



Munich Personal RePEc Archive

Policy strategies for a transition to a bioeconomy in Europe: the case of Italy and Germany

Imbert, Enrica and Ladu, Luana and Morone, Piergiuseppe and Quitzow, Rainer

Unitelma Sapienza, TU Berlin

2017

Online at <https://mpra.ub.uni-muenchen.de/78143/>
MPRA Paper No. 78143, posted 06 Apr 2017 13:37 UTC

Policy strategies for a transition to a bioeconomy in Europe: the case of Italy and Germany

Enrica Imbert[♦], Luana Ladu^{}, Piergiuseppe Morone^{♦1}, Rainer Quitzow^{*}*

[♦] Unitelma-Sapienza, University of Rome, Viale Regina Elena, 295 – 00161 Rome, Italy

^{} Technische Universitaet Berlin, Strasse des 17 Juni 135 – 10623 Berlin, Germany*

^{}Institute for Advanced Sustainability Studies, Berliner Strasse 130 – 14467 Potsdam*

Abstract: Grand societal challenges call for a transition from a society based on finite fossil resources towards a bio-based economy, based on renewable resources. Such a transition should involve not only the energy sector, but also the manufacturing sector. As acknowledged in the European Bioeconomy Strategy, the promotion of a bioeconomy is dependent on policy efforts across a wide spectrum of policy spheres. In the literature on sustainability transitions, this insight is captured in the increasing interest in the concept of policy mixes or policy strategies for promoting transitions to more sustainable modes of production and consumption. In this paper, we present a comparative analysis of bioeconomy strategies in Germany and Italy with a focus on the bioplastics sector. The paper adds to the existing literature on policy mixes by extending the concept of a policy strategy and applying it for the purpose of the comparative analysis. Moreover, the analysis is linked to the discussion on multi-level systems of governance in the European Union. A key finding is that linkages between the two policy strategies via policy making within the European Union have helped in reinforcing the nascent transition to a bio-based economy in Europe.

¹ Corresponding author: piergiuseppe.morone@unitelma.it

1. Introduction

The traditional take-make-waste economic model is unfit to face major economic and demographic world trends – including population growth and global middle class explosion (Morone, 2016) – provided also that fossil resources are dwindling and set to get ever more expensive (Green European Foundation, 2012). Hence, a transition away from a fossil-based society is needed (Elzen et al., 2004). In this transition the promotion of the Bioeconomy², in which production processes are based on sustainable biological resources, plays an important role. Indeed, the bioeconomy is becoming a key segment of the European economy, with an estimated annual turnover of 2.2 trillion euros and 22 million people employed, representing 9% of the total employment in the EU (European Bioplastics, 2016a).

The European Commission has pointed out the following advantages and opportunities of a transition to a bioeconomy, including: (1) reduction of CO₂ emissions and resource and land-use efficiency; (2) new business opportunities and growing EU global market leadership through cascading use of biomass and reuse of waste materials; (3) new integrated research structures, promoting European leadership through knowledge and technology transfer; and (4) economic and employment stimulus to rural and regional development. However, potential risks should not be underestimated. These include: (1) competition between food supply and biomass production; (2) reindustrialisation and centralisation of the agri-food production; (3) over-exploitation of natural resources and loss of biodiversity; (4) loss in consumer trust (EC, 2011).

Both seizing the opportunities of innovation and technological change and mitigating potential risks of a bioeconomy depends strongly on how policy and regulation is employed in governing the transition process. At the same time, the bioeconomy does not represent a discrete policy domain or sector, but it spans a variety of traditional and emergent policy fields and industrial sectors. These include the fields of energy, agriculture, forestry, material and chemical production as well as different areas of environmental policy and management – e.g. natural resource and land management, waste management, climate policy (Ladu and Quitzow, 2017).

