%) CFB: 1 plant (2%) RK: 1 plant (2%)	**Total installed power (MWe):** 804.6

LEGENDA (1):
ACG = Air Cooled Grate
WCG = Water Cooled Grate
BFB = Boiling Fluidized Bed
CFB= Circulating Fluidized Bed
RK = Rotary Kiln

LEGENDA (2):
WET = Scrubber
ESP = Electrostatic Precipitator
BF = Bag Filter
CR = Chemical Reactor
DeNOx = NH3 o SCR

THERMOVALORIZATION PLANTS MSW - RDF: WEB SITE

PIEMONTE
Mergozzo (VB) conservco.it
Vercelli (VC) tmt-vercelli.it
Torino, gerbido trm.to.it
LOMBARDIA
Bergamo (BG) a2a.eu
Brescia (BS) a2a.eu
Busto Arsizio (VA)accam.it
Como, loc. La Guzza (CO)acsm.it
Corteolona (PV) ecoenergia.it
Cremona (CR) aemcremona.it
Dalmine (BG) readalmine.it
Desio (MI) beabrianza.it
Parona Lomellina (PV) lomellinaenergia.it
Milano, Silla 2 amsa.it
Sesto San Giovanni (MI) coresesto.it
Trezzo sull'Adda (MI) termotrezzo.it
Valmadrera (LC) sileaspa.it

TRENTINO ALTO ADIGE
Bolzano eco-center.it
FRIULI
Trieste acegas.mediatech.it
VENETO
Padova acegas.mediatech.it
Schio (VI) acegas.mediatech.it
Venezia, loc. Fusina altovicentinoambiente.it
Verona ecoprogettovenezia.it, agsm.it
EMILIA ROMAGNA
Granarolo dell'Emilia (BO) feafrullo.it
Coriano (RN) gruppohera.it
Ferrara, loc. Canal Bianco gruppohera.it
Forlì gruppohera.it
Modena gruppohera.it
Piacenza tecnoborgo.com
Ravenna gruppohera.it
Reggio nell'Emilia agac.it

Addenda to Chapter 3

TOSCANA
Arezzo, loc. San Zeno aisaspa.com
Castelnuovo di G. (LU) severa.it
Livorno aamps.livorno.it
Montale (PT) cis.pt.it
Pisa, loc. Ospedaletto geofor.it
Pietrasanta,loc.Falascaia (LU) termoversilia.it
Poggibonsi (SI) sienambiente.it
Rufina (FI) aerspa.it
Scarlino (GR) scarlinoenergia.it
MARCHE
Tolentino (MC) cosmari.sinp.net
UMBRIA
Terni asmterni.it
LAZIO
Colleferro, Mobilservice (Roma)
consorziogaia.it consorziogaia.it
ColleferroSan Vittore del Lazio (FR) aceaspa.it
CAMPANIA
Acerra (NA) impregilo.it
PUGLIA
Taranto, Comune di Statte amiutaranto.it
Massafra (TA) appiaenergy.com
Modugno (BA) euroenergygroup.com
BASILICATA
Melfi (PZ) fenicespa.com
Potenza veoliaes.it
CALABRIA
Gioia Tauro (RC) tecspa.it
SICILIA
Messina, loc. Pace messinambiente.it
SARDEGNA
Cagliari, loc. Capoterra tecnocasic.it
Macomer, loc. Tossilo (NU) tossilo.it

A3.6) BIOGAS PLANTS DISTRIBUTION (PER REGION AND SUBSTRATE)
BIOMASS PLANTS FROM MSW LANDFILL ARE NOT INCLUDED

REGION	ANIMAL MANURE + organic residues energy crops*	URBAN SLUDGES**	AGROINDUSTR. effluents	MSW+URBAN SLUDGES	TOTAL
LOMBARDIA	48	12	2	1	63
EMILIA-ROMAGNA	30	21	7	1	59
TRENTINO - ALTO ADIGE	34	8	0	1	43
VENETO	17	11	3	3	34
PIEMONTE	6	21	0	1	28
TOSCANA	1	10	1	1	13
PUGLIA	0	11	1	0	12
CAMPANIA	1	5	3	0	9
SARDEGNA	7	0	0	1	8
MARCHE	0	7	1	0	8
LAZIO	0	5	1	0	6
LIGURIA	0	5	0	0	5
FRIULI-VENEZIA GIULIA	2	3	0	0	5
UMBRIA	2	2	0	0	4
BASILICATA	2	0	1	0	3
ABRUZZO	1	0	1	0	2
VALLE D'AOSTA	2	0	0	0	2
CALABRIA	1	0	0	0	1
SICILIA	0	0	1	0	1
TOTALE	154	121	22	9	306

Source C.R.P.A. Reggio Emilia

**Organic residues: agroindustrial residues and MSW organic fraction*
***Source Gerli A., Merzagora W. (2000).*

Addenda to Chapter 3

A3.7) BIOGAS PLANTS FUELLED WITH ANIMAL WASTE, ORGANIC RESIDUES AND ENERGY CROPS

REGION MUNICIPALITY	ORGANIC SUBSTRATE	t/d	TOTAL VOLUME digestor (*) [m³]	POWER kWe
LOMBARDIA TOTAL PLANTS: 48				
1 Bagnolo S. Vito (MN)	Swine manure	78	4,000 (1)	-
2 Pegognaga (MN)	Swine manure	80	4,500 (1)	-
3 Cavriana (MN)	Swine manure	65	1,300 (1)	-
4 Fossato di Rodigo (MN)	Biomass	-	-	955
5 Bagnolo S. Vito (MN)	Swine manure	105	2,100 (1)	30
6 Poggio Rusco (MN) (A)	Silomais	82	7,200 (2)	1,500
7 San Benedetto Po (MN) (A)	Silomais	82	7,200 (2)	1,500
8 Persico Dosimo (CR)	Swine manure	-	1,340 (2)	180
9 Castelleone (CR) (A)	Silomais	28	15,000 (6)	750
	Swine manure			
10 Vescovato (CR)	Swine manure	-	-	90
11 Cumignano sul Naviglio (CR)	Swine manure	70	1,400 (2)	270
12 Formigara (CR)	Swine manure	14	3,500 (2)	1,200
	Biomass			
13 Castelleone (CR)	Bovine manure	44	4,820 (4)	500
	Silomais	24		
14 Trigolo (CR)	Swine manure	85	1,700 (2)	60
15 Pandino (CR)	Bovine manure	50	1,000 (1)	125
16 Pizzighettone (CR)	Swine manure	70	7,060 (4)	1.000
	Energy crops	57		
17 Rivolta d'Adda (CR)	Silomais	17,3	2,000 (2)	400
Località San Giorgio				
18 Moscazzano (CR) (C)	Swine manure	-	(1)	370
	Ensilage			
19 Castelleone (CR) (C)	MSW, bovine and swine manure, silomais, agroindustrial residues	55	7,200 (4)	1.600
20 Faverzano di Offlaga (BS)	Swine manure	40	800 (1)	15
21 Gambara (BS)	Swine manure	40	801 (1)	30
22 Lograto (BS)	Swine manure	45	900 (2)	30
23 Montichiari (BS)	Swine manure	20	400	30
24 Visano (BS)	Swine manure	100	2,000 (1)	-
25 Lonato (BS)	Swine manure	325	6,500 (1)	-
26 Chiari (BS)	Swine manure	27,5	550 (1)	15
27 Orzinuovi (BS)	Swine manure	40	800 (2)	75
28 Sacca di Esine (BS)	Swine manure	12,5	250 (1)	-
29 Manerbio (BS)	Swine manure	35	700 (2)	30
30 Poncarale (BS)	Swine manure	22,5	450 (1)	-
31 Castegnato (BS)	Swine manure flottato	-	(1)	-
32 Manerbio (BS)	Swine manure	140	2,800 (2)	60
33 Orzinuovi (BS)	Swine manure e biomass	-	-	330
34 Darfo Boario Terme (BS)	Swine manure	17,5	350 (1)	15
35 Faverzano di Offlaga (BS)	Bovine manure	65	1,300 (1)	30
36 Artogne (BS)	Swine manure	35	2,250 (2)	75
37 Martinengo (BG)	Swine manure flottato	-	(1)	-

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REGION MUNICIPALITY	ORGANIC SUBSTRATE	t/d	TOTAL VOLUME digestor (*) [m³]	POWER kWe
38 Treviglio (BG)	Swine manure	85	1,700 (2)	100
39 Torre Pallavicina (BG)	Swine manure	95	1,900 (1)	165
40 Corbetta (MI)	Swine manure	90	-	-
	Energy crops	28		
41 Maleo (LO)	Swine and bovine manure	70	4,790 (2)	955
	Energy crops			
42 Borgo San Giovanni (LO)	Swine manure	-	-	955
	Biomass			
43 Villanova Sillaro (LO)	Swine and bovine manure	75	1,500 (1)	15
44 Villanova Sillaro (LO)	Swine and bovine manure	80	4,800	850
45 Tavezzano (LO) (C)	Swine manure	100	2,798 (2)	125
46 Costa de' Nobili (PV)	Swine manure	-	-	1,689
	Biomass	-		
	Agrofood industry residues	-		
47 Gambarana (PV) (C)	Biomass	-	-	350
48 Mezzana Bigli (PV)	Swine manure	125	2,500 (1)	30
EMILIA-ROMAGNA TOTAL PLANTS: 30				
49 Spilamberto (MO)	Swine manure	247	(2)	600
	Agroindustrial residues	69		
50 Piumazzo Castelfranco (MO)	Bovine manure	39	1,700 (1)	150
51 Forlimpopoli (FC) (A)	Rabbit and poultry manure	41	(2)	225
	Energy crops			
52 Mercato Saraceno (FC)	Swine manure	58	(2)	-
53 Meldola (FC)	Swine manure	-	(1)	-
54 Fratta di Bertinoro (FC)	Swine manure	-	(1)	-
55 Sogliano al Rubicone (FC)	Swine manure	-	(1)	190
56 Bagno di Romagna (FC)	Swine manure	-	(1)	60
57 Basilicagoiano (PR)	Swine manure	60	1,200 (2)	50
	Whey			
58 Basilicanova-Montechiarugolo (PR)	Bovine manure	30	648 (1)	60
59 Fontanellato – Località Albereto (PR)	Bovine manure	15	1,260 (1)	75
60 Casalbaroncolo (PR) (A)	Swine manure	11,4	1,530 (1)	200
	Bovine manure	9		
	Energy crops	9,3		
61 Busseto (PR) (A)	Bovine manure	9	5,800 (3)	1,131
	Energy crops	51		
62 Bosco Camillo - Sorbolo (PR) (A)	Silomais	-	-	1000
63 Neviano degli Arduini (PR) (C)	Bovine manure	-	700 (1)	20
64 Neviano degli Arduini (PR) (C)	Bovine manure	-	600 (1)	20
65 Tizzano val Parma (PR) (C)	Bovine manure	-	400 (1)	20
66 Tizzano val Parma (PR)	Bovine manure	-	600 (1)	20
67 San Pietro in Casale (BO) (A)	Poultry manure, silomais, MSW	-	2,500 (5)	190
68 Castenaso (BO)	Bovine manure	11,5	2,400 (2)	360
	Energy crops	2		
	agroindustry residues	15		

