

# Research Paper

## The challenges and opportunities of the European Union lead market initiative: case bio-based products

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The role of innovations as an engine for European competitiveness is largely accepted as a part of the EU Lisbon strategy, and the Lead Market Initiative (LMI) has been seen as an innovative platform for advancing the knowledge-based bio-economy in Europe. Our research questions are; first, what are the main challenges and opportunities of the LMI on bio-based products in comparison to other EU initiatives such as JTIs and CIP? Second, does the LMI address those challenges adequately, and what areas of improvement can be identified? Methodologically, we use a qualitative case study approach with data from both documentary sources and in-depth elite interviews. Based on our results, the strong demand-side characteristics of LMI, such as public procurement, standardization and legislation, can accelerate the time-to-market in case of the bio-based products and services. However, the speed of diffusion is dependent on overcoming the problems of the critical-mass market creation and fragmented supply-side of bio-based industry. Ensuring coherence and coordination of activities between policy-makers in the Member states, EU Commission services, businesses and other stakeholders is also crucial to the success of LMI for bio-based products.

### 1 Introduction

Economic globalization has changed the world's economic order in a remarkably short time and has brought new challenges and opportunities. Europe will not be able to compete in this new environment unless it becomes more innovative and responds more effectively to consumer needs and preferences (European Commission, 2010). The EU Lisbon strategy has addressed these challenges, aiming to stimulate growth and create more and better jobs while making the economy greener and more innovative. Innovative use of renewable raw materials could be the key to utilizing the important potential of biomass in Europe. According to Van Dam et al. (2005), innovations and new product development are the essential parts of the commercial attractiveness of bio-based products, and industries should be encouraged to market more ecologically improved products based upon

sustainable production.

A new impetus for demand-side innovation policies has emerged during the 2000s, as a response to insufficiency of traditional supply-side innovation policies to meet the challenges posed in promoting competitiveness of European Union, with the aim of focusing on the creation of innovation-friendly markets, strengthening R & D resources, increasing structural mobility, and fostering a culture, which celebrates innovation (Edler and Georghiou, 2007 p. 951). Demand-side innovation policy, and in particular the role of public procurement, has been at the centre of recent discussions on innovation policy (Aschhoff and Sofka, 2009).

The Lead Market Initiative (LMI) is the European policy for six important sectors that are supported by actions to lower barriers to bringing new products or services to the market in bio-based products, e-health, protective

textiles, recycling, renewable energy and sustainable construction (European Commission, 2009a). The European Commission, Member States and industry work together to carry out the action plans for these lead markets. According to the European Commission (2007), bio-based products are non-food products derived from biomass (i.e., plants, algae, crops, trees, marine organisms and biological waste from households, animals and food production). Bio-based products may range from high value-added fine chemicals such as pharmaceuticals, cosmetics, food additives, etc., to high volume materials such as general bio polymers or chemical feedstock (i.e., building blocks). The definition pointedly excludes traditional bio-based products, such as pulp and paper, wood products and biomass as an energy source.

According to Beise (2004), the lead markets refer to the countries that first adopt a dominant global innovation design; they lead the international diffusion of an innovation and set the global standard. The aim of the LMI used by the European Commission is "to identify the first set of markets with the potential to become 'lead markets' calling for urgent and coordinated action through ambitious action plans for these markets, in order to rapidly bring visible advantage for Europe's economy and consumers" (European Commission Communication, 2007). The six target sectors including bio-based products were selected based on their strategic importance to the innovative and competitive Europe, but also because of the relatively strong role of public sector demand in these products and services.

However, there are also several other programmes and initiatives in the European Union for the bio-based products concurrently directed towards the bio-based sector in addition to the Lead Market Initiative (LMI); the 7th Framework Programme (FP7) and Joint Technology Initiatives (JTIs), the Competitiveness and Innovation Programme (CIP), the establishment of European Institute of Innovation Technology (EIT), and several European platforms such as the Sustainable Chemistry Platform (SusChem) and the Forest Sector Technology Platform (FTP).