Hence, as acknowledged in the European Bioeconomy Strategy, the promotion of a bioeconomy is dependent on policy efforts across a wide spectrum of policy spheres (EC, 2012). In the literature on sustainability transitions, this insight is captured in the increasing interest in the concept of policy mixes or policy strategies for promoting transitions to more sustainable modes of production and consumption. It has been acknowledged that real world transitions to more sustainable socio-technical systems are influenced by multiple policy instruments from different policy domains and across different levels of government (Borrás and Edquist, 2013; Flanagan et al., 2011; Jänicke and Lindemann, 2010; Quitzow, 2015a). In this vein, an increasing number of scholars have raised questions about how to design, assess and compare policy *mixes* for promoting sustainability transitions (Flanagan et al., 2011; Kivimaa and Kern, 2016; Quitzow, 2015a; Rogge and Reichardt, 2016).

² The bioeconomy is defined by the European Commission as the production of renewable biological resources and the conversion of these resources and waste streams into value added products, such as food, feed, bio-based products and bioenergy via innovative and efficient technologies provided by industrial biotechnology (European Commission, 2012).

After a number of primarily conceptual contributions, related concepts and analytical frameworks are being refined and tested empirically. This paper contributes to this growing literature by applying and extending the existing concept of a policy strategy (Quitow, 2015) and applying it to a comparative analysis of bioeconomy strategies in Germany and Italy. It focuses in particular on the bioplastics sector, a major area of innovation and market growth in recent years (Kaeb, 2016). This is not only a new field of application of the concept, but, given the multi-sectoral nature of the bioeconomy, also particularly relevant to the discussion. Conceptually, the paper adds to the literature by extending the argument for the purpose of the comparative analysis, while linking it to the discussion on multi-level systems of governance.

The remainder of the paper is as follows: section 2 analyses the theoretical framework; section 3 introduces the two case-studies and the methods used; section 4 reports the results; section 5 provides a policy mix assessment and section 6 presents concluding remarks.

2. Theoretical background and framework for the analysis

2.1 Policy mixes for sustainability transitions

As indicated, a number of scholars have made efforts in recent years to develop improved concepts and approaches for assessing and comparing policies for the promotion of transitions to more sustainable socio-technical systems. In earlier work on policy mixes, a particular focus was placed on the interaction of different policy instruments (Gunningham and Grabosky, 1998) and on the importance of designing coherent policy mixes (Kern and Howlett, 2009). Others have focused attention on how policy mixes develop over time on the basis of pre-existing governance arrangements. They highlight a variety of processes in the practice of policy making that lead to increasingly complex and frequently incoherent instrument mixes (Rayner and Howlett, 2009).

In recent years, scholars from the field of innovation and sustainability transitions have developed a broader conceptualization of the policy mix concept. These efforts have aimed at developing a framework for the empirical analysis of policy mixes in support of innovation in environmentally-friendly technologies and the related technological innovation systems. In doing so, these authors extend the concept beyond the realm of policy instruments and highlight in particular the dynamic nature of policy making. In addition to the narrow concept of an instrument mix, Rogge and Reichardt's (2016) policy mix framework includes what they refer to as the policy strategy, consisting of policy objectives and principal plans, as well as policy processes. Quitow (2015a), on the other hand, defines policy strategy as an overarching concept. Building on concepts from the literature on strategy and strategic management, the proposed definition of a policy strategy encompasses not only policy objectives, policy measures and policy processes but also the institutional capacities needed for policy development and implementation. Moreover, it highlights the fact that sustainability transitions and the related policies are strongly dependent on existing political opportunity sets and prevailing governance arrangements and are riddled with normative value judgements. It thus deemphasizes the importance of policy coherence, a central pillar of previous conceptualizations, and places stronger emphasis on the identification of trade-offs and the relationship between the external opportunity set and the chosen strategy.