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REGION MUNICIPALITY	ORGANIC SUBSTRATE	t/d	TOTAL VOLUME digestor (*) [m³]	POWER kWe
69 Medicina - Frazione Ganzanigo (BO) [C]	Silomais	82	5,860 (2)	1,416
	Grains residues			
	Yellow grease, vegetable oils			
70 Medicina (BO) [A]	Animal manure	-	-	1,064
	Vegetable biomass	-		
71 San Giovanni in Persiceto (BO)	Animal manure, bedding	-	-	990
	for livestock, agoind. residues	1,4		
	Energy crops	60		
72 Podenzano-Località Gariga (PC) [A]	Bovine manure	12,6	1,230 (1)	100
	Silomais	-		
73 Castel San Giovanni (PC) [C]	Swine manure	110	2,799 (2)	180
	Silomais	4		
74 Gragnano Trebbiense Loc. Copremoldo di sopra (PC)	Bovine manure	60	1,399 (1)	120
75 Besenzone - C.na Casa Bianca (PC) [C]	Swine manure + bovino	58	1,500 (1)	90
76 San Pietro in Campiano (RA)	Bovine manure	15	5,000 (3)	845
	Sorghum ensilaged	30		
	Agroindustrial residues	20		
77 Bondeno (FE) [A]	Bovine manure	11	23,200 (12)	4,248
	Energy crops	208		
78 Argenta (FE) [A]	Bovine manure	10	6,855 (3)	1,065
	Sorghum triticale	41		
	Agroindustrial residues	30		
VENETO TOTAL PLANTS: 17				
79 S. Maria di Zevio (VR) [A]	Silomais	13,7	1,900 (1)	-
80 Nogarole Rocca (VR)	Swine manure	22,5	450 (1)	15
81 Valeggio sul Mincio (VR)	Swine manure	90	14,800 (2)	200
82 Minerbe (VR)	Bovine manure	22	5,200 (3)	845
	Insilato mais	41		
	Poultry manure	-		
	Agroindustrial residues	-		
83 Isola Rizza (VR)	Poultry manure ovaiole	-	5,000 (4)	920
	Rabbit manure	-		
	Silomais	-		
84 Casaleone - Località Muraiola (VR) [A]	Silomais	82	7,200 (2)	1500
85 Sandrigo (VI)	Bovine manure	43	1,920 (1)	110
	Energy crops	-		
86 Villaga (VI)	Animal manure	9	670 (1)	90
	Silomais and powder mais	2,3		
	Whey	3,3		
87 San Liberale di Marcon (VE)	Bovine manure	9	1,323 (1)	346
	Poultry manure	5		
	Energy crops	3		
88 Teglio Veneto (VE)	Bovine manure	10	5,200 (4)	1,064
	Poultry manure	15		

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REGION MUNICIPALITY	ORGANIC SUBSTRATE	t/d	TOTAL VOLUME digestor (*) [m³]	POWER kWe
	Energy crops	18		
89 San Stino di Livenza (VE) [C]	Bovine manure	-	-	1,500
	Silomais	-		
90 Lozzo Atesino (PD)	Bovine manure	500	5,000 (1)	-
	Msw drainage			
	Agroindustrial sludges			
91 Limena (PD)	Bovine manure	-	-	1,000
	Silomais	-		
92 Camposanpiero (PD)	Animal manure	-	3,300 (1)	-
	Msw and sludges	-		
93 Abano Terme (PD)	Bovine manure	-	720 (1)	70
94 Zero Branco (TV)	Swine manure	105	2,100 (1)	30
95 Treviso (TV)	Animal manure	-	-	-
	MSW	-		
	Depuration sludge	-		
TRENTINO ALTO-ADIGE TOTAL PLANTS: 34				
96 Terento (BZ)	Bovine manure	-	-	380
	Biomass	-		
97 Campo Tures (BZ)	Bovine manure	-	-	940
	Biomass	-		
98 Val Sarentino (BZ)	Bovine manure	-	780	37
	Biomass	-		
99 Terento (BZ)	Bovine manure	-	-	37
100 S. Cassiano (BZ)	Bovine manure	-	-	65
101 Terento (BZ)	Bovine manure	-	250	50
102 Campo Tures (BZ)	Bovine manure	-	4,528	18
103 Campo di Trens (BZ)	Bovine manure	10	950 (2)	50
	Milkey residues	0,5		
104 Casies (BZ)	Bovine manure	8	500 (1)	25
	Kitchen vaste	0,5		
105 Dobbiaco (BZ)	Bovine manure	2,5	450 (1)	15
	Kitchen vaste	0,5		
106 Rodengo (BZ)	Bovine manure	8	950 (2)	30
	Kitchen vaste	0,5		
107 San Cassiano (BZ)	Bovine manure	8	500 (1)	50
	Kitchen vaste	1		
108 Prato allo Stelvio (BZ)	Bovine manure	-	1,470 (2)	-
	Straw			
	Organic residues			
109 Valle Caseis (BZ)	Bovine manure	-	500	-
110 Campo Tures (BZ)	Bovine manure	-	150	-
111 Terento (BZ)	Bovine manure	-	700	-
112 Valle Caseis (BZ)	Bovine manure	-	140	-
113 Valle Caseis (BZ)	Bovine manure	-	65	-
114 Brunico (BZ)	Bovine manure	-	48	-
115 Luson (BZ)	Bovine manure	-	150	-

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REGION MUNICIPALITY	ORGANIC SUBSTRATE	t/d	TOTAL VOLUME digestor (*) [m^3]	POWER kWe
116 Verano (BZ)	Bovine manure	-	-	-
117 San Candido (BZ)	Bovine manure	-	78	-
118 Valle Caseis (BZ)	Bovine manure	-	400	-
119 Renon (BZ)	Bovine manure	-	120	-
120 Valle Caseis (BZ)	Bovine manure	-	100	-
121 Malles (BZ)	Bovine manure	-	-	-
122 Valle Aurina (BZ)	Bovine manure	-	-	-
123 Fiè (BZ)	Bovine manure	-	200	-
124 Aldino (BZ)	Bovine manure	-	-	-
125 Dobbiaco (BZ) (c)	Bovine manure	-	-	-
126 Sluderno (BZ) (c)	Bovine manure	-	-	-
127 Senales (BZ)	Bovine manure	-	-	-
128 Malles (BZ) (c)	Bovine manure	-	-	-
129 Marebbe (BZ) (c)	Bovine manure	-	-	-
PIEMONTE TOTAL PLANTS: 6				
130 Pozzolo di Formigara (AL) (c)	Bovine manure	-	-	500
	Biomass	-		
131 Alessandria (A)	Bovine manure	220	2,2437 (9)	2,130
132 Carrù (CN) (C)	Bovine and swine manure	400	6,700 (3)	1,000
	Silomais	40		
133 Bra (CN)	Swine manure	70	3,400 (1)	342
	Silomais	15		
134 Villastellone (TO)	Bovine manure	18	1,100 (1)	116
	Silomais	3		
	Whey	3		
135 Val Bormida (C)	Bovine manure	-	-	50
CAMPANIA TOTAL PLANTS: 1				
136 Salerno (A)	Animal manure + biomass	-	-	1,000
SARDEGNA TOTAL PLANTS: 7				
139 Lanusei (NU)	Swine manure	20	400 (1)	-
140 Loceri (NU)	Swine manure	30	600 (1)	
141 Bottidda (NU)	Swine manure + bovino	50	1,000 (2)	125
142 San Gavino Monreale (VS)	Swine manure	86	1,890 (1)	330
143 San Gavino Monreale (VS)	Swine manure	120	(2)	-
144 Isili (CA)	Swine manure	-	-	-
145 Paulilatino (OR))	Swine manure	400	400	-

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REGIONE COMUNE	MATRICE ORGANICA	t/d	VOLUME TOT digestore(*) [m³]	POTENZA kWe
BASILICATA TOTAL PLANTS: 2				
146 Agromonte Magnano (PZ)	Swine manure	-	-	-
147 S. Chirico Raparo (PZ)	Swine manure	-	(1)	-
TOSCANA				
148 Campagnatico (GR) [A]	Bovine manure	60	5,715 (3)	836
CALABRIA				
149 Montalto Uffugo (CS)	Animal manure	-	-	100
FRIULI-VENEZIA GIULIA TOTAL PLANTS: 2				
150 Spilimbergo (UD) [C]	Animal manure + biomass	-	-	250
151 Pordenone (PN) [C]	Animal manure	-	-	30
VALLE D'AOSTA TOTAL PLANTS: 2				
152 Nus (AO)	Bovine manure Agroindustrial residues	- -	-	50
153 Ayas (AO)	Swine and bovine manure	55	-	1,000
ABRUZZO TOTAL PLANTS: 1				
154 Capitignano (AQ) [C]	Swine manure	50	4,735 (1)	100

(C) Plant under construction
(A) Plant under authorization
– Not available datum
(*) Number of reactors of the plant

Source C.R.P.A. Reggio Emilia

Addenda to Chapter 3

A3.8) BIOMASS BOILERS INVESTMENT COST

The following figures give the investment cost range for small, medium and large biomass boilers.