The research questions of this paper are; first, what are the main challenges and opportunities of the LMI on bio-based products in comparison to other EU initiatives such as JTIs and CIP? Second, does the LMI address those challenges adequately, and what areas of improvement can be identified? We will also gain better understanding of the interplay between various

European Commission driven innovation policy instruments towards the creation of the knowledge based bio-economy in EU, especially of the challenges in integrating public sector innovation into other policy fields.

## 2 Theoretical Background

Theoretical concepts connected to analysis of the Lead Market Initiative can be found in the literature on innovation management, especially related to innovation systems (Edquist and Hommen, 1999). Functions of innovation systems have previously been studied in Hekkert and Negro (2008), Malerba (2002) and Oltra and Maider (2008), which focus on sectoral systems of innovation. In Kubeczko et al. (2006), the main question was the extent to which sectoral and other innovation systems support innovation performance in the European forestry sector. Aschhoff and Sofka (2009) have classified four main types of public innovation policy tools to consist of regulations, R & D subsidies, scientific and technological infrastructure and the use of public procurement. Finally, Bélis-Bergouignan and Levy (2010) have emphasized the need to integrate a stronger consideration of natural resources into the analysis of innovation systems.

Edquist (2008) separates four key activities in systems of innovation; 1) knowledge inputs to the innovation process (e.g., R&D, competence building through individual and organizational learning), 2) the demand-side activities, 3) providing constituents for systems of innovation (enhancing entrepreneurship and intrapreneurship to diversify existing firms, and creating new research organizations and policy agencies) and 4) support services for innovating firms. From the systems of innovation perspective, innovation policy is partly a question of supporting interactions in this system that identify existing technical and economic opportunities or create new ones. It can be also said that the selected initiatives function as innovation platforms, a forum bringing the stakeholders and networks required together. According to Malinen and Haahtela (2007), these forums take care of shared strategic processes and leadership of the network which finally leads to decision-making and possible investment related to the strategy.

The rationale for the more demand-side oriented innovation policy is associated with a range of market and system failures affecting the translation of needs into functioning markets for innovative products and services, but policy prescriptions emerging from "systems"

approaches to innovations tend to focus predominantly on the supply side of economic life (Edler and Georghiou, 2007). In a recent article Uyarra and Flanagan (2010) also point out that “there is an increasing consensus in innovation policy discussions that the demand side of innovation has been neglected”. According to Ahvenharju et al. (2010) the development of the demand-side innovation policy is a relatively new field, and there is no sustainable theoretical background to develop these innovation policies. While it is widely recognized that by using public policies it is possible to affect demand in many fields, it is still unclear what principles one should use to choose the innovations and solutions or markets which should be advanced, for example, with standards and, at the same time, which are the effective public instruments. For example, public procurement in the EU is guided by national policy frameworks coupled with an overarching EU policy framework that is designed to open up the EU’s public procurement market to competition, outlawing “buy national” policies and promoting the free movement of goods and services (Brammer and Walker, 2011).

Beise and Cleff (2004, p. 455) have defined “lead markets” to be “regional markets with specific attributes that increase the probability that a locally preferred innovation design becomes internationally successful as well”, as an extension of the concept “lead users” (von Hippel, 1986). As the relevant lead users we consider here the public sector, because of its public procurement practices, and private companies, but the question how these two groups differ from each other goes beyond the scope of our empirical analysis. According to Georghios and Edler (2007, p. 955) characteristics of a lead market include existence of customers willing to pay a premium for the particular characteristics of the innovation, general favorable conditions to innovations (such as an efficient and responsive regulatory structure and security to intellectual property), compatible infrastructure, sufficient market scale, and sufficiently generic products requirements to allow for expansion/export into wider markets.