A recent contribution by Kivimaa and Kern (2016) has extended the discussion on policy mixes from its focus on the promotion of innovation in emerging technology fields to the

broader process of sustainability transitions. They propose a framework for the analysis of policy mixes aimed at “creative destruction” rather than “mere niche creation”. In doing so, the authors aim to break out of a discussion focused primarily on policies for the development of clearly delineated, technology-specific innovation systems. In this way, their approach is in sync with the increasing momentum of energy transition processes in a number of countries and the increasing need to address the politically challenging task of phasing out incumbent technologies. In terms of their underlying policy mix concept, however, they remain focused on the original concept of an instrument mix rather than the broader concepts proposed by Rogge and Reichardt (2016) and Quitzow (2015a).

In this article, we build on and further develop the concept of a policy strategy proposed by Quitzow (2015a) to compare the policy strategies for the promotion of the bioeconomy in Italy and Germany, focusing particular attention of the field of bio-based plastics. In doing so, we seek to add to the literature in the following ways. Firstly, we apply the policy strategy for conducting a comparative analysis of two countries. While explicitly designed for this purpose, Quitzow (2015a) employs the proposed framework for the assessment of a policy approach in a single country, i.e. India’s policy strategy for the promotion of solar energy. In this article, we make the first attempt at applying the framework to conduct a comparative analysis of policy strategies. The concept is considered particularly useful for this purpose, as it emphasizes the importance of country-specific circumstances for the choice and design of the policy approach. For the purpose of this comparison, we propose a number of additional concepts aimed at categorizing different types of policy strategies. Secondly, we place particular attention on how the policy strategies are linked to policy making at the European level. We highlight the importance of considering how the policy strategies are inter-linked within the European multi-level system of governance.

2.2 Comparing policy strategies within systems of multi-level governance

For the comparison of the chosen policy strategies, we apply a slightly simplified version of the policy strategy concept proposed in Quitzow (2015a). The framework proposed in Quitzow (2015a) provides a detailed set of criteria for the assessment of each element of the policy strategy, i.e. *policy objectives, policy measures, the strategy (or policy) process and institutional capacities*. The simplified framework proposed in this paper focuses primarily on the *comparison* rather than the *assessment* of these elements. In this vein, the analysis places greater importance on the characterization of the policy strategies and the identification of the key similarities and differences between the two countries and less on the assessment of the strengths and weaknesses of the policy strategies.

Moreover, in a slight modification of the framework in Quitzow (2015a), the paper begins with a review of policy objectives, policy processes and institutional capacities. The analysis of the policy process focuses particular attention on policy coordination and the engagement of stakeholders in policy development. This is followed by the analysis of policy measures, corresponding to the concept of instrument mixes in Rogge and Reichardt (2016). This part of the analysis follows and is structured based on the system functions approach for the analysis of technological innovation systems, as proposed by Hekkert et al. (2007). For each system function, the relevant policy measures are identified (see table 1 for an overview of the framework).

Table 1: Overview of the analytical framework for the comparison of policy strategies

1. **Policy objectives** formulated in relation to the relevant policy field
2. **Policy process**, including policy coordination, engagement of stakeholders, monitoring and review during policy development, implementation and revision
3. **Institutional capacities** for acquisition of strategic knowledge, coordination and engagement of stakeholders and policy implementation
4. **Policy measures to promote system functions**, as described in Hekkert et al. (2007)
 - Knowledge development (a)
 - Knowledge diffusion (b)
 - Entrepreneurial activities (c)
 - Guidance of the search (d)
 - Resources mobilization (e)
 - Market formation (f)
 - Creation of legitimacy (g)