The indicated values take into account the following considerations:

1) Costs are valid for grass-root plants
2) Costs are all-inclusive (with exception of storage silos and boiler housing)
3) Maximum and minimum cost values for the same boiler size depend on equipment quality
4) Costs of same size fossil fuel boilers (gasoil, methane, GPL) can be evaluated around 30% of biomass boilers.

FIG. 1 - SMALL SIZE PLANTS

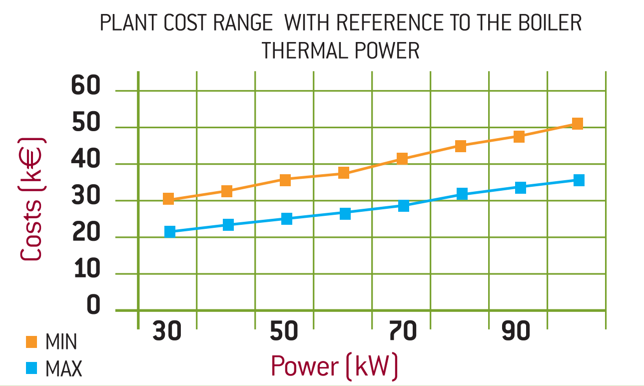


FIG. 2 - MEDIUM SIZE PLANTS

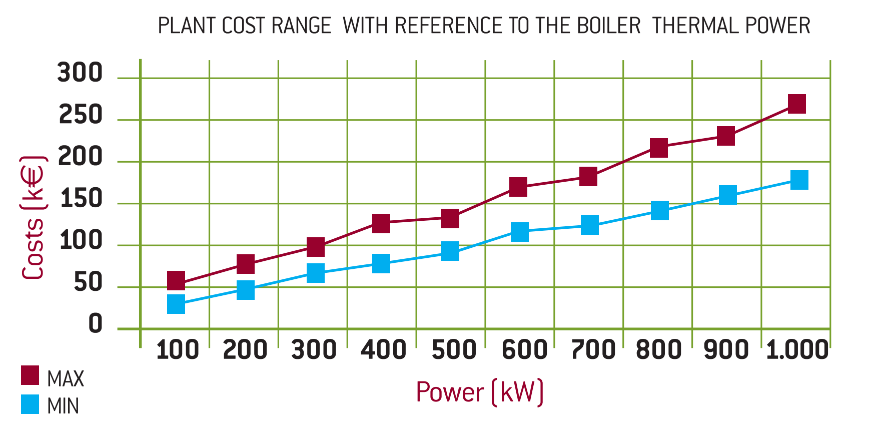
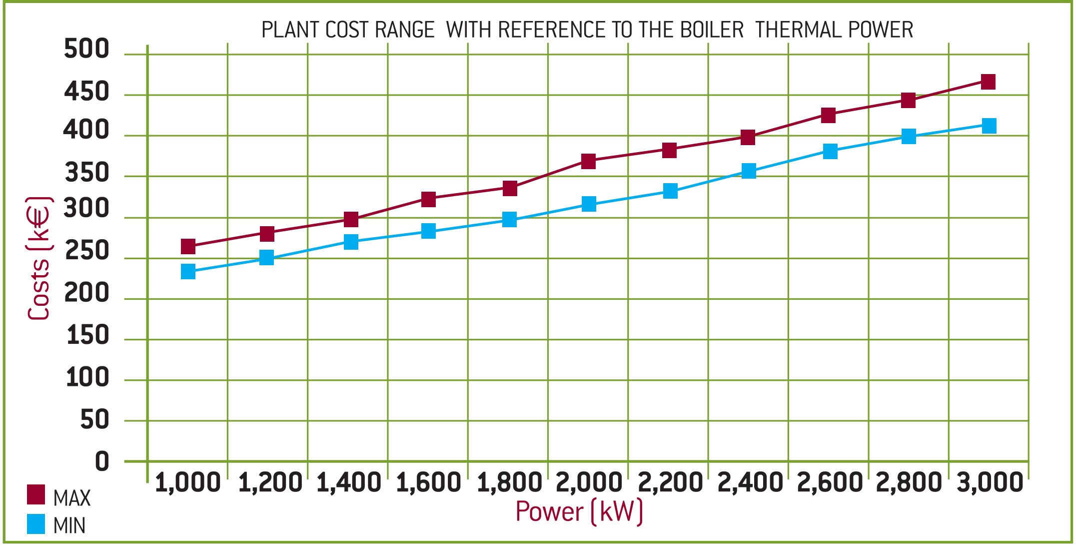


FIG. 3 - LARGE SIZE PLANTS



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A3.9) CLIMATIC ZONES IN ITALY (PROVINCES)

REGION	PROVINCE	CLIMATIC ZONE
ABRUZZO	L'Aquila	E
	Chieti	D
	Pescara	D
	Teramo	D
EMILIA ROMAGNA	Bologna	E
	Ferrara	E
	Forlì	D
	Modena	E
	Piacenza	E
	Parma	E
	Ravenna	E
	Reggio Emilia	E
	Rimini	E
BASILICATA	Matera	D
	Potenza	E
MOLISE	Campobasso	E
	Isernia	D
CALABRIA	Catanzaro	C
	Cosenza	C
	Crotone	B
	Reggio Calabria	B
	Vibo valentia	D
CAMPANIA	Avellino	D
	Benevento	C
	Caserta	C
	Napoli	C
	Salerno	C
FRIULI VENEZIA GIULIA	Gorizia	E
	Pordenone	E
	Trieste	E
	Udine	E
LAZIO	Frosinone	E
	Latina	C
	Rieti	E
	Roma	D
	Viterbo	D
MARCHE	Ancona	D
	Ascoli Piceno	D
	Macerata	D
	Pesaro/Urbino	D/E
LIGURIA	Genova	D
	Imperia	C
	La Spezia	D
	Savona	D
LOMBARDIA	Bergamo	E
	Brescia	E
	Como	E
	Cremona	E
	Lecco	E
	Lodi	E
	Mantova	E

REGION	PROVINCE	CLIMATIC ZONE
	Milano	E
	Pavia	E
	Sondrio	E
	Varese	E
TOSCANA	Arezzo	E
	Firenze	D
	Grosseto	D
	Livorno	D
	Lucca	D
	Massa	D
	Pisa	D
	Pistoia	D
	Siena	D
TRENTINO A.A.	Bolzano	E
	Trento	F
PIEMONTE	Alessandria	E
	Asti	E
	Biella	E
	Cuneo	F
	Novara	E
	Torino	E
	Verbania	E
	Vercelli	E
PUGLIA	Bari	C
	Brindisi	C
	Foggia	D
	Lecce	C
	Taranto	C
SARDEGNA	Cagliari	C
	Nuoro	D
	Oristano	C
	Sassari	C
SICILIA	Agrigento	B
	Caltanisetta	D
	Catania	B
	Enna	E
	Messina	B
	Palermo	B
	Siracusa	B
	Trapani	B
UMBRIA	Perugia	E
	Terni	D
AOSTA	Aosta	E
VENETO	Belluno	F
	Padova	E
	Rovigo	E
	Treviso	E
	Venezia	E
	Verona	E
	Vicenza	E

4] Sustainability/Guarrantees

THE DEBATE ON SUSTAINABILITY CRITERIA
METHODOLOGIES
ADDENDA

The sustainability of a bioenergy project - in technical, environmental, social and economic terms - is at the heart of the ongoing lively debate on the future of bioenergy in Italy and across the world. The core issue is the need to strike a balance between driving forces and critical points, by finding the conditions to maximise the former and reduce the latter. Chapter 4 of the previous ITABIA Report "Biomass for Energy and the Environment" outlined in detail the "Current and prospective environmental benefits of bioenergy supply chains", as well as the fundamental principles and basic concepts of sustainability of the energy use of biomass. Such principles are still valid today and, therefore, they shall not be repeated in this report. Emphasis will be placed, instead, on the ongoing debate regarding the criteria and methods for implementing the above-mentioned principles, and stress will be placed on the need for clear certification and plans for constantly monitoring initiatives and related operations.

4.1] THE DEBATE ON SUSTAINABILITY CRITERIA

Sustainable development rests upon three main pillars: economy, society and the environment. Any actions and initiatives that are based on these three pillars need to be integrated one with the other in order to achieve the goal of a sustainable society. Biomass sources can contribute to reaching this goal, as long as they are effectively made renewable, through correct territory and soil management, safeguard of ecosystems, flexibility in meeting the needs of local populations.

The concept of sustainability, and the criteria for a coherent definition of this important principle, are interpreted and discussed in very different ways. Sustainability requires supply chain certifications and monitoring plans.

Certification ought to take into account that there are:

- a great variety of biomass;
- a great variety of workers in the agricultural, forestry and industrial sectors;
- a real risk of environmental damage for import/export of large quantities of biomass to and from very distant places.