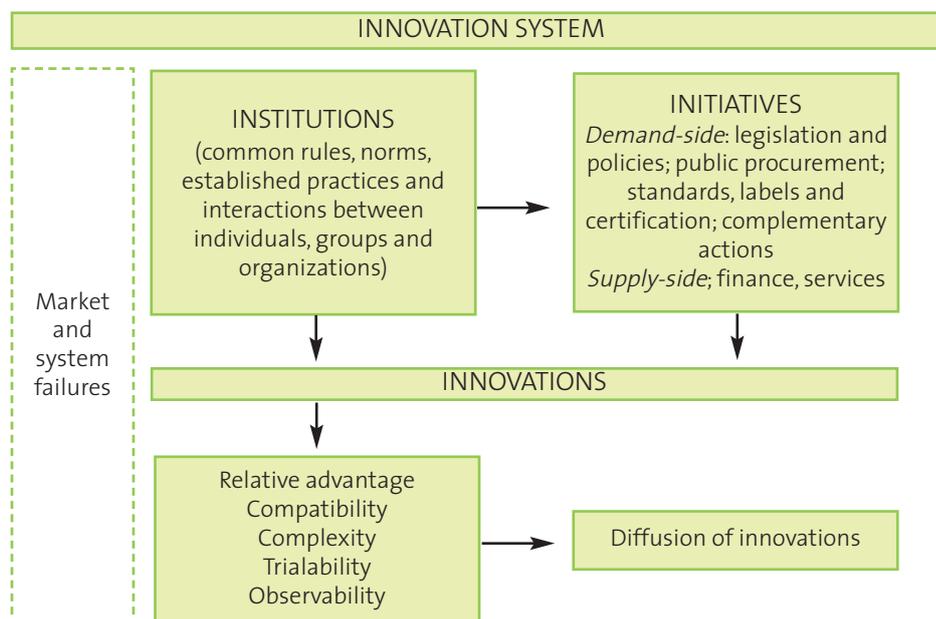
The innovation diffusion approach (Rogers, 2003) also proves us measures to understand the mechanism behind successful policy initiatives better. According to Rogers (p.22), “diffusion is the process by which an innovation is communicated through particular channels over time among members of a social system”, and the idea has been used in the several related

studies (e.g., Beise and Rennings, 2006, Peres et al., 2010). According to Rogers (2003), time is involved in diffusion in (1) the innovation-diffusion process, (2) innovativeness, and (3) the rate of adoption of innovation. The innovation-decision process is that process through which an individual (or another decision-making unit) passes from the first knowledge of an innovation to forming an attitude toward the innovation, a decision to adopt or reject, to implementation of the new idea, and confirmation of this decision. Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adoption of new ideas than other members of a social system.

Rogers (2003) formed five attributes facilitating diffusion of innovations as relative advantage, compatibility, complexity, trialability and observability. Rogers suggests that relative advantage, simplicity and an innovation’s compatibility with a potential adopter’s or organization’s norms and procedures, account in particular for considerable variance in explaining adoption decisions. According to Dearing (2009), the other two attribute categories he distinguishes, observability and trialability, are not as consistently important across innovation types for producing adoption, though it is reasonable to assume that for high risk, expensive, and obtrusive innovations, trialability should be especially important, while for complex innovations with many process steps and those innovations that embed high degrees of ambiguity or tacit knowledge in their operation, the visibility of the innovation in the process and observability of outcomes should be especially important.

Based on literature review, we have formulated our theoretical framework as shown in Figure 1 to consist of the key role of institutions and initiatives within the innovation system, through which innovations for bio-based products are being created and diffused in Europe. Similar to most past research, we focus on predicting the rate of adoption based on the innovation attributes (Rogers, 2003). In the background, the theoretical framework also suggests that innovation system includes institutions and initiatives with inherent vulnerability to market and system failures. It should be noted that the system described in Figure 1 is meant for mainly serving as a guiding tool for conducting the interviews, and not meant to be understood to comprise any formal theoretical framework to be tested.

Figure 1 Theoretical framework (modified from Edler & Georghiou 2007, Edquist 2008, Oltra & Maider 2008 and Rogers 2003).



### 3 Data and methods

Exploratory study of a phenomenon in a new context justifies the qualitative approach chosen for this study (Silverman, 2000). The methodology we used is a qualitative case study approach with data from both documentary sources and in-depth key stakeholder interviews. In qualitative studies, since it is desirable to use data and method triangulation to decrease the possibility of systematic delusion, the data of this study has been collected from various sources by interviewing multiple high-level experts. Data analysis has been conducted by using several theories to complete the triangulation.

Secondary data consists of previous research, literature and reports and working papers of the European Commission (including analysis of e.g. the LMI Mid-term Evaluation Report, 2009b). Since the data should be as rich as possible in terms of the research problem, the Commission members and the R&D&I and bio-based sector stakeholders, as the implementers of the European innovation policy actions, were among the core elite group to be interviewed (5 personal high-level interviews). Since all research themes were well covered by the interviews and convergence emerged between the respondents, even this small number of interviews was likely to be sufficient.