Source: Authors' own depiction

The paper then characterizes the two policy strategies, using the following conceptual categories. Firstly, as discussed in Quitzow (2015a) as well as the broader literature on government strategies (Steurer, 2007), strategies and the related processes of strategy formation may be situated on a continuum between what has been referred to the planning and learning school in public administration. On one end of the spectrum are *emergent, bottom-up* processes of strategy formation (Mintzberg et al., 2009). In this case, strategies develop according to what has been referred to as logical incrementalism (Quinn, 1980) or grassroots processes of strategy formation (Mintzberg, 1989). Such processes are composed of multiple incremental steps, which may end up forming a logical whole that helps guide further action. This also aligns with the perspective on policy mixes proposed by Rayner and Howlett (2009). They have emphasized that policy mixes frequently develop over time by processes whereby new policy objectives and instruments are layered on top of existing ones (layering), new policy objectives are added without substantial changes to the existing instruments (drift) or policy instruments are changed without a change in goals (conversion). On the other extreme of the spectrum are *deliberate, top-down strategies*, which are formulated in insulated planning units and subsequently implemented by the rank and file of the bureaucracy. In this case, strategy formation involves a deliberate process of strategy formulation. In practice, neither of these ideal types exists in practice. Nevertheless, they offer useful categories for situating different policy strategies along this spectrum.

On the basis of this characterization, we discuss how these differing policy strategies interact and are helping shape the broader dynamics of a possible transition to a bioeconomy in Europe within a multi-level system of governance. As highlighted in Rogge and Reichardt (2016), policy mixes are embedded in multi-level governance systems spanning supranational, national and sub-national levels of governance. This multi-level nature of the policy mix has been hotly debated, for instance, as it relates to the interaction between the European Union's Emissions Trading Scheme and national support schemes for renewable energy among the European member states (del Río González, 2007). Recent literature on European multi-level climate governance has pointed out the importance of reinforcing

governance dynamics, triggered by policy actions at different levels of governance (Jänicke and Quitzow, 2017). As the authors point out, the European Union's explicit multi-level approach to policy making coupled with an "opportunity structure" for environmental policy innovation helps to promote dynamics of multi-level reinforcement in favour of a relatively robust climate policy.

Through the empirical analysis presented below, we shall argue that the dynamic interaction of policy strategies in frontrunner countries like Italy and Germany is contributing to a similar reinforcement of innovation in the European bioeconomy. Indeed the diversity of strategies, inter-linked within Europe's multi-level governance system, will prove to be an essential driver of the transition towards a bioeconomy (for a similar argument for the solar energy sector, see Quitzow (2015b)).

3. Empirical strategy

3.1 Delimitation and selection of cases

The analytical framework developed in section 2 has been applied for the comparison of the policy strategies in Italy and Germany for the promotion of a bioeconomy with a particular focus on the bio-plastics sector. The focus of the analysis is on national level policies as well as the interactions of the national policy strategies with policies at the level of the European Union. The study does not attempt to provide a comprehensive review of policies at the European level. It only makes reference to key areas of inter-linkages with the national strategies. Similarly, the sub-national level of policy making is not considered in detail. Only major policy initiatives with national relevance or strong linkages with national policies are mentioned.

The focus on the bioplastics sector was chosen, as it represents one of the most advanced segments in the field of bio-based materials. It is particularly pertinent to the debate of a transition to a bioeconomy, as it involves a fundamental transformation of the existing, petrochemical industry. In this it differs from a number of other sectors of the bioeconomy, some of which represent entirely new, emerging technology fields (e.g. in the medical field) or technological innovations aimed at incrementally enhancing rather than transforming existing areas of production (e.g. in the food and agricultural sector).

Italy and Germany are both major European member states with a relatively high consumption rate of plastic (PlasticEurope, 2015) as well as frontrunners in Europe's bioeconomy. Germany and Italy rank, respectively, 1st and 3rd in the European Union in terms of total turnover within the sector of the bioeconomy (Intesa San Paolo and Assobiotech, 2015). They, therefore, represent highly relevant cases for the analysis of the transition to a bioeconomy within Europe.

3.2 Methods of data collection

The empirical analysis of the policy strategies is based on the following strategy for data collection. In a first step, an initial review of the literature, including government documents, academic literature and grey literature, allowed the identification of the main areas of policy debate, key policy documents and the most relevant actors in the sector. This provided the basis for the identification of key stakeholders from government, industry, civil society (including both NGOs and trade associations) and the research community to be interviewed.