Today, public and private stakeholders are focusing their attention on biofuels for transportation. The certification of biofuels, and of the whole biomass system, is certainly an adequate way of guaranteeing the sustainable production of bioenergy. However, as AEBIOM (European Biomass Association) declared, this certification should also be extended to competing food products having the same geographical origin and to equivalent fossil fuels, so as to prevent unbalances in production areas between energy and food uses of the same raw material (for example: the use of palm oil "disputed" between food and biofuels).

The monitoring plan plays a fundamental role, since it provides central and local administrations with objective assessment tools which, through efficiency indicators for each undertaken action, help analyse the results obtained in relation to set objectives. It is useful in intervention plans and it is also a flexible and effective tool for progressively correcting and adapting the actions undertaken. The monitoring plan is mainly aimed at confirming and strengthening the environmental and economic advantages of biomass use, as an alternative source to fossil energy. Its second goal is to further improve technologies, by adopting changes and improvements that may be detected and suggested by the monitoring activity.

These three concepts - sustainability, certification and monitoring - should be dealt with in more detail in a separate document. This report shall only present some major issues that are being debated at global, European and national level, while more detailed information can be obtained from other related documents.

4.1.1] THE GBEP DEBATE

A wide debate is taking place within the GBEP's "Task Force on Sustainability". Its conclusions are not yet available. However, the division of sustainability criteria into 4 main baskets is believed to be a well-founded objective. The baskets include a series of indicators which are hereafter summarized.

Environmental Basket: includes, amongst other things, assessments on greenhouse gas emissions, the fertility of land used to produce new crops, the carbon balance on the use of land for new crops, air and water quality, biodiversity and ecosystem conservation.

Economic Basket: concerns the efficient use of resources, rural, social and economic development, support policies.

Social Basket: assesses the social advantages of commercial policies, food safety, access to natural resources (water, territory, etc.), creation of new employment, rural development, co-participation of local populations in the use of the territory, creation of

4. Sustainability/ Guarrantees

revenue, social health and wellbeing. **Energy Security Basket:** refers mainly to the contribution of bioenergy in mitigating the import of fossil energy at national and local level, particularly in rural environments, through diversification of energy resources, energy efficiency and development of innovative energy technologies with low environmental impact.

4.1.2) THE EU DEBATE

The latest developments of the European debate regard the European Directive on Renewable Energy Sources (RES-Directive) and, specifically, articles 15, 16 and 17 of the basic text. Two large on-line consultations have been organized and promoted by the European Commission: one on biofuels and the other on the sector's heat and electricity supply chains.

Particular attention is rightly paid to biofuels for transportation and liquid biofuels, which are the most critical and controversial supply chains in terms of environmental protection. The Directive lays down that these products cannot be taken into account in future energy and environmental balance statements, unless the Directive's sustainability criteria are met.

The first criteria regards the amount of greenhouse gas emissions that is reduced by the use of biofuels. The saving, calculated on the life cycle, must be of at least 35% if compared with the replaced fossil fuels. The RES-Directive provided the values of saved greenhouse gases and the calculation rules. The European Council and Parliament subsequently set further goals. The Council, for example, set out the following target for CO_2 saving: 35% until 2017 and 50% from 2017. The Parliament, instead, laid down that by using biofuels, greenhouse gases are saved by 45% until 2015 and by 60% after that date. An agreement between the two positions was finally reached at the end of 2008 and mirrors the Council's parameters.

The second criteria establishes that biofuels and liquid biofuels must not be obtained from crops produced in high biodiversity territories, natural protected areas, uncontaminated forests, pastures or areas with high carbon store functions.

Biofuels and assimilated products also need to meet the standards contained in Regulation 1782/2003, regarding the support schemes and the criteria for good agricultural and environmental practices.

The open question is whether a new sustainability scheme may also be necessary for biomass heat and electricity supply chains, whether such scheme ought to be binding for Member States, whether it should be applied regardless of plant size or if a certain output capacity should be required, and, lastly, whether the fulfillment of sustainability conditions should be clearly indicated by plant and service suppliers. Stances on these issues vary greatly. A new sustainbility scheme is viewed as superfluous by AEBIOM, at least in the preliminary kick-off phase. Nonetheless, the binding nature of Directives for Member States is positively viewed as a guarantee for local users and populations, it has in fact obtained wide consensus and has prevented contrasts. It ought to be remembered that Parliament deems it necessary to extend the sustainability criteria - including air and groundwater pollution, deterioration of the quality of soils, exploitation of children's labour, etc. - to all biomass sources, and not to biofuels only. Moreover, these criteria ought to concern not only biomass that is cultivated in Europe, but also biomass that can be retrieved from outside Europe.

4.1.3) SOME REMARKS ON ITALY

In Italy, the debate is not well organised. The Italian Biofuels Technological Platform has set up an ad hoc working group within the Scientific Committee dealing with environmental and sustainability problems. The Bioenergy Network that has been recently established by ITABIA, Fiper and Aiel, has pointed out the need for a sustainable approach for biofuels and has contributed to developing a questionnaire on heat and electricity supply chains. The latter supply chains are believed to require a new sustainability scheme, because in some Member States the biodegradable fraction of Municipal Solid Waste (MSW) and Industrial Solid Waste (ISW) is often used together with other types of biomass, in compliance with the current EU general definition of "biomass". There is thus the risk that this biomass mix is not adequately managed, causing conflicts and opposition by the local populations. Moreover, a certain quantity of residue biomass, particularly the moist fraction, could be used to restore and preserve the organic matter in soils that are particularly poor in humus, instead of generating heat or electricity. The European sustainability scheme needs to be based on a systemic view of the biomass sector, even if some degree of flexibility should be given to Member States. A new sustainability scheme is thus necessary for the heat and electricity supply chains.

The most challenging 2020 target of the EU Directive may be the 10% of biofuels in final transport consumption.

With reference to this issue, mention should be made of vegetable oils: not only can vegetable oils be used in second generation production, but they are also the only potential source for replacing diesel (either if produced in Italy or imported). Their use for electricity production, which today is highly promoted and cost-effective, may heavily interfere with their availability and use in the transport sector: national laws and Action Plans need to carefully assess this aspect.

4. Sustainability/ Guarrantees

4.1.4) REMARKS ON THE KEY ELEMENTS OF THE DEBATE

The issues above underline that there are 5 key elements which need to be briefly discussed:

A) Geographical cover of the biomass resource.
B) The CO_2 balance.
C) Defence of soil and groundwater.
D) Energy balances.
E) Social,economic benefits.

A) GEOGRAPHICAL COVER OF THE BIOMASS RESOURCE

The search for new energy resources from different geographical areas, that are also delocalised and reproducible is fundamental action that all national, continental and global policies need to take. Biomass is available in large world regions (excpet for the Middle East). Its really exploitable potential amounts to about 2000 Mtoe (today, it amounts to about 800 Mtoe against a primary energy demand of over 8000 Mtoe) and is equally divided between North America, South America, Africa, Asia and Europe. The resource is thus available in large areas across the world, as well as seas and oceans.

B) THE CO_2 BALANCE

The CO_2 balance is particularly important during the phases of production, transformation and use of energy biomass.

As it is known, vegetable species grow through photosynthesis, which subtracts CO_2 from the atmosphere that is then stored in the biomass (for every ton of dry biomass, the carbon content amounts to about 0.5 t due to the absorption of about 1.2 t of atmospheric CO_2). Having access to precise data on the quantity of biomass produced by a plant of dedicated arboreous and herbaceous crops and assessing its environmental impact in terms of capture and storage of atmospheric carbon dioxide is important to promote energy crops that can offer new business opportunities to agriculture. However, the biomass then needs to be collected, pre-treated, transported, converted through a variety of machines which certainly do not encourage a neutral CO_2 balance. There are many different types of machines that are usually employed for biomass collection and first transformation, which range from simple motor saws to complex tractors and chippers. The engines of these machines are generally fuelled by traditional fuels, having a subsequent impact on air quality and CO_2 balance.

The monitoring activity should help assess the emission factors of each and every fuel handling and treatment operation: for example, it may help see how much NOx or CO_2 is emitted on average per weight unit of fuel handled and fuelled to the boiler, both for already chipped fuel and for fuel that is supplied to the plant in the form of trunks, chunks or branches. With regard to the CO_2 balance, the monitoring activity will help assess the incidence of fossil CO_2, over the "good" CO_2, contained in the fuel before handling and chipping operations.

Interestingly, the absolute value of emissions will be directly proportional to machine size, while larger machines will have better "emission factors".

The emissions produced by the machines used strongly depend on a series of factors, such as:

> type of engine fuel used,
> engine power,
> its adjustment,
> its state of wear,
> usage conditions,
> etc.

Fossil CO_2 emissions produced by transport also negatively affect the CO_2 balance. This impact is not significant if travelled distances are short, or if long distances are covered by transporting large quantities of biomass (transport on lorries or ships).

ITABIA has calculated that long-distance road transport (up to 1000 km) on 25 t lorries has only a 10% negative impact on the CO_2 balance.

C) OTHER ENVIRONMENTAL ISSUES: PROTECTION OF SOIL AND GROUNDWATER

The growth of dedicated energy crops can be useful to protect the soil both in highly exploited areas and marginal areas. In fact, these crops require less care and energy inputs than food crops and can, in general, reduce the impact on soils where farming is intensive (occupied areas) and also improve land management in abandoned areas (marginal non-occupied areas). The effects of dedicated crops on these two different types of soil need to be monitored using distinct methodologies.

Exploited areas

In these areas, where soil exploitation is high, the greatest risk that is run is the loss of soil fertility and the subsequent use of support energy productions, such as excessive cultivation and high impact fertilization. To monitor the effects of dedicated energy crops on fertile level land, that are planted instead of food crops (e.g. two-year rotation of sunflower /hard wheat), can be monitored by either making simple quality and quantity considerations or by carrying out more complicated analyses.

