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ROLE AND PRIORITIES OF BIOMASS CHEMISTRY IN ITALY

Foreword

The current policies for Sustainable Growth and the efficient use of resources clearly represent an opportunity for chemistry both as scientific research and as industry, since they can provide solutions to environmental problems, particularly concerning the safety of products and in terms of minimization of their environmental impact, their weight, energy consumption, and CO_2 emissions throughout the lifecycle of the materials.

The commitment of Italian companies clearly shows that the challenge has been taken up by the industrial world and that Italy, for once, is not holding back. This may provide the starting point for a new programme, that might sustain the development of industrial chemistry in Italy, through matching the engagement of the enterprises and the preparation of a favourable external context by raising the awareness of the importance of a “technological infrastructure” for the sector. In short, that it is possible to create a positive stimulus not only to the specific sector but also industry-wide and to the agricultural sector.

One of the most interesting fields, though certainly not the only one, is represented by the possibility of using biomass for manufacturing basic chemical compounds in partial substitution of the traditional raw materials of fossil origin in the petrochemical sector, because on the one hand the cost of oil is high and increasing daily, and on the other biomass may simplify some of the productive processes and its use could revitalize rural communities. This possibility enhances the already well-established role of chemistry in the production of bio-fuels and biomaterials.

It is increasingly evident that the major European countries are competing with each other in supporting sustainable chemistry, both through the substitution of processes and products and in the transformation of biomass into industrial raw materials, and through industrial policies aiming to create national excellence, in order to exploit to the limit market trends towards sustainability, as well as the opportunities deriving from EU action leading to more efficient use of resources.

Sustainable chemistry

Sustainable chemistry consists of the development and the application of products, processes and technological solutions conducive to the improvement of workers' and consumers' health, to lowering environmental impact and to a reduction in the consumption of non-renewable energy sources and raw materials. In its social, environmental and economic expression, sustainability represents the result of a joint effort of the scientific community and enterprise, for whom sustainability represents the main commitment to social responsibility.

The concept of sustainable chemistry has always been supported by the entire Italian chemical industry, that brought it about through the voluntary initiative of "*Responsible Care*".
The *Responsible Care* programme is based on the involvement of chemical companies in:

- continuously improving products, processes and behaviour in safety, health and environmental matters, in order to give a significant contribution to sustainable development in industry, local communities and society,
- implementing and improving the health and the safety of workers and of the people living close by the industrial areas (investing in safety and in a lower environmental impact),
- increasing environmental protection by reducing as far as possible emissions to air (less green house gasses (GHG) and volatile substances), water and ground, in order to reduce the environmental impact of industrial activities on climate changes and on local communities.

The chemical industry is committed to on-going reduction in the use of resources in the productive activities and to increasing the energy efficiency of the sector by reducing energy consumption and encouraging the use of renewable energy.

Within sustainable chemistry:

- logistics and transport have to be carried out safely, aiming to reduce their environmental impact,
- industrial products have to be managed according to current legislation and, moreover, responsibly in respect of the users and the environment, paying attention to the product throughout its life cycle, in order to improve performance, safety and to minimise impact on the environment,
- many different safety and environmental certification schemes are promoted and considered to comprise the requirements and the industrial scope of the *Responsible Care* programme.
- communication with the public must be transparent and based on maximum cooperation. Enterprises should clearly communicate the goals and the evaluation of the results achieved with the stakeholders in the policy. They should inform customers about usage, transport and disposal of their products and encourage them to adopt policies coherent with the guidelines of the programme,
- industrial waste management has to be carried out responsibly, in order to minimize the amount and to ensure correct disposal.

The actions carried out by industry to improve the *Responsible Care* programme and to sustain the spread of its principles and values has been a key point of the goals in recent years, due also to the cooperation with national and international authorities, institutions and organizations that contribute to sustainable development. The companies taking part promote R&D activities in matter of safety, health and environment, in order to develop safer and more environmentally friendly processes and products.

The commitment of Italian companies shows that the challenge has been successfully taken up without delay. On this basis a programme may be set up where this commitment, together with the development of a favourable environment, will sustain the development of chemistry in Italy, leading to positive spin-off, not only in this sector, but also on the industrial and agricultural sectors.