Following this, semi-structured interviews were conducted with 7 stakeholders in Italy and 11 stakeholders in Germany, representing the stakeholder groups mentioned above. A summary of stakeholders' classification is reported in a table in the annex. Interviews were conducted between November and January 2017. All interviewees received a questionnaire ahead of the interview to allow them to prepare for the interview. Each interview lasted between 50 to 90 minutes. Following the interview, interviewees received an overview of key findings and results obtained and were encouraged to provide additional feedback. In addition, data collected during the interviews was validated and followed up with additional desk research on an ongoing basis. In a final step, the empirical data was presented to an expert in each country for a final validation of the findings.

4. Policy strategies for a bioeconomy in Germany and Italy: empirical results

The following section presents the detailed empirical results on the German and Italian policy strategies for a bioeconomy. After a short overview of the bio-plastics sector in the respective country, we present policy objectives, policy processes and institutional capacities as well as policy measures. To guide the reader, policy measures related to the various system functions are labelled using the corresponding letters in table 1. Following this, we briefly review their respective links to the European level of policy making.

4.1 Germany's policy strategy

4.1.1 The German bioeconomy

With its strength in science and applied research, Germany occupies an internationally leading position in the bioeconomy. With 60,000 to 100,000 jobs directly and indirectly related to the material use of renewable raw materials, Germany ranks among the frontrunners in the material use of renewable raw materials (BMEL, 2014). In 2015, the German biotechnology sector counted with 593 dedicated biotechnology companies and 133 companies in which biotechnology is part of the business activities (Ernst & Young, 2016). This young but rapidly growing sector generated about 3.2 billion euros in turnover per year and about 40,000³ jobs (compared to 1 billion and 30.000 jobs in 2007). A growing area of application is that of bioplastics, with a production capacity of an estimated 109,515 tons in 2016⁴, representing a share of approximately 2 to 3 percent of global production capacity. Nonetheless, the transition of Germany's large chemical sector remains at an early stage. In 2013, renewable raw materials account for 13 percent of the feedstock for material production by the chemical industry in Germany (VCI, 2013). Despite a large and established chemical sector in Germany, small and medium-sized enterprises (SMEs) in industry and agriculture are considered the main drivers of innovation in the German Bioeconomy (Bioeconomy strategy). In terms of R&D expenditures by firms in the biotechnology sector, Germany ranks second in Europe after France (OECD, 2016b).

4.1.2 Policy objectives, policy processes and institutional capacities

In Germany, there are no strategies or policies exclusively targeting the promotion of bioplastics. However, the two main national strategies related to the transition toward a bio-based economy support the growth of the national bioplastics sector. These strategies are the

³ This statistic includes both the total number of employees in dedicated biotechnology companies and not.

⁴ Data provided by European Bioplastics.

National Research Strategy Bioeconomy 2030 (Nationale Forschungsstrategie BioÖkonomie 2030, NFS 2030) (BMBF, 2010) and the National Policy Strategy on Bioeconomy (Nationale Politikstrategie Bioökonomie) (BMEL, 2014), approved in 2010 and 2014, respectively.

The development of the NFS 2030 was initiated by the Federal Ministry of Education and Research in 2009. It represents a component of the government's Hightech Strategy, the country's main innovation strategy (BMBF, 2014). Its strategic objectives are to make Germany an internationally competitive and dynamic location for research and innovation for bio-based products, while taking responsibility for global food security and the protection of climate, natural resources and the environment. The promotion of the industrial use of renewable resources represents one of five focus areas and aims to promote German technological leadership within a market deemed to have high potential for growth and employment (BMBF, 2014: 31). Bioplastics are explicitly mentioned in this context.