Non exploited areas

These areas need to be monitored for protection from hydrogeological damage, such as slope stability, water channeling, soil conservation, etc, which cause certain visible effects on the landscape. Monitoring the effects of crop cultivation in a marginal, degraded area may require complex and expensive studies to be carried out on the territory, or may be limited to the collection of data focused on the environmental recovery favoured by the cultivation activity.

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D) ENERGY BALANCES AND PRODUCTIVITY

In order to set up a plant of dedicated arboreous or herbaceous energy crops (Short Rotation Forestry or oilseed and starchy crops), numerous agronomic operations need to be carried out, which require the use of specialised workforce and mechanized processes. These operations can be divided into three phases: the first one is the nursery phase for scion production , the second one is the planting in the field and the third one regards the crops harvesting.

Monitoring a plant of dedicated crops can help to estimate economic and energy costs of the operations needed as well as to find solutions to improve yields and reduce costs (also on the basis of experiences made elsewhere). The first step consists in the planning of the timescale of operations and in the evaluation of the relevant consumption of machines, followed by an assessment of economic and energy costs.

E) SOCIAL AND ECONOMIC IMPACT

Positive effects. Positive social and economic effects are expected in those areas where short rotation forestry is going to be significantly implemented. Short rotation forestry is in fact introduced in farms through the creation of new and articulate businesses which on the one hand employ highly specialised staff and on the other can help boost production processes in marginal areas, where land may be left abandoned by the population. The development of new forms of businesses and new end uses of the rural environment have some positive effects on employment mainly in relation to the following:

> introduction of new products on the market;
> use of innovative technologies;
> hiring of specialised and professional staff;
> increase in business staff;
> use of public funding.

Negative effects. One of the main problems hindering the development of renewable energy sources today is their social acceptance. This lack of acceptance concerns nearly all the RES, from wind to geothermal heat, from hydroelectricity to biomass. It is now widely recognised that the low public acceptance of the latter source has been the main cause of initiatives being unsuccessful, even for plants producing electricity from virgin biomass.

This attitude towards RES, though it is much less hostile than in the past, still exists today. Paradoxically, renewables are set aside mainly for environmental reasons, even though they are promoted for their environmental benefits.

Some remarks may be useful to understand the complexity of the problem with regard to plants producing energy from renewable sources and, particularly, from biomass.

Amongst all the renewable sources, biomass seems to be the most penalized of all for three main reasons:

1. Final energy conversion always takes place through the combustion process (boilers, endothermic engines, etc.), which emits potential pollutants. Combustion is perceived as a negative process, due to the “chimney effect”, and it is often used as a synonym for "air pollution": this explains why some environmental organisation in the USA have proposed that all energy sources based on combustion should not be considered as renewable energy sources. Moreover, for people residing near and around the chosen site, the impact caused by construction of the plant may be more severe than that of plant operation. The construction phase can in fact last for many months (noise, dust from the yard, noise and dust from the vehicles, soil pollution from bentonite, oil, light pollution, etc.).

2. The assimilation of biomass into waste and its incineration are criticised for the potential risk of toxic emissions (particularly dioxins). In some cases, biomass plants fuelled with forest residues are not welcome because it is feared that they may be the “Trojan horse” for reaching the real objective (that of incinerating urban waste). Unfortunately, Institutions do very little to differentiate between waste and biomass. To give one example only: most of community and national statistics on energy provide general data including both biomass and waste (which, as a matter of fact, an assimilation).

3. Biomass is the renewable source that, more than any other, is closely integrated in the territory, which is another reason why local populations are concerned with the potential effects that the use of biomass may have not only on the environment, but also on the economic activities.

Opinion polls have shown that RES are more accepted in those areas where plants fuelled by renewables are already in operation. One can thus draw to the conclusion that many of the prejudices when energy plants are proposed, disappear once the citizens can see for themselves the benefits they bring.

4.2) METHODOLOGIES

The principles, concepts and criteria described above, which may or may not be shared, need to be further studied with a view to develop an international comprehensive “corpus” of criteria and methods. Meanwhile, national methodologies are to be developed by establishing certification criteria and monitoring plans, in line with licensing laws, in order to ensure the correct development of all the future bioenergy initiatives.

4.2.1) CERTIFICATION CRITERIA

Detailed and comprehensive certifi-

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cation criteria for biomass energy transformation are an essential tool for Public Administrations (State, Regions Provinces, Municipalities, etc.) that make the laws on the matter.
In view of the future enactment of the proposed Directive on RES and of national implementation decrees deriving thereof, the lawmakers need to have precise tools at hand to establish whether new plants and new supply chains that will become operational today until 2020 can access incentives and licensing procedures.
The strong expected development of the Energy biomass market, at industrial and domestic level, raises some problems, which are clearly outlined in a study on the certification of bioenergy supply chains carried out by the AGREEN Consortium (Agriconsultig, CRA, ITABIA) for the Sicily Region in the framework of the MiPAAF National Biofuels Programme (PROBIO). An excerpt of the study is reported below:

• ***Safeguarding the endogenous nature of biomass:*** *large quantities of this material are imported due to the increased use by large industries (biomass power plants), which import ships of chipped wood from overseas, and by pellet producers who import sawdust and forest residues. This trend, which is rightful from a merely commercial viewpoint, limits greatly the environmental and economic benefits that the endogenous nature of biomass can guarantee. The use of biomass in areas that are very remote from fuel production areas reduce considerably the environmental benefits associated with renewable sources and the Kyoto Protocol.*

• ***Tracing the material:*** *this need depends on the energy use of biomass. Biomass, in fact, is no longer only used in medium and large heat/electricity producing plants, but it is also increasingly employed in households heating (pellet stoves, briquets, etc.) and for food in wood-fuelled ovens. In these cases, a certification on the origin of biomass and its subsequent conversions and treatments is fundamental.*

• ***Degree of actual energy benefit of biomass use:*** *and electricity production and in increasing the percentage of energy produced from renewable energy, but often it is unclear when and how such environmental compatibility and energy/economic sustainability can be guaranteed. It has not been univocally defined how much of the energy costs sustained for production/collection, treatment, storage and distribution of agricultural and forest residue biomass or biomass from dedicated crops is subsequently paid back by the energy use of the material .*

These problems underline an issue that is shared by all the experts in the sector: even though the driving force of the supply chain is the demand in fuel, the critical point was and still is today the supply of biomass and the ability to favour industrial investments in the territory by using local biomass in compliance with sustainable development.

The **certification criteria** of the various bioenergy supply chains will have to deal with the following main parameters:

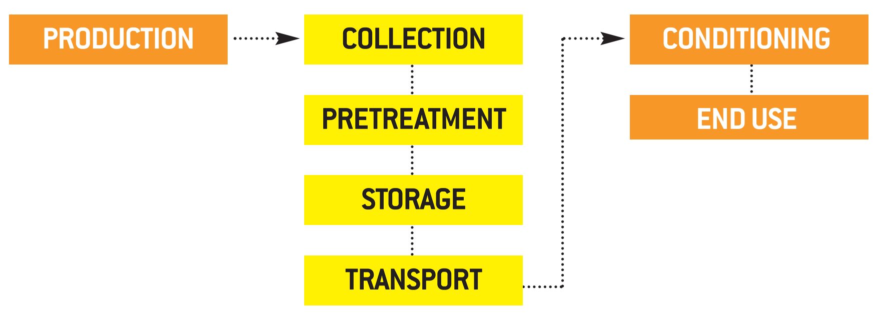
> TECHNICAL PARAMETERS:
1. Tracing of biofuel supply.
2. Correct plant size.
3. Nominal energy yield before and after fossil fuels consumption (i.e.:operations of biofuel pre-treatment).
4. Actual energy yield and CO_2 balance (annual average) before and after fossil fuels consumption.
5. Compliance with current technical norms.

> ECONOMIC PARAMETERS:
1. Investment costs (according to installed capacity).
2. Operation costs (fuel, workforce, maintenance, financial costs and amortization).
3. Annual economic saving "versus" use of fossil sources.
4. Pay-Back assessment.

4.2.2) MONITORING PLANS

It is particularly difficult to define the monitoring plan for an action aimed at the energy production from biomass, due to the intrinsic nature of this energy source: the following considerations regard some basic elements.
Contrary to the other renewable energy sources, biomass needs to follow a series of steps before it can reach the plant, that is why it is highly important to analyse the whole fuel cycle.
Setting fuel supply strategies is, in fact, very important both for economic and environmental reasons. Economically, such strategies would help reduce fuel costs by acting on the numerous and articolate variables of the

THE FUEL SUPPLY CHAIN



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system. Environmentally, they would minimize the potentially negative effects on ecosystems and optimize positive effects.
The Figure above shows a simplified chain. The system is actually much more complex, and it is made up of a series of forward and backward paths among the various components.
The system for energy production from biomass is even more complex if we analyse it from an environmental point of view. Its environmental impacts differ not only from that of conventional energy sources but also from other renewables for a series of reasons that can be summarised as follows:
a. impacts are not localized in one area only, but are divided along the chain, from production, to transport, to storage, to energy conversion, to final use;

b. they concern more than one productive system: for example, biofuel production involves the agricultural sector (fuel production and supply) and the industrial sector (transformation and use);
c. some impacts can be hardly quantified, such as for example the benefits that the cultivation of energy crops in marginal hilly areas bring to soil erosion;
d. there are more than one methods for assessing the environmental impact:the most common among the methods used is the EIA (Environmental Impact Assessment) which focuses on localized impacts derived from "large plants". Another method,the LCA (Life Cycle Analysis) , has a wider scope and effectively assesses the chain impacts, but it is structured so as to define the "environmental content " of goods or products.
It is worth of note that in this case the system is made up of different subsystems:
1. agricultural
2. forestry
3. industrial
4. energy production

These sub-systems, each having its specific features, often clash with each other. There are in fact, for example, many norms regulating conversion plants that need to comply with the norms of the industrial sector and there are many norms regarding the fuel that need to comply with the rules of the agricultural sector.
Such a varied situation has a significant impact on the choice of quality and quantity indicators.
Social indicators play a particularly important role for bioenergy, due to the close interaction with the territory. It is for example important to evaluate public opinion and the interest shown by potential users in district heating plants, rather than the acceptance by the local community for a large electricity production plant. Furthermore it is also important to assess the overall impact the installation of energy plants has on employment.
In conclusion, it is believed that, in light of the ambitious targets setted by the RES Directive, the Monitoring Plan should be structured in a way that it can follow up the various initiatives, by providing indications on how to authorise, start up and manage actions that are expected to have a positive and effective economic, environmental and social impact on the territory.