The internal validity of this study was ensured by drawing results logically from the data in combination with theory. Primary data is presented by summarizing the key notes on the responses and constructing an illustrative comparative table of the various initiatives. Internal validity was also ensured by linking the results to the existing literature (Eisenhardt, 1989).

Rich presentation of the initiatives improves the external validity of this study, which was particularly important, as the core research subject was one of the initiatives. The theoretical framework was formulated and operationalized based on the secondary data, which consists of previous research, literature and reports and working papers of the European Commission (e.g., analysis of the LMI mid-term evaluation report, 2009b).

Operationalization of the theoretical framework served as a guide formulating the background questions for the themed interviews and later when analysing the results gained from the data. Specific formulation of the research subject at the outset enabled the formulation of research questions and analysis of the primary and secondary data. The background questions were formulated according to the operationalization of the framework and the themes that arose during the research process were flexible enough to

give space for the discussions that arose during the interviews, so that they could be considered as relevant data. In the study, careful documentation was also used to ensure the reliability of the results. The questions were thoroughly explained during the interviews, in the case of unclear interpretation of concepts.

## 4 Results

### 4.1 Evolution and characteristics of the LMI for bio-based products

The idea of the Lead Market Initiative started in 2006, when Aho et al. (2006) introduced the concept of EU lead markets. The report recommended the development of innovation-friendly markets in a more targeted way by creating conditions to facilitate the transformation of technological and non-technological innovation into commercial products and services. The LMI was launched in 2007, and runs to 2012, but unfortunately no budgetary figures were given out at the time when this research was conducted. A plan of action for the next 3-5 years for each lead market was formulated, and the work started at the beginning of 2008. The governance structure and the progress of the initiative have been described in the mid-term progress report on the Lead Market Initiative (European Commission, 2009b) and the final evaluation of the initiative will be implemented in 2011. There is presently some evidence of new innovation policy developments in 12 out of 16 Member States partly as a result of and largely coinciding in a timely way with the LMI, and Finland, the UK and the Netherlands are now putting demand-side innovation policy at the centre of national innovation strategies.

Interestingly, the bio-refineries are included in the LMI on bio-based products, but other bio-energy products belong to the LMI on renewable energy. The LMI excludes traditional paper and wood products, but innovative bio-based products made from wood and lingo-cellulose are included in bio-based products. A representative of forest-based industry criticizes the exclusion of traditional wood-based products: *"it was a pity that they excluded these traditional wood-based products from the definition of the LMI on bio-based products. The areas should have been wider in the first place. It is good that there are those pharmaceuticals and vaccines but the traditional products could have been there also..."*

In bio-based products, there is already a

growing demand for the new products provided that they are relatively competitive. According to the mid-term progress report (2009) *"as bio-based products are not one uniform product group, but a range of products with different characteristics and uses, the Lead Market Initiative helps to ensure the coherence of measures aiming to address demand-side problems with rules and regulations that govern the manufacturing process from raw material to final product."*

Legislation and policy activities of the LMI on bio-based products include the establishment of an advisory group, which includes representatives from Member countries and industries. According to the mid-term progress report of Lead Market Initiative for Europe (2009b), encouragement of Green Public Procurement (GPP) for bio-based products has been completed for public procurement actions. The GPP Communication proposes the way in which guidelines now include criteria that allow bio-based products to be given preference in tender specifications. Public procurement plays a major role by creating niche markets for environmental technologies, and by allowing feedback between experimental users and the emerging technology producers. A staff member of the Commission explains the challenges within the Commission, and the added value that the LMI has brought to the situation: *"the main challenge of these demand-side instruments is the cooperation between people with different backgrounds, for example, the people in public procurement."*

For the LMI on bio-based products, standardization and labelling, certification of product performance standards can help signal the environmental performance of products and processes. The Commission has identified a lack of suitable European standards for bio-based products, in particular for determining bio-based product content as well as other functional product capabilities, evaluation of environmental impacts, and a number of other purposes. One informant perceived positive progress: *"Before the LMI, public suppliers didn't have contacts with researchers, and the work of standardization developers was not linked to the work of innovation politicians."*