The Policy Strategy on Bioeconomy, spearheaded by the Federal Ministry for Food and Agriculture (BMEL), is closely aligned with the NFS 2030, albeit with a broader mandate linked to the government's Sustainability Strategy. Its strategic aim is to make "use of the areas of potential for the bioeconomy in Germany, and also help to strengthen the structural transition to a biobased economy" (BMEL, 2014: 9). It identifies a total of eight cross-sectoral and thematic entry-points, including the promotion of a coherent policy framework for a sustainable bioeconomy, the promotion of growth markets, innovative technologies and products and the sustainable production and provision of renewable resource. Again bioplastics are explicitly cited as one promising field of application. Neither of the strategies sets quantitative targets.

The process of strategy development was characterized by the progressive broadening of the thematic scope from innovation to a more comprehensive approach to promoting a bioeconomy. In tandem with this, a progressive increase in the degree of policy coordination and stakeholder involvement has taken place. This was supported by the development of institutional capacities for formalized stakeholder involvement, acquisition of strategic knowledge, monitoring and review and coordination within government. During the development of the NFS 2030, the BMBF consulted with other relevant ministries, including food and agriculture, economy and energy, environment. A broader consultation of stakeholders, e.g. from civil society or the *Länder* governments, did not take place. In addition, the Bioeconomy Council, composed of seventeen experts from business and science, was created to advise the government on the strategy. A key aspect of the Council's mandate has been to promotion of increased stakeholder engagement during strategy implementation (Davies et al, 2016).

With its explicit focus on policy coordination, the Policy Strategy involved a more active coordination among the relevant ministries, which was institutionalized in the form of the Inter-Ministerial Working Group on Bioeconomy for coordination among ministries and *Länder* governments. A broader involvement of stakeholders took place in the form of workshops. It stopped short of a formal consultation process and did not actively reach out to the broader public (Davies et al, 2016). The mandate and activities of the Bioeconomy Council have also broadened over time to include the task of monitoring and review of the bioeconomy with a focus on the resource base, economic and social aspects. The BMEL has established a formalized monitoring of strategy progress in the form of detailed monitoring

reports (BMEL, 2016). Finally, the Fachagentur Nachwachsende Rohstoffe (FNR), created in 1993, acts as a central agency for implementing and coordinating various aspects of government policy related to the bioeconomy.

4.1.3 Policy measures

As indicated in the previous section, the German policy strategy for a bioeconomy has a strong focus on research and innovation, and the strategy documents provide important guidance for innovators. In the industrial sector, this is further supported by the Biorefinery Roadmap (*Roadmap Bioraffinerien*) [d]. It offers an analysis of relevant fields of knowledge and a preliminary assessment of future developments in the field of biorefineries (BMEL, BMBF, BMU, BMWi, 2012). Public support for knowledge development and diffusion is also extensive. The BMBF alone dedicated 2.4 billion euros in bioeconomy-related R&D funding for the period 2010 to 2016 (BMBF, 2010). In 2016, total public R&D funding for the bioeconomy in Germany amounted to 120 million euros [a] (Ernst & Young, 2016). Knowledge diffusion is promoted via the support of R&D networks and clusters, including the Bioeconomy Science Centre, the Cluster Industrielle Biotechnologie, the initiative “Nächste Generation biotechnologischer Verfahren – Biotechnologie 2020+”. Cooperation with European partners is promoted via the ERA-Net Industrial Biotechnology [b].

Despite large-scale funding for R&D and innovation, the Bioeconomy Council has identified an important weakness in translating research results into commercial products and integrating them into industrial processes (Bioökonomrat, 2016). Measures to bridge this gap include the Innovation Initiative for Industrial Biotechnology, initiated in 2011 with the aim of establishing strategic alliances between science and business in industrial biotechnology (BMBF, BMEL, 2014). The program Biotechnologie - BIO Chance (as part of KMU innovativ) supports SMEs eager to apply biotechnological methods but unable to shoulder the related risks (Müller W. 2014). This is complemented by the European Network of Transnational collaborative RTD for SME's projects in the field of Biotechnology – EuroTransBio [a,b,c]. An important investment of 50 million euros from BMBF, the government of Saxony-Anhalt, the BMEL und the BMUB was devoted to the establishment of a biorefinery demonstration project in Leuna, which will support the upscaling of production processes from research level to industrial scale under the leadership of the Fraunhofer Center for Chemical-Biotechnological Processes (CBP) [a,e]. Entrepreneurial activities are supported via a number of facilities, like the High-Tech Gründerfonds, EXIST or INVEST, which provide general support for start-ups. In addition, the GO-Bio initiative provides start-up support dedicated exclusively to biotechnology firms [c]. Despite these measures, the majority of interviewees confirmed that Germany lacks a strong support framework for enabling SMEs to mobilize financial resources for investments in industrial-scale biorefineries.