In short, policies for sustainable chemistry require adequate intervention that encourages the efficient use of resources, in particular in the following fields:

- waste cycle (reuse, recycle and valorisation of organic substances)
- technological innovation (conventional technologies and biotechnologies)
- development of processes and products with improved environmental and energy impact
- substitution of dangerous products (REACH Regulation)
- sustainable logistics and promotion of the national offer of bio-fuels, bio-lubricants and alternative fuels.
- biomass chemistry.

Biomass chemistry

One of the most interesting fields of sustainable chemistry is the field of chemistry from biomass. Biomass chemistry is organic chemistry, as is petro-chemistry, based on functional groups, but with a new profile, as it makes use of renewable raw materials, such as biomass.

The transformation of biomass of agricultural, industrial or natural origin into chemical substances, both for energy and industrial uses, is a chemical process through which basic compounds are obtained that can be used directly to produce energy (bio-fuels) and intermediate chemical compounds, that are then transformed into end products just like raw materials of fossil origin.

Biomass was the principle source of raw material for the chemical industry until the 1920’s, when the greater availability of oil shifted the supply onto fossil

hydrocarbons. From biomass chemistry the so called "*bio-based products*" are obtained totally or partially from organic material, excluding fossil and mineral non-renewable sources.

Materials from biomass can have different origins:

- agricultural crops usually destined to food or fibre production
- specific crops, especially if dedicated to exploit marginal areas of poor productivity.
- by-products or waste material from the food industry or farming.
- biomass from forests or from similar sources (such as pruning, or from maintenance services of parks and gardens)
- material gathered in natural environments or those more or less influenced by human activity (algae)
- microorganisms or other organisms cultivated under artificial conditions.

Tradition and innovation of biomass chemistry

Biomass chemistry has a long industrial tradition, particularly in the field of processing starches, oils and fats. Such industries have been well rooted in the territory for a long time and they comprise a network between suppliers of biomass, from agriculture or other sources, and industrial activities.

The network makes a number of qualified materials available, within a short distance, for use in production processes. As far as agriculture is concerned, it is often necessary to establish with the farmers certain specific procedures and choices of crop varieties to enhance the producers' revenues and their technical know-how, and at the same time allow the local resources of the territory to be exploited.

Territorial networking also benefits from small to medium industrial plants adapted to the territory, well acceptable to local communities thanks to the economic value

of job availability, of environmental sustainability and of innovation throughout the value added chain from raw materials to the end product.

Beyond the important value of a strong local rooting and integration, the companies active in this sector play an extremely important role in the production of materials with a generally high level of specialization, vital for different industrial sectors. The industries of paper, textile, pharmaceutical, rubber, cosmetics, food, plastics, glues, and many others already depend on biomass supplies, from which they make a large number of products destined for technical and everyday use.

This network of enterprises, with their skills and territorial rooting, is the basis of the current industrial system of bio-economics and for its further development in innovation and sustainability. At the moment the sector is indeed in a process of deep renewal in all three levels that characterize it: Technology, Bio-refinery, Bio-products.

Technologies

The conventional chemical technologies applied to biomass aim, on the one hand, at innovation, on the other hand at making the consolidated processes more and more sustainable. Bio-technologies, in all their different forms starting from agricultural production, represent the most innovative area.

Among industrial bio-technologies, there are some, called *white biotechnology,* that consist of the use of modern biotechnologies in the transformation processes of biomass and of other raw materials and in the sustainable production of chemicals, materials and fuels.
The main areas of research, development and innovation in the field of industrial biotechnologies have been identified as:

- New enzymes and microorganisms
- Microbial genomics and bioinformatics
- Metabolic models and their engineering (cell factories)
- Study of the functioning and optimization of bio-catalysis

- Design of functional processes using bio-catalysis
- Fermentation processes and related engineering
- Design of integrated, sustainable and innovative industrial systems

Bio-refineries

Within the context of the chemistry of biomass, the concept of bio-refinery has been defined, in analogy with the refining process in the petrochemical industry, as a productive system for fuels and other products from raw materials.

The aim of bio-refinery is to produce a number of products, using renewable bio-based resources as sources of carbon and employing biological and biotechnological processes, as well as conventional chemical ones.