General features of the monitoring plan

The supply chains for the production of biomass energy are made up of numerous phases which can deal with so many different sectors. It is thus necessary to define the scope, establishing:
1. Which phases are to be considered.
2. Which actions make up these phases.
3. What is the environmental, economic, energy and social impact of the various actions.
4. Which impacts need to be monitored, which impacts need to be simply mentioned or briefly described and which ones can be overlooked.

1. Below we report the main phases of the wood-to-energy supply chain:
a. Biofuel production (firewood, chipped wood, pellet).
b. Biofuel supply.
c. Energy conversion (various technological plants).

2. The various actions of each phase are:
a. Biofuel production
> Planting and management of new dedicated crops.
> Cutting and collection (residue biomass and/or new crops).
> On-site pre-treatment (packaging, chipping, temporary storing, etc.).
b. Biofuel supply
> Transporting the raw material.
> Handling and final treatment of the biofuel.
> Stocking and supplying the biofuel to the plant.

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c. Energy conversion plants
> Production, distribution and end uses of heat and/ or electricity.
> Disposal of ashes.

3. These phases have beneficial effects on the environment, energy, society and economy:
a. The main positive effects on the environment regard:
> Atmosphere
> Noise and vibrations
> Traffic
> Other: territory protection, defence of soils, use of fertilizers and phytosanitary product, hydrogeology, liquid effluents, ash disposal, etc.
b. Effects on energy: energy balances of supply chain processes.
c. Effects on society and economy: direct and indirect employment.

In the frame work of the PROBIO Project, ITABIA has recently set up the monitoring schemes for detecting the following data:

A) Cycle of biofuel production and supply
> CO_2 absorption of new crops.
> Defense of soil and groundwater.
> Energy balance of new crops.
> Effects on employment.
> Emissions of machines and CO_2 balance.
> Noise of machines and plants.
> Energy balance of cutting, collection and chipping of raw material.
> Energy balance and CO_2 balance of raw material transportation.
> Assessment of heavy traffic.
> Energy content of biofuel.

B) Energy conversion plants
> Plant emissions and CO_2 balance.
> Ahses: quantity and disposal.
> Energy balance of heat production.
> Energy balance of heat and cooling production.
> Energy balance of pellet production.
> Cogeneration energy balance.

Addendum A4.1 provides an example of the monitoring scheme used for the "Energy balance of solid fuel cogeneration plants (chipped wood)".

4.2.3) CONCLUSIONS

The future of bioenergy largely depends on the ability to find sustainability criteria that can guarantee the development of the various supply chains. To this end, the efficiency of activities needs to be monitored in order to fulfil the set of local and national objectives. A monitoring plan can also play a fundamental role in the activation of new plants in the framework of certified supply chains. From a practical point of view, it will be important to define the elements needed to guarantee the sustainability of initiatives to be activated in various contexts (urban, rural, etc.), and to lay down the legal measures needed to comply with strategic objectives, to increase resources and tools, monitor and estimate the impact of measures adopted within Europe and within Member States.

The concept of sustainability ought to be approached by taking into account: the environment (for example, biodiversity, deforestation, etc.), society (acceptability of installation of new plant), economy (supply chain activities), politics (local and National development plans), technology (maturity of technologies and processes).

The approval of results regards four main areas:
a) Better diffusion of research on bioenergy supply chains.
b) Establishing useful tools to lay down national and local laws.
c) Development of cooperation between Member States in the bioenergy sector.
d) Development of the bioenergy market in Europe, through greater knowledge on economic models and development potentials.

4] Addenda

A4.1] COGENERATION ENERGY BALANCE

GENERAL REMARKS

Monitoring cogeneration plants (combined production of electricity and heat) is important to assess the economic feasibility of this technology, mainly because investment costs are slightly higher than those necessary for a heat producing plant.

Obtaining valid, cost-effective energy results, which are to be assessed through a careful monitoring activity, is the main condition for cogeneration plants to become increasingly popular throughout the territory, bringing benefits not only to the environment, but also to the energy balance which is directly proportional to the economic outcome of the initiative.

Assessments need to consider the following:

- **Thermal yield of the boiler:** useful heat transferred to the turbine for the production of electricity, compared to the primary energy of the fuelled biofuel.
- **Electric yield of the turbine:** useful electricity produced, compared to the heat transferred to the turbine.
- **Thermal limit of the cogeneration plant - T.L.:** ratio between useful thermal energy recovered and total useful thermal and electrical energy produced.
- **Index of Energy Saving - IES:** percentage of energy saving by producing the same quantities of useful electricity and heat through cogeneration that would otherwise be produced with two separate processes.

Assessments are carried out through measuring devices that are installed on the plant and detect the capacity and temperature of the various thermal flows both in the primary circuit (input and output from the boiler), and the secondary circuit (input and output from heat recovery network), and through meters for reading electrical productions before and after self and auxiliary consumptions. When measuring the quantity of fuel entering the plant during the monitoring phase, the test should be performed disposing of a certain amount of fuel, which has been weighed beforehand and already analysed for its energy content.

This method can be applied to any plant of any size and to any range of operational temperature (the temperature is higher in diathermic oil boilers for fuelling ORC turbines).

The correct monitoring of cogeneration plants should follow the following indications.

Devices: Installation of on-line calories counter, internal and external thermometers, system measuring fuel flow, system measuring flue gas flow, electricity readers.

Primary energy input measurement: double-weight Mahler calories counter

Frequency of measurement: Every two months.

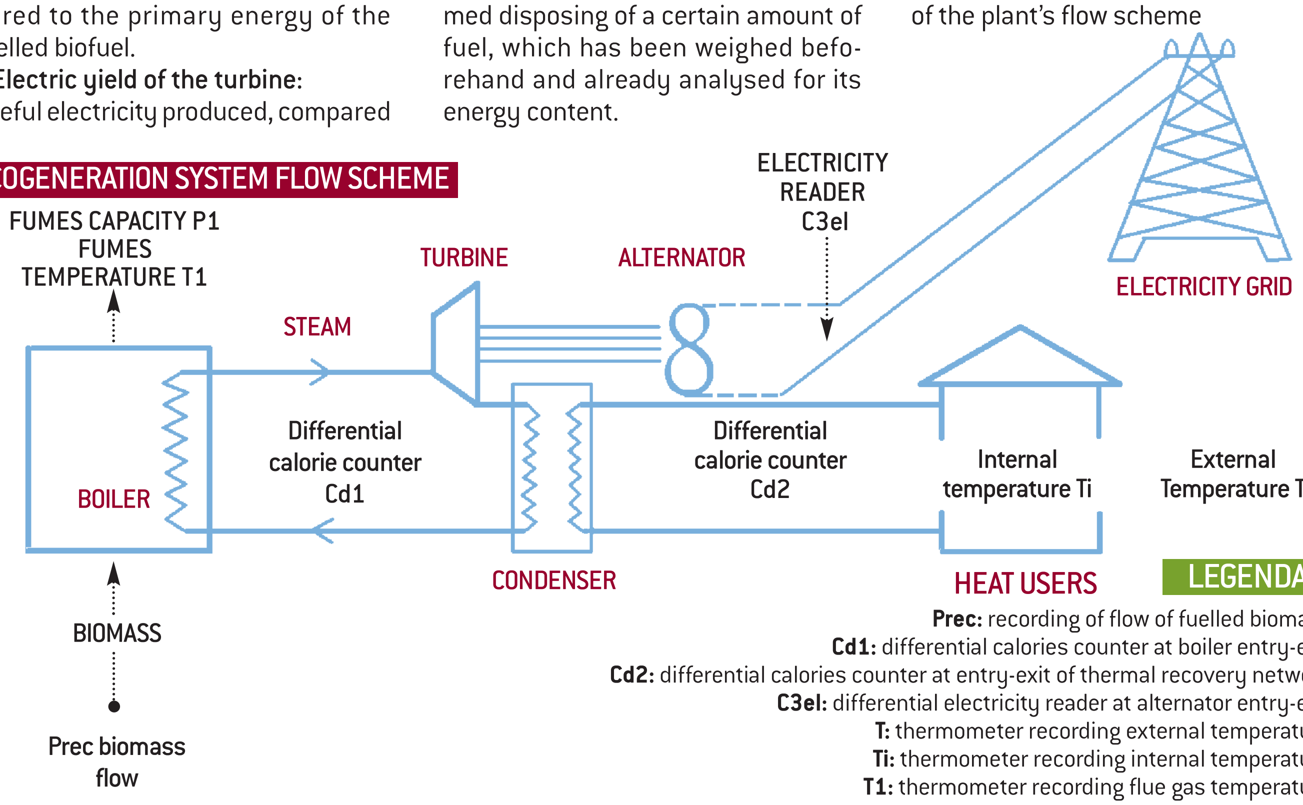
Duration of measurement: 5 hours

Recommendations:

> Measurements must be made during constant plant operation, when operation capacity is in a range close to the maximum output.