The development of skilled human resources for the bioeconomy represents one of the priority areas of the Policy Strategy. However, the only targeted initiative at the federal level for its implementation is an international partnership for the development of research and educational offerings involving the University of Hohenheim (BMEL, 2016).

The formation of a market for bio-based plastics has received some legislative support in the form of the German Packaging Ordinance (VerpackV⁵) in the past. Until December 2012 it included an exemption for certified biodegradable packaging (FNR, 2014) from the fees and minimum recycling quotas under the Green Dot Dual System (Grüner Punkt), Germany's mandatory recycling system, and an exemption from mandatory deposits for biodegradable, single-use beverage containers with a share of at least 75% bio-based materials (Umweltbundesamt, 2013). Shortly before these exemptions expired, an amendment of the Biowaste Ordinance (BioAbf), which regulates the recycling of biowaste, implemented a tightened regulatory framework for the inclusion of biodegradable plastics in composting schemes, which has since been limited to compostable biowaste bags [f].

In 2015, the market for compostable biowaste bags received a potential boost with the adoption of the Closed Cycle Management Act (KrWG), which obligates the separate collection of biowaste (BiPRO/CRI, 2015). However, the implementation has been relatively slow. Many municipalities do not yet provide separate biowaste collection schemes, and there is no obligation to accept compostable biowaste bags (European Bioplastics, 2016b). Another potential boost came with the passing of EU legislation to reduce the consumption of lightweight plastic carrier bags, which allows exemptions for bags below a certain thickness (EU 2015/720). Germany has, however, opted to subject plastic carrier bags to charges by retailers⁶ [f].

The reluctance of German legislators to promote markets for bio-based plastics is related to the significant controversy regarding its environmental impacts, when applying a life-cycle perspective. Both the German environmental protection agency and a number of environmental NGOs maintain that environmental benefits of bio-based plastics vis-à-vis conventional plastics cannot be demonstrated conclusively. This is partly related to the lack of compatibility with existing recycling schemes (Umweltbundesamt, 2013; Deutsche Umwelthilfe, 2013). Correspondingly, no interventions targeted at legitimizing the use of bio-plastics have been taken by the German government. Among other things, biobased plastics do not receive preference under the environment ministry's ecolabel, *Blauer Engel* [g].

Rather, measures aimed at the legitimation of bio-based products are limited to awareness raising and stakeholder dialogue on the bioeconomy more generally. This has been carried forward by the Bioeconomy Council as well as the specialized agency for Fachagentur für Nachwachsende Rohstoffe. The latter, for instance, supports the public procurement of bio-based products via the provision of information on relevant products. Uptake in green public procurement schemes remains limited, however (Peuckert and Quitzow, 2016). The Council has organized events like the Global Bioeconomy Summit in 2015 in Berlin, attracting over 700 participants from about 80 countries around the world (OECD 2016) [g].

4.2 Italy's policy strategy

4.2.1 The Italian bioeconomy

Within the EU-28, Italy has been identified among those countries with a "bioeconomy geared toward the Agro-Food industry and Bio-based chemical industries" (Ronzon et al.,

⁵ Packaging Ordinance of August 21, 1998 (Federal Law Gazette I p. 2379), last amended by the 5th Amendment to the