Ideally, bio-refinery should adopt cascading processes based on single or multiple biomasses as raw materials, from which it is possible to obtain products with the highest added value, extracting energy from materials at the end of their life cycle, taking into consideration practices of environmental alleviation, in particular with attention to GHG emissions, the “zero waste” concept and the efficient use of resources.

Bio-refineries can be divided into two general categories:

- energy oriented bio-refineries, that include plants destined to the production of bio-fuels;

- product oriented bio-refineries, that include chemical products, foodstuffs, animal feed and other materials.

It is not strictly necessary to concentrate the bio-refining process in a single plant, but may be split at various points along the production chain, delocalizing the productive sites according to the supply sources of raw materials and of the impact on the territory.

Delocalization allows optimal management of the sustainability of the productive system, mainly as far as access to primary biomasses supply is concerned, on which costs and environmental impact of the transport have a great influence.

The smaller dimensions of the plants, compared to conventional petrochemical ones, allow complete, non-traumatic integration in the territory, contribute to a higher flexibility of the productive system and make for easier access to all the requirements of the productive cycle, such as energy and water. Following the goal of reducing waste to zero, the idea of recovering energy from the materials at the end of their life can represent a significant aspect for the sustainability and the use of renewable energy sources on a local scale.

Bio-refineries are already part of the chemical industry solidly rooted in the Italian territory. Industrial productive entities such as starch plants and enterprises transforming oils and fats may be seen under the concept of bio-refinery and it is indeed thanks to the acquired merits and skills that they can be set in the dynamics of bio-economics, as they are open to the changes necessary to this sector.

Bio-products

Biomass chemistry makes the creation of new value chains possible, involving agriculture, forestry, fishing, aquiculture and the food industry.

Products deriving from the biomass chains are in any case to be considered bio-based products, even if they are similar to analogous products of conventional chemical industry, as they originate from organic materials (trees, algae, crops, plants, marine organisms, organic wastes derived from household activities, from food industry or from livestock farming).

Bio-fuels are, among all products from biomass, those that have recently gained highest prominence, as they have achieved specific goals in substituting conventional substances in the energy chain. If we consider the products already

in use for a long time and others recently introduced, among the chemical by-products from biomasses, we can number:

- fuels
- lubricants
- solvents
- polymers
- plastics
- fillers
- basic chemical compounds (building blocks)
- surfactants and cleansers
- pharmaceuticals, cosmetics, agrochemicals products and other products of fine chemistry.

Bio-products and energy uses

The destination of biomass to the production of chemicals, on the basis of potential added value, can be considered a priority relative to the direct use for producing energy such as combustion in thermo-electric plants.

If the use of biomass for energy generation represented a significant step in the process of sustainability and an alternative to non-renewable sources, the next step must be to extract from biomass all the potential added value in terms of technological and economic resources that current technologies and their expected developments can achieve.
Just as the use of mineral oil by-products for fuel is certainly not the best industrial, nor least replaceable, use we can make of them, as they can provide more important materials, the same is true for biomass.
The use of biomass for energy purposes as the end result of the value-extraction cycle is all the same appreciable in terms of both environmental and economic sustainability, as it is not right to consider it as waste material.

There are still further aspects of the products from biomass that need to be considered carefully.

Some products obtained from biomass show characteristics that enhance their life-cycle sustainability (possibility to become compost, biodegradability). These characteristics have been highly considered especially for bio-polymers and have made their market success possible, supported mainly by environmental and social considerations.

In other cases there are products with only one component originating from biomass (e.g. compounds) that are integrated with products of more conventional origin, often improving their technological characteristics as well as their sustainability. On the one hand, this allows the versatility of the *bio-based* products to be highlighted, on the other hand it reminds us that these products are perfectly suitable for the technological role that has been assigned to them and, at the same time they can have a lower environmental impact.

A technological view of the future

The quantities of traditional biomass available in Italy are limited. The goal to access sources of alternative materials, for example wastes and ligno-cellulose residues, is driving the transition from first generation technologies to those of so-called second and third generation, which are capable of exploiting materials that, due to their composition and provenance (in some cases otherwise unusable), are not employed in other chains and are suitable for recovery as renewable resources.

The perspective of technological innovation is now under development and sees Italy playing a leading role world-wide. The aspects of supplies from sources normally used for foodstuffs (for animals or for humans) are often perceived as conflicting. These aspects of conflict can be overcome by promoting as much as possible the use of biological materials of different origins, such as crops in areas not suitable for food production, wastes from crops, wastes from the food industry or forestry activities, organic wastes, other materials from resources not fully

exploited such as algae or other aquatic and marine materials, but at the moment they do not seem to be completely replaceable.