As supplementary actions, the Commission has already completed the mapping of bio-refineries, which can also be used as a platform to promote various new bio-based chemicals and materials. The European Commission sees partial progress on the LMI on bio-based products as also deriving from its decision to

Table 1 Key characteristics between LMI, CIP and JTIs (list of attributes by Rogers, 2003)

Innovation attributes	LMI - Lead Market Initiative on bio-based products	CIP - Competitive-ness and Innovation Programme	JTI - Joint Technology Initiatives
Relative advantage	Strong emphasis on the use of demand-side instruments	Wide scope (three specific programmes: EIP, ICT-PSP, IEE*)	Strong technology orientation
Compatibility	On a positive side, LMI instruments will remain in the innovation policy over the longer term On a negative side, costly to implement in full scale	Funds the networks, uses also demand side instruments	Focuses mostly on traditional supply side instruments
Complexity	Coordination of the EC is being criticized	Different EC departments deal with different CIP actions or programmes (shows in bureaucratic discussions in the Commission)	Success rate of the initiatives differs. EC strongly involved in funding
Trialability	Based on interviews, definition of bio-based products still unclear (except for the bio-based sector representative)	Not applicable	Not applicable
Observability	The LMI will merge under the Innovation Partnerships	Observability The LMI will merge under the Innovation Partnerships Research and innovation funding of CIP will be merged Not applicable	Not applicable

\* The Entrepreneurship and Innovation Programme, The Information Communication Technologies Policy Support Programme, The Intelligent Energy Europe Programme.

start a major research initiative on the sustainable use of biomass in March 2010 under FP7. Long-term implementation is also planned for actions which propose and implement the elaboration of normative documents for Life Cycle Assessment (LCA) methodology related to bio-based products, e.g., European guidance documents, technical reports and standards. As an example, the Joint Research Centre (JRC) is developing a methodology for information about sustainability of biomass production, which is also part of the long-term implementation of the LMI on bio-based products.

Table 1 briefly compares the LMI and two other key technology instruments of EU, namely CIP and JTIs. We identified demand side orientation in the LMI as its relative advantage,

which should be more efficient in supporting market creation and speeding up the time to market in case of new bio-based products and services, as compared to other initiatives with stronger focus on traditional supply side instruments. On the other hand, from compatibility point of view, the LMI involves costly measures, and there was impression that European Commission has had difficulties in terms of coordination of the initiative. The use of information guidance on the program content has also failed, since the definition of what products qualify as relevant bio-based products included in the LMI was still unclear even for some of our high level experts.

The Competition and Innovativeness Programme (CIP) runs from 2007 to 2013 with

an overall budget of €3621 mill., the main target being to enhance competitiveness of small and medium-sized enterprises in Europe. The program supports innovation (including eco-innovation), provides improved access to finance and delivers business support services in the regions. Demand side instruments strongly present in the LMI have been included in the CIP, but the challenge has been in the compatibility, in the adoption of these tools in practice.

The CIP has a wide scope as it is further divided into three operational programs, each of which has its specific objectives. One of the objectives of its' Entrepreneurship and Innovation Programme (EIP), which is related to the LMI, is to support policy-making that encourages innovation. A member of the Commission staff criticizes the current discussion of the CIP within the Commission: "when it comes to the CIP, the actual conversations concentrate on the bureaucratic issues. Is there going to be another CIP after 2013 or should these research and innovation issues be put together. This discussion is nothing to do with content...The instruments will be used together anyways, as can be seen from the new innovation strategy, which was published today. It is not relevant to consider whether they should be under one or two programs. This is the current discussion in the Commission and it is the old story about internal power-sharing. Who is responsible for what...This is often the problem, and indeed, it doesn't help understanding the real issues, especially if one doesn't know the power structure of the Commission...When it comes to content everybody usually agrees."