> The position of the measuring devices must be indicated in the drawing of the plant's flow scheme

COGENERATION SYSTEM FLOW SCHEME



LEGENDA

Prec: recording of flow of fuelled biomass
Cd1: differential calories counter at boiler entry-exit
Cd2: differential calories counter at entry-exit of thermal recovery network
C3el: differential electricity reader at alternator entry-exit
T: thermometer recording external temperature
Ti: thermometer recording internal temperature
T1: thermometer recording flue gas temperature
P1: system measuring flue gas flow

Addenda to Chapter 4

ENERGY BALANCE SCHEME

The scheme below is an example for the collection and recording of detected data:

TYPE OF PLAN			
COMPONENT: ENERGY BALANCE		**TOPIC:** COGENERATION	
Place:		Municipality:	
Data of mesurement:		Duration (hr):	
Number.:			
Instruments used:			
Type of plant:			
Type of fuel:			
Consumption (kg/h):	Moisture (%):	icv (kcal/kg):	
	Average annual :	Power output (kWh):	

RESULTS OF MEASUREMENT:

		Value	
Biomass (t) Prec:			
Input heat (Kcal)			
Boiler output useful energy (Kcal) Cd1			
Heating useful energy (Kcal) Cd2			
Produced electricity (kWh) C3El			
Fumes capacity (m3/h) P1			
Fumes T (°C) T1			
External T (°C) T			
Boiler yield (%)			
Electricity yield (%)			
Global yield (%)			

NOTES:

Completed by:

5] Mowing towards a new Bioenergy Action Plan

GENERAL REMARKS
STRATEGIC DIRECTIONS
INVESTMENTS NEEDED

Article 4 of the European RES Directive sets forth that each Member States must adopt a national Action Plan to meet the 2020 targets and submit it to the Commission by 31 March 2010. Member States must establish the measures they intend to adopt to achieve those targets. Fines and sanctions shall be applied in case of non-fulfilment.

5.1] GENERAL REMARKS

In view of the obligations Italy will have to comply with in the near future, it may be useful to explain some of the directions the national Action Plan needs to follow in the biomass sector.
The previous chapters have underlined the following:
> biomass of agricultural, forest, animal origin to be used for energy purposes is a fundamental resource for the actual diversification of energy sources and reduction of the environmental impact of the consumption system;
> Italy can and must reach some important targets over the next decade, such as using various types of biomass of various origin to produce approximately: 3 Mtoe of electricity, 9-10 Mtoe of heat, 4-5 Mtoe of biofuels for a total amount of replaced fossil energy of 16-18 Mtoe;
> public resources must be sufficient to give a substantial boost to supply chains, create low environmental impact energy, prevent an unsustainable use of budgets, and ensure an equal division of the added value across all the supply chain components;
> regions and local Institutions must use all the available spaces to promote the start up of supply chains in their territories and give a boost to agricultural and industrial entrepreneurship;
> activities of research, experimentation and development, that are financed with public and private funds and adequately coordinated, need to be promoted;
> Italy must show the European institutions its willingness to promote and sustain the sector through far-reaching perspectives and programmes. Italy must also strengthen its participation in international and community programmes in order to increase the exchange of experiences and strengthen its research capacity on applicable innovations, both in the short and long term.
Therefore, Italy needs to do the following in the short run:
a] Re-define a framework Programme in line with European Union directions.
b] Streamline and simplify licensing norms and procedures.
c] Re-define its approach with the European Commission in the procedures of approval of national laws.
d] Promote integrated initiatives that bring significant benefits to the territory, identifying solutions that fit in the community framework.
e] Develop consultations at national level and with each regional Administration.
f] Develop information campaigns and qualified training programmes.
g] Draft local projects that can become operational.
h] Spread good practices and success cases.
i] Develop demonstrative projects, particularly small and medium scale projects.

In order to rationalize the entire system and develop an Action Plan that is compatible with the national territory and its social and economic situation, the three pairs of key elements that are described in this Report need to be taken into account. They are the architraves of the national bioenergy system:
> **Resources/efficiencies**
> **Market/good practices**
> **Sustainability/guarantees**

5.2] STRATEGIC DIRECTIONS

ENERGY DIRECTIONS

For bioenergy to have an adequate weight in future energy balances, public and private stakeholders need to focus their attention on the following issues:
> development of a system of incentives (administrative, economic, tax, etc.), which can help overcome the current fragmentation of norms, which is dynamic enough to adapt to the evolution of the whole sector and its segments and rewards technological innovation and the constant improvement of efficiency;
> promotion of supply chain integration, through specific financial tools for the creation of interprofessional structures, also through direct investment of public capital in strategic initiatives;
> activation of demand both through an adequate information and promotion campaign, and through the introduction of environmental constraints favouring the use of biomass or imposing, if and where necessary, the use of biomass as raw material;
> standardisation of end products

5. Moving towards a new Bioenergy Action Plan

(with particular reference to solid and liquid biofuels) so as to give stability to the market and adequate guarantees to consumers. Issues related to products, as well as environmental impact, energy balance, etc. need to be considered;

> re-definition of constraints on the thermal use and/or use of agricultural and forest biomass due to its incoherent classification within waste, by enhancing its "environmental content", where possible;

> promotion of the recovery of vegetable oils used and other secondary materials that need to be disposed of and are ideal in energy conversion processes (biodiesel, biogas, etc.);

> promotion of significant projects which, by enhancing ongoing initiatives, can practically start up the sector and be the testing ground for subsequent technological improvements.

ENVIRONMENT DIRECTIONS

In order to fully exploit the potential of biomass in offsetting the greenhouse gas effect, the following need to be done:

> improvement of forest management techniques aimed at territory protections, absorption of CO_2 from atmosphere, maintenance and creation of productive activities and related employment.

> use of liquid biofuels in areas at risk, such as historical centres of artistic cities, navigable inland waterways, etc.

Moreover, a study that was performed by ENEA some time ago and then continued by ITABIA, showed that in central-southern Italy, including the islands, about 2 million hectares of conventional farm land are abandoned due to the lack of agricultural revenue. This corresponds to an overall abandoned area of 6.7% of the national territory. These lands are mainly located in plain or hill piedmont areas, which can all be easily reached (they were in fact farmland that was once cultivated). Using these areas again for energy purposes could be the opportunity to assess the actual potential energy contribution of renewable sources, prevent the further degradation of land and provide new forms of employment.

TERRITORY DIRECTIONS

Actions must concern:

> Improvement of quality of agricultural land, through gradual re-establishment of standard levels of organic matter that can strengthen the biological capacities of vegetable species and reduce external inputs;

> Identify species and/or vegetable varieties that can maximise productive efficiency in terms of usable biomass, by developing production rules and crop rotations favouring their introduction and widespread use;

> Contribute to safeguarding biodiversity, through a wider use of all the range of native vegetable species (even those that are not currently being cultivated), and by increasing the areas were forest varieties are grown;

> Development of dedicated or energy-oriented crops.

COMPLEMENTARY ACTIONS

The above-mentioned key actions must be flanked by complementary actions, namely:

> integration of research, development and demonstration activities, in order to direct public and private stakeholders towards priority objectives and make the best use of available resources;

> information and communication to be provided at school level, in order to develop a better basic culture, which may allow to shift deadlines according to environmental problems;

>strengthen international cooperation for the exchange of information, experiences, study and research.

5.3) INVESTMENTS NEEDED

It is rather difficult to foresee the investment costs Italy will incur in by 2020 in the bioenergy sector to achieve the targets set by the RES Directive. Specific programmes and expense projections for the targets achievement on all "renewable" may be developed and made only after the national Action Plan has been defined.

It is however important to identify,

5. Moving towards a new Bioenergy Action Plan

at least for the bioenergy sector, the main cost items and provide approximate projections.

1. BUILDING AND REVAMPING OF ENERGY CONVERSION PLANTS

As already mentioned in Chapter 3.3, ITABIA has made some projections based on the 2007 Position Paper of the Italian Government (which were coherent with those of the RES Directive) estimating investments for about Euro 15 billion by 2020 for heat production plants and for about Euro 5 billion for electricity plants.

Such projections are based on the actual bioenergy quantities to be provided to meet the final gross consumption and on the subsequent need to build new plants (grass-root or revamping and/or replacement of old plants).

It was not possible to make an equally realistic projection for biofuels, due to a series of technological and legal variables.

However, a recent study by UNFCCC (United Nations Framework Convention on Climate Changes), linking investment costs of the whole 20/20/20 Package to the world's GDP, has shown that the creation of plants for second generation biofuels in Italy may have an investment cost of about Euro 6 billion. These remarks show that the total national investment cost for bioenergy conversion plants may amount on average to about 26 billion from today to 2020, which correspond to about 1% of national GDP.

2. SUPPORT MEASURES (INCENTIVES AND TAX EXEMPTION)

Projections cannot be easily made on the cost of the support measures Italy will adopt, particularly due to the unstable national legislation on tax exemption for biofuels for transport. The IT portal of AGIENERGIA reports that, according to ENEA assessments, Italy will spend about Euro 42 billion for incentives and tax exemptions for the RES Package. A significant portion of that amount (Euro 15-20 billion) will concern bioenergy, with particular regard to incentives on electricity (Green Certificates) and tax exemption measures for biofuels.

3. SCIENTIFIC AND TECHNOLOGICAL RESEARCH

According to the criteria of the UNFCCC study and the national GDP, national investments on research and development of new technologies shall amount to about 15 billion euros. A significant amount of these funds (8-10 billion Euros) will be used for bioenergy (energy efficiency and second generation biofuels).