Besides the supply from alternative biomass sources, many areas for improvement can be followed up on a strictly technological level, as for example in exploitation of conventional catalysis, towards more selective processes of synthesis with lower energy needs.

The frontier that can be defined as third-generation is more specifically of a biotechnological nature and starts from research into the engineering of microbial metabolism, which emerges as an enabling technology for the progress of chemistry in the twenty-first century.

The potential exploitation of microorganisms for the production of chemicals is enormous. The room for investigation at the genomic and metabolic level opens up the possibility of a more efficient use of renewable resources. Microbial catalysis and orientation of microorganism metabolism together with both knowledge tools such as genomics and the development of fermentation technologies, are the resources on which future industrial biotechnologies will be based as a new dimension of biomass chemistry.

Conditions for the development of biomass chemistry

Summarizing a shared vision that is also found in the documents of the European Union on bio-economy in its various forms, the general factors to be considered regarding the opportunities that biomass chemistry offers in terms of sustainable development are:

- use of renewable and expandable resources
- potential reduction of GHG
- a more sustainable cycle of production
- potential for reuse and recycling
- improved toxicological, eco-toxicological and environmental impact profile
- improvement of biodegradability and of the possibility to be composted
- support to rural development

- increase of industrial competitiveness thanks to eco-efficient products based on biomass
- widespread innovation across the value chain

Biomass chemistry, as a relevant part of a bio-economy that measures itself now on a global scale, has to refer to the general European strategy in this sector and has to be highly integrated with related EU policies, particularly with the Common Agricultural Policy (CAP), for which a radical reform has been set in motion.
Biomass chemistry must be able to efficiently access all the support mechanisms at a EU level, starting from those related to research and development activities and industrial cooperation.
As with any activity in the field of bio-economy, the development of biomass chemistry requires a determined collaboration among all stakeholders:

- citizens and consumers,
- universities and research,
- biomass manufacturers and suppliers,
- manufacturing industry of the “bio-based” products,
- industrial and non-industrial users of final products,
- national and European Institutions

This should lead to the enacting of modes of partnership that can render the relationship between the different actors more effective, by adopting all possible modes of information interchange and of communication activities that promote not only an adequate culture and level of knowledge, but also the awareness of acceptability and social sustainability offered by the chemicals derived from biological sources.
Europe has an important potential for job creation in the coming decades within a system of sustainable development and in focussing on bio-economy.
This is indeed the message that the countries of the European Union clearly received from the recent Copenhagen Conference. During the meeting not only the major protagonists comprising the bio-economy in the Old World measured up against each other, but also against the representatives of non-European

countries, such as South Africa , Argentina, China: this means that the challenges bio-economy is now called upon to face are global challenges and the time has come for action.

The vision of the future in European strategy

By now economic development in formerly industrialized countries has taken on the direction of sustainability and of a knowledge-based economy. This approach has been adopted by the EU under the Europe 2020 strategy, a strategy of collective action aimed at growth that needs to be

- smart (based on knowledge and innovation)
- sustainable (more competitive and more efficient in the use of renewable resources)
- inclusive (promoting social and territorial cohesion).

This strategy includes a series of reference initiatives (the so-called “flagship initiatives”), including

- “The Union for innovation”
- “An industrial policy for the globalization era”
- “A Resource-Efficient Europe”

The promotion of biomass chemistry fits perfectly into the vision for the future proposed in particular by the “A Resource-Efficient Europe” initiative. This starts from the assumption that the use of renewable resources is no longer an option in the development of the European Union. This initiative can be traced back in its intent to a long-term frame of actions in different areas, providing the necessary support to policies related to climate change, transport, energy, industry, raw materials, agriculture and fishery, biodiversity and development on a regional basis. The final aim is to encourage investment and innovation and to develop balanced policies in this regard.

This strategic vision has highlighted a particular attention to bio-economy that was the subject in 2012 of a specific document of the Committee. The document identifies bio-economy as a tool for innovation and sustainable growth inasmuch as the use of renewable bio-resources can be directed towards the production of goods of significant added value.