As mentioned in the Introduction, the 7th Framework Programme (FP7) consists of many areas in which the bio-based sector has ample possibilities to participate in the calls for proposals and apply for funding. Since the FP7 as an entity is far too large for this case study, the Joint Technology Initiatives (JTIs) – part of the Framework Programme – has been chosen for comparison with the LMI in this study. For the bio-based sector, JTIs such as the Nanoelectronics Technologies 2020 (ENIAC), the Hydrogen and Fuel Cells Initiative (FCH) and the Innovative Medicines Initiative (IMI), are interesting as they offer platforms to conduct demanding research and technology programs. The JTIs have already been developed further and the use of the LMI instruments may be too late. One member of the Commission staff explains: "The LMI supports other initiatives, but, for example, with JTIs, it is too late. In the Innovation Partnership, which is one of the key

elements in the new innovation strategy, current instruments are used instead. It must be mentioned in this context that the Innovation Partnership is not a new instrument but a policy tool in which these current instruments are used." One officer who has been working with the LMI since the Aho et al. (2006) report reveals that: "when we were identifying themes the sectors did not raise their hands...As to JTIs, the public private partnership for R&D in embedded systems, Artemis, has been carrying out some standardization activities." A member of the Commission staff generalizes links between the Framework Programme and the LMI: "The framework programme has weaknesses related to the LMI because very little has been done. Information Society and Media Directorate-General has been doing something, but I don't know exactly what demand-side policy instruments they have been using..."

Recently in October 2010, another new strategic approach called Innovation Partnerships was launched to "to streamline, simplify and more efficiently coordinate existing instruments and initiatives and complement them with new actions if needed" (European Commission Communication 2010). This should make it easier for partners to co-operate and achieve results more quickly than now. The partnerships will build upon relevant existing tools and actions and, when applicable (e.g., for Joint Programming and the LMI), integrate them into a single coherent policy framework. While the Innovation Partnerships emphasizes flexibility; there will not be a 'one-size-fits-all' framework. One interviewee elaborated the future of the LMI in innovation as: "Maybe they (the European Commission) will build the LMI inside these Innovation Partnerships. Since the areas are different, areas of the LMI might be re-considered. This Innovation Union is like an umbrella and so these partnerships will guide the future actions of LMI."

#### 4.2 Opportunities and challenges of the LMI for bio-based products

The current state of these instruments can be compared from the diffusion of innovation perspective based on Table 1, where the two first attributes, relative advantage and compatibility, are considered as the most important ones. Based on the differences identified in Table 1, relative advantage of the LMI corresponds mainly to opportunities perceived in promoting market uptake of bio-based based products, whereas from policy point of view, related challenges are deriving from lacks in compatibility as well as

complexity and difficulty to co-ordinate different instruments. In Competitiveness and Innovation Programme some demand-side networking approaches have also been used, but their role has not been very significant in comparison to LMI, and Joint technology Initiative has traditional technology orientation. Regarding compatibility, it is not possible draw clear conclusions regarding LMI in comparison to Competitiveness and Innovation Programme or Joint technology Initiative because of its newness and lacking budgetary figures. Overall, the characteristics identified suggest both scope for and a need for actions to be streamlined in order to enhance especially coordination and the implementation phases of the European Union innovation policies on the bio-based sector.

In the following we will discuss further the relative advantage, compatibility and complexity of the LMI, respectively, but mainly as based on the evidence from expert interviews. From the view of relative advantage, one member of the Commission staff describes the role of the Lead Market Initiative in the new innovation strategy: *“demand-side instruments are linked to research projects, which is new. In the Lead Market Initiative, it was possible to test these demand-side instruments and now these policy tools are supposed to support other policies...Most previous EU policy initiatives have focused on supply side measures which tried to push innovation. Demand-side measures give markets a greater role in ‘pulling’ EU innovation by providing market opportunities. Initial steps have been taken under the EU Lead Market Initiative, but a bolder approach connecting both supply and demand sides is needed.”* On one hand this expert showed a strong belief in the efficiency of demand side innovation policy, but also showed scepticism whether the coordination between demand and supply side policies in case of the LMI for bio-based products is yet sufficient.