4. AGRO-FOREST SECTOR: REFORESTATION AND ENERGY CROPS

According to the UNFCCC, the projected annual spending of the agro-forest sector at international level amounts to about Euro 50 billion for the reduction of fossil emissions produced by agricultural businesses, forestation and new energy crops. This data, calculated according to the Italian GDP, means that Italy will be spending about Euro 20 billion by 2020.

CONCLUSION ON BIOENERGY INVESTMENT COSTS

The above-mentioned projections show that adapting to the RES Directive for the bioenergy sector will cost Italy about Euro 80 billion by 2020.

This figure, however, does not take into account the remarkable economic savings that would result from reduced fuel imports, construction of new traditional plants, and, in particular, reduction of environmental costs caused by air pollution.

The figures provided above are the most expensive investment projections for Italy where Italy does not resort to the flexibility mechanisms set forth in the RES Directive on the exchange of credits with other Countries.

Useful Information

ITABIA
Italian Biomass Association

ITABIA (Italian Biomass Association) is a not for profit Association founded in 1985 with the aim of promoting the diffusion of efficient and environmentally-sound biomass production and conversion systems for energy and industrial purposes. Most of ITABIA's activities concerns the transfer of knowledge to public and private bodies, research centres, manufacturers, agroforestry entrepreneurs, etc.
ITABIA has established an efficient net of key persons and bodies able to support the actions and giving help for the achievement of expected results. In fact, ITABIA's membership is composed of about one hundred specialists coming from scientific institutions, public bodies and industries with special interest in biomass sector.
ITABIA has the capacity of establishing and of co-ordinating national teams having the task of defining strategies, and implementing action plans. From the operational point of view, ITABIA usually organises seminars, workshops, meetings where all the results attained by other partners, as well as information coming from other sources, are disseminated. Special means are currently utilised like, ITABI@NET (newsletter for ITABIA's members) and the WEB site.
ITABIA's experience covers a wide range of topics from biomass production, to biomass recovery and utilisation. Itabia has been actively participating in several international networks - most of them promoted and financed by the European Commission - together with different stakeholders in order to face the problems from different point of view. Actually ITABIA is collaborating with the Italian Ministry for Agriculture and Forest Policy and with the Ministry for the Environment and Territory for implementing National Programmes and Action Plans for the deployment of biomass energy.
ITABIA promoted the foundation of the European Association for Biomass (AEBIOM).

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Web site: **www.itabia.it**
E-mail: **itabia@mclink.it**

The Measure Unit

The measure units used in the report are mainly referred to the International System of Measure Units (I.S), as shown in the following table:

ENERGY MEASURE UNITS:
The energy content of a substance is normally expressed with its own specific heating value, and it is measured in kcal/kg (solid and liquid substances), in kcal/l for liquid substances, in kcal/m^3 for gaseous substances; in this last case the symbol Nm^3 is preferred to indicate the equivalent cubic metre at a pressure of 1 atmosphere. The specific heating value of some combustible substances is shown in the following table:

As far as wood is concerned, great importance must be given to the relevant moisture content, as shown in the following table:

MULTIPLES SYMBOLS:

	SYMBOL	FACTOR
KILO	**k**	10^3
MEGA	**M**	10^6
GIGA	**G**	10^9
TERA	**T**	10^{12}

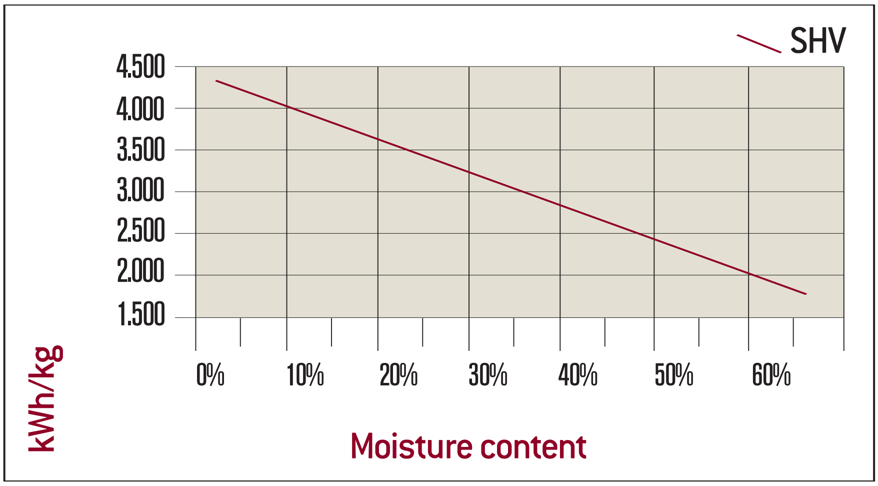
	UNIT NAME	UNIT SYMBOL
LENGHT	metre	m
WEIGHT	kilogram	kg
TIME	second	s
ELECTRIC CURRENT	ampére	A
TEMPERATURE	kelvin	°K

Useful Information
The Measure Unit

BIOENERGY: MEASURE UNITS OF COMMON USE

	SYMBOL	NAME	VALUE
AREA	m^2 km^2 ha	square metre square kilometre hectare	– 10^6 m^2 10^4 m^2
VOLUME	m^3 m_{st}	cubic metre stere metre	–
WEIGHT	kg t l	kilogram ton liter	10^3 g 10^6 g
CAPACITY ENERGY	J cal	joule calory	1W.s 4,185J
POWER	W	watt	1J/s

SUBSTANCE	(kcal/kg - kcal/m^3)
WOOD	2500 - 4500
PEAT	3000 - 4500
COAL WOOD	7500
LIGNITE	4000 - 6200
ANTRACYTE	8000 - 8500
COKE	7000
FUEL OIL	9800
KERO	10400
GASOIL	10200
GASOLINE	10500
CRUDE OIL	10000
LIQUID WELL GAS	11000
NATURAL GAS	8300



CONVERSION FACTORS FOR ENERGY MEASURE UNITS

	kJ	kcal	kWh	tep
1 kJ	1	0,239	$0.278x10^{-3}$	$23.9x10^{-9}$
1 kcal	4 .1868	1	$1.163x10^{-3}$	$0.1x10^{-6}$
1 kWh	3,600	860	1	$86x10^{-6}$
1 tep	$41.9x10^6$	$10x10^6$	$11.63x10^3$	1

Useful Information
Web site

WEB SITES

For more information and a better understanding, the websites reffered to are suggested.

AEBIOM (European Biomass Association): www.ecop.ucl.ac.be/aebiom/
AGROENERGIA: www.agroenergia.it
AIIA (Associazione Italiana di Ingegneria Agraria): www.aiia.info
AIEL (Associazione Italiana Energie Agroforestali): www.aiel.cia.it
AIEE (Associazione Italiana degli Economisti dell'Energia): www.aiee.org
AMBIENTE ITALIA (Istituto di ricerche): www.ambienteitalia.it/solare/index.htm
APER (Associazione Produttori di Energia da fonti Rinnovabili): www.aper.it
ASSOBIODIESEL (Associazione Italiana Produttori di Biodiesel): www.assobiodiesel.it/
ASSOCOSTIERI (Associazione Nazionale Depositi Costieri Olii Minerali): www.assocostieri.it
ASSODISTIL (Associaz. Naz.le Industriali Distillatori di Alcoli e di Acquaviti): www.assodistil.it
ASSOLTERM (Associazione Italiana Solare Termico): www.assolterm.it
ASSOSOLARE (Associazione Nazionale dell'Industria Fotovoltaica): www.assolare.org
ATLANTE EOLICO DELL'ITALIA: www.ricercadisistema.it
ANEV (Associazione Nazionale Energia dal Vento): www.anev.org
BIOFUELS ITALIA (Piattaforma Tecnologica Italiana Biocarburanti): www.biofuelsitaliatp.it
CEAR (Consorzio Energia Alternativa per il Riscaldamento): www.consorziocear.com
CETA (Centro di Ecologia Teorica e Applicata): www.ceta.ts.it/
CNER (Consorzio Nazionale Energie Rinnovabili agricole): www.cner.it
CTI (Comitato Termotecnico Italiano): www.cti2000.it
CNR-IVALSA (Istituto per la Valorizzazione del Legno e delle Specie Arboree): www.ivalsa.cnr.it
CRPA (Centro Ricerche Produzioni Animali): www.crpa.it
ENEA Centro ricerche Casaccia: www.casaccia.enea.it
ENEA Centro Ricerche Trisaia: www.trisaia.enea.it
ETA - Energie Rinnovabili: www.etaflorence.it
EUBIA (European Biomass Industry Association): www.eubia.org/
FIPER (Federazione Italiana Produttori Energie Rinnovabili): www.fiper.it
FIRE Italia (Federazione Italiana per l'Uso Razionale dell'Energia): www.fire-italia.it
Fondazione per lo Sviluppo Sostenibile: www.fondazionesvilupposostenibile.org
GBEP (Global Bioenergy Partnership): www.globalbioenergy.org
GSE (Gestore dei Servizi Elettrici): www.gsel.it/ita/index.asp
GIFI (Gruppo Imprese Fotovoltaiche Italiane): www.gifi-fv.it
IEA (International Energy Agency): www.iea.org
ITABIA - Italian Biomass Association: www.itabia.it
ISES Italia (International Solar Energy Society): www.isesitalia.it
KYOTO CLUB: www.kyotoclub.org
LEGAMBIENTE: www.legambiente.com www.fonti-rinnovabili.it
Ministero dell'Ambiente e della Tutela del Territorio e del Mare: www.minambiente.it
Ministero delle Politiche Agricole, Alimentari e Forestali: www.politicheagricole.it
RENAEL (Rete delle Agenzie Energetiche Locali, c/o Rete di Punti Energia): www.renael.it
SEE (Sustainable Energy Europe): www.sustenergy.org www.campagnaSEEitalia.it