The concept of the bio-economy, as mentioned in this document, is wide and includes farming and forestry, fishery and aquaculture, food processing and bio-industries (Bio-based industries).

The development of biomass chemistry contributes to the general effort of the bio-economy towards European industrial and scientific competitiveness, and supports European efforts to global sustainability in its economic, social and environmental aspects.
Finally, the opportunities for integration with the Common Agricultural Policy are critical to the success of the industrial strategy of the bio-economy as this sector determine policies on:

- availability of conventional and specific biomass for the bio-industry,
- incentives to farmers to encourage this availability with consequent integration of income,
- Establishment of business networks between farms and industrial enterprises, with special attention to their local implementation.

A European strategy for research and innovation

The shortage of resources destined to research provides a strong incentive to rationalize public and private research, strategically directing it to innovation and technological implementation of the outcome of the research itself.
Firstly it is necessary to know what skills are available and what projects are in progress, evaluating their potential and the means for protecting intellectual

property rights. The nature of this complex chain calls for strong integration between skills and interested parties during the stages of research, development and innovation. Chemistry from biomass requires the availability of specific skills that must be promoted through an appropriate level of training, facilitating processes of exchange and integration between the world of industry and the world of secondary and university education.

In view of the strategic importance of the features of innovation and of the scientific and technological multidisciplinary aspects, the strategy for the bio-economy and the resulting action plan outlined by the Commission specifically refer to the Seventh Framework Program for Research and Technological Development, which is drawing to its conclusion, and to the new Framework Program for Research and Innovation, *Horizon 2020*.

In the general context of practical initiatives in support of research at the European level, we can mention:

- *European Research Area*, whose purpose is to create a single pole in Europe for knowledge and technology in order to take full advantage of transnational synergies and complementarities,
- *European Innovation Partnership*, proposed within the priority initiative "Union for Innovation", for the definition of a new approach to research and innovation in the EU,
- *Public-Private Partnership,* foreseen within the research and innovation programs (7^{th} Framework Program and now Horizon 2020) to enable coordination between companies and other stakeholders so as to define and organize their research and innovation programs which are strongly linked to the market of product and process innovation.

Two start up partnerships fit into this context of collaboration between public and private:

- SPIRE (*Sustainable Process Industry through Resource and Energy Efficiency*) that is oriented towards innovation in all fields of efficient use of energy and resources, in a wide range of industrial processes. SPIRE also

aims to facilitate the use of raw materials of biological origin and improve the industrial demand for these materials.

- BIOBASED FOR GROWTH, whose purpose is to generate a variety of value chains from biomass through to the final product. These value chains should lead to new supply options for the “bio-based” production platforms, and consequently also for the projects foreseen under SPIRE, to which it is intended to be complementary.

Promotion and characterization of products from biomass

The activities under the community “*Lead Market Initiative*” can be a useful tool to promote the market for products from biomass chemistry. The competitiveness of these products can be sustained by tools such as *public procurement* or certification and specific labelling schemes. While adopting these tools it is necessary to encourage the market to acquire highly innovative products, where the positive effect for the system is evident; it is also necessary to pay special attention to maintaining the conditions of fair competition, to avoid distorting the market in ways unjustified by the products’ value.

Among the various hypotheses proposed in this context some appear to be particularly important:

- the development and application of standards qualifying the origin from biomass, sustainability and the other specific characteristics of the single products,
- the definition of suggested or binding targets for certain categories of bio-based products, in general or in specific fields of application, such as their use in sensitive areas,
- tax breaks,
- the encouragement of activities of public supply aimed at *bio-based* products,
- coherent communication strategies at all levels.

In terms of efficiency and sustainability, the products of chemistry from biomass are to be considered and qualified in the light of criteria referring to the products' entire Life Cycle Assessment, and where possible to specific evaluation standards. The eco-efficiency index, (as defined by the *World Business Council for Sustainable Development*), combining general indicators with others defined according to the product sector, is one of the tools that can be adapted to this purpose, highlighting in this way the creation of added value together with reduced environmental impact.
Concerning the product supply chain, specific identification instruments, labeling included, can be defined based on objective and acknowledged criteria.

Industrial development of chemistry from biomass

The development of production technologies for biomass chemistry contemplates structures that may have different characteristics:

- pilot plants
- demonstration plants
- industrial scale bio-refineries
- conversion of disused industrial sites
- adaptation of existing plants to the use of biomass
- plants with consolidated technologies in the use of biomass

Particularly for the most innovative technologies the need is evident for starting from small scale structures, as pilot plants and demonstration plants, that make it possible to study and assess the subsequent up-scaling to industrial-sized bio-refineries.
The transformation of existing plants in order to exploit conventional biomass, or new biomass sources as these become available, is a further possibility, as is the chance to obtain new products based on the output of traditional bio-refineries currently treating conventional biomass.

The system of bio-refineries also offers opportunities to reorganize industrial areas in decline or disused; in this way it allows new job creation, bringing significant environmental benefits to the neighboring territories.

As for the relation with the territory, if on one hand we can envisage plants of considerable size, making reindustrialization projects of declining areas interesting, on the other the close link with the territory, the proximity of biomass supply sources and the diversification of productive technologies leave room for smaller structures and firms and for their consolidation in networks with actors from the supply side to the consumers of the single company processes.

On the supply side, a further opportunity of reuse exists for degraded and contaminated areas which can be destined to biomass production, with the possible effects of environmental reclamation and hydro-geological consolidation, where again coordination with agricultural and territorial policies plays an important role.

Elements for a policy supporting chemistry from biomass

The Italian chemical industry is aware that it is able to play a primary role in the implementation of sustainability policies. These policies involve the entire sector, already actively engaged in this sense, both in the conventional productive sectors and in the more innovative ones.

Beyond being a significant energy user, it also produces entire classes of products which appear to be more and more important in the formulation of bio-fuels and of many other materials that fall fully within the perspectives of both sustainability and bio-economy.

The Italian chemical industry wants to pay the utmost attention to the concept of the chemistry from biomass, in the perspective of the development and innovation of the entire sector, in a fully sustainable dimension. The successes already achieved provide the stimulus to continue in a field where the main European countries and global competitors, some of which have already outlined clear policies to support the bio-economy, are measuring themselves. All this to take up

all the opportunities that the global context and the framework of the EU strategies in particular seem to offer.

In the general context of the national chemical industry, a modern industrial policy can play a key role for the harmonious development of chemistry from biomass, providing a possibility for reconfiguration and renovation with a positive impact on employment and local development, while improving the profile of sustainability.

The strong interconnection with public administration, the need for integration with the Community strategies and instruments and the strict dependence on the regulatory system reinforce the role that a proactive industrial policy can play in directing these sectors.

In Italy there has always been chemistry from biomass making products for traditional use (starches, oils and lubricants, etc.) which is now joined by new enterprises and new industrial initiatives. This industry is investing heavily in renewal through the setting up of innovative products and new processes to exploit both conventional and new biomass.

The effort that is being made, though, requires prompt action in Italy too, and this can be achieved through a policy of support, in order not to miss the economic and social opportunities it offers. That is what other countries are doing and we must measure ourselves against others' industrial policies in terms of competition.

In an overall perspective of the economy of knowledge, the European Union has clearly outlined a Strategy on Bio-economy, in the context of which national initiatives must fit. While maintaining a strong coherence with community strategy, the development of chemistry from biomass in our country can only take place within the context of an organic industrial plan, which needs to be underwritten by all stakeholders and promptly implemented.

First, it is important to establish a table of comparison and coordination between institutions and industry, making it possible to define actors in the chain of activities and to highlight their interests and needs. Starting from the comparison table, the second step is to proceed with an analysis of the impact of the various factors of influence and of the opportunities that arise in favour of the development of biomass chemistry.

Policy of development and regulation

The development of chemistry from biomass requires a clear, stable and well defined regulatory frame governing the activities and outlining the incentive levels. This may require a revision of the regulatory legislation in force, especially in relation to its simplification, in the various contexts in which the supply chain develops, from primary production of biomass in agriculture or in alternative contexts, up to the final phases of disposal, recycling and reuse, with particular attention to environmental standards.

Since the availability of raw biomass material is a strategic element, the rules that govern its availability and classification should be reviewed and simplified so as to become functional to the development of the sector, while necessarily safeguarding the aspects of human and environmental safety.

The access to raw materials of biological origin also requires close coordination with the application of EU agricultural policies on a local level. Their application, already occurring on a regional level, can be more easily directed to support based on the realities linked to a particular territory, and which takes adequate account both of income levels of the biomass producers, i.e. farmers, and of environmental requirements. These are, in any case, ever more influential in determining agricultural policies and the protection of biodiversity. The impact on the environment and ecosystems, the preservation of the landscape and hydro-geological stability are among the factors of increasing impact on the entire system downstream.

The revision of the regulations should also lead to the simplification of procedures that allow the establishment and transformation of production activities, starting from the pilot plants that enable the subsequent scaling up to production volumes of industrial size, including the functional upgrading of the existing installations. Particular attention should be paid to the conversion of industrial areas, encouraging their reuse with special attention to the aspects of social sustainability and the benefits for employment.

The focus on sustainability should, finally, be reflected in terms of assessment and identification of the products deriving from biomass, increasing their value through the appropriate environmental "footprints" and through labelling that identifies their provenance. This should lead to the creation of positive reference lists for any bio-oriented "*procurement*" initiatives.

In this perspective, it is essential to establish the definition of standards that objectively qualify products in terms of their sustainability, a prerequisite for correct information to the market, where the final choice is made. To this end the implementation of the Advice on the *Lead Market Initiatives* for EU *bio-based* Products is useful.

Development policy and support to research

The coordination between the different actors of the chain has to be based on research, with a careful analysis of public and private activities. The harmonization and the orientation of their goals, after an accurate census, are functional to the rational use of available resources and to the access to EU plans already oriented towards the bio-economy.

The new program of support to research of the European Union is clearly open to *bio-based* industries and is an opportunity not to be missed, especially in view of the establishment of *Public - Private Partnerships* to ensure access to available resources.

The prospect of integration of public and private research, enabling an "active participation and a convergence with Horizon 2020 goals", also fits in the creation of a national "cluster" of "green chemistry" according to the information from MIUR (Ministry of Education, University and Research) presented in the "Notice for the development and strengthening of national technology clusters" (May 2012). The MIUR document is linked in particular to what is reported in the Communication n. 809 COM (2011) of the EU Commission on the proposal for a Regulation

establishing the framework programme for research and innovation (2014-2020) - Horizon 2020, which in paragraph 2.3 of part III ("Bio-sustainable and competitive industries") says: “The objective is the promotion of European low-carbon emission bio-industries, which are efficient from the point of view of sustainable and competitive resources. The activities focus on the promotion of the bio-economy with the transformation of industrial conventional processes and products into biological products and processes being efficient in the use of energy and resources, with the development of bio-refineries that use biomass, biological and biotechnological waste by-products and those derived from primary production, and with the opening of new markets through the support to standardization, regulation and demonstration/experimental activities and others, taking into account the consequences of the bio-economy on land use and the changes for intended uses of the land”.

The purpose of this *cluster* is explained as "*the development of technologies for conversion of second and third generation biomass (“non food sustainable” biomass) into green energy and chemistry*”. This initiative, which explicitly takes into account also the Communication of the 2008 Commission for the creation of industrial clusters that shall be competitive worldwide, provides that "companies, universities, other public or private research institutions, other subjects including those financially active in the field of innovation" will join and be focused on specific scientific and technological areas, such as the area here defined as" green chemistry ". As part of the clusters, the parties involved have to submit a five-year strategic development plan and specific development projects of industrial research and training activities related to them.This initiative is viewed with great favour by the national chemical industry, which sees in it an important tool for the promotion of chemistry from biomass.

The development of innovation also involves leading edge business enterprises, born around areas and projects that often have difficulty in accessing financial resources. The promotion of these forms of business enterprise, facilitating their establishment, their access to sources of financing, and acting on the fiscal level,

is an important step in promoting research, development, innovation and technology transfer.

Conclusions

The Italian chemical industry feels strongly committed to supporting, with its own resources and skills, a plan for the development of chemistry from biomass. This represents a real opportunity for innovation, economic growth and social responsibility to the benefit of the entire national community, and the chance to play a central role in terms of international competitiveness .

Chemistry from biomass is presented as the logical crowning of the highly successful effort towards sustainability carried out by the Italian chemical industry. In this sense, the national chemical industry calls for the rapid implementation of a support policy, long term and effective, based on the "triple helix" concept: industry, research, public service.