Secondly, there was concern on how to move on with the creation of markets and what will be the foundation of pricing of the new bio-based products. A Commission officer defines the greatest challenges implementing LMI on bio-based products as: *“Are we really willing to pay for these kinds of products? What affects pricing? For example, good standards tend to decrease the prices... Pricing in public procurement, especially in green public procurement, also includes these environmental aspects. Because of the lack of raw material these products tend to be expensive and the*

*prices of agricultural products tend to fluctuate a lot. If we succeed in having good regulation, investments will increase.”*

Third, the challenge remains regarding simultaneous coordination of various policy instruments. Also according to Ahvenharju et al. (2010) whereas it is possible to affect demand in many fields by using public policies, it is still unclear what principles one should use to select the innovations and solutions, or markets which should be advanced, for example, with standards, and at the same time, what are the effective public resorts. Ensuring coherence and coordination of activities between policy-makers in the Member States (including procurement agencies and standardization bodies), Commission services, businesses and other stakeholders, such as NGOs and consumers, is clearly crucial to the success of the LMI (Mid-term progress report...2009b). They also suspects that the sectors defined in the LMI are perhaps too broad from the domestic perspective, which makes coordination task a complex and challenging one. According to Ahvenharju et al. (2010), this calls for active connection of the LMI to domestic policies of the Member States.

## 5 Discussion and conclusions

The LMI is the first comprehensive effort towards a coordinated policy approach based on the demand-side innovation policy in Europe, hoping to accelerate time-to-market of bio-based products and services (European Commission, 2007, 2009a and 2009b). As our research question we analysed whether the LMI adequately addresses these challenges, and what areas of improvement can be identified? According to our analysis, the opportunities embedded in the LMI are multitude in promoting innovation and new product development of bio-based products, but so are the main challenges of the LMI on bio-based products including more efficient combination of supply and demand side policy instruments, creating transparency at national and transnational level, and better coordination between various policy instruments. As the LMI type of approach could in the future, if continued, prove to be an important platform in helping to bridge the gap between the demand and supply side of innovation policy through generation of new technologies and advancing market penetration of the new products. Over the long run the greatest positive effects of European Union innovation policy on bio-based products may emerge not only from better co-ordination, but

also through creating new learning networks and bilateral contacts across policy areas, actors (such as mobilised public procurers and standardisation organisations), as well as across various sectors and the European Commission services.

However, as an answer to the second part of question, in this particular case, the diffusion of new products seems to be particularly dependent on overcoming the problems of critical-mass markets and a fragmented supply side. Unfortunately the weak co-ordination and lack of complementarity between different other EU initiatives for bio-based products has so far to some extent probably inhibited timely implementation of these measures. An interesting exception can be found in area of the biorefinery technology, mainly boosted by the ambitious targets of the European Union Energy and Climate Policy towards 2020. The absence of standards and certification systems has hindered the market update of bio-based products, and using several related policy initiatives has been so far relatively inefficient in speeding up the time-to-market.

Methodologically, as a limitation of this study, one might question the applicability of Roger's innovation attribute typology (2003) when analysing a larger industry level initiative. However, it was found to be relatively applicable in empirical analysis, although information on some other initiatives presented in Table 1 could have been more comprehensive, facilitating a more in-depth analysis of underlying similarities and differences between instruments. We also excluded from our analysis the role of legislation, which can be seen as a shortcoming.

However, despite the number of interviews in the study being small, the data and findings drawn from it saturated during the research process, so that even the present sample was likely to be sufficient (Yin, 2003). Although interview material covered all research questions, more interviews would have been useful from a broader perspective, including representatives from other EU Member countries to facilitate more in-depth analysis of potential domestic implementation issues and challenges.

In order to further evaluate the success of the Lead Market Initiative and to discuss the future of bio-based products markets at European level, we recommend further research on the subject after the end of the initiative, even though not all impacts are likely to materialize in the immediately coming years. In the future research, challenges in particular related to legislation issues of creating lead

markets should be considered. An interesting question is also if the relevant diffusion attributes can be assumed to be identical for the different groups of lead users, namely the public sector, private enterprises and consumers (see recently, e.g., Schreier and Prugl 2008), but answering this question would require empirical analysis of antecedents of becoming a lead user by different user groups. Finally, in order to build a more coherent picture of the various initiatives directed to activating innovations in the EU the study, a supplementary study which would focus more deeply on the various institutes' and stakeholders' views could be considered. In doing so, a multidisciplinary approach to R&D&I subjects is essential, as the initiatives rarely focus just on one sector or range of products in the economy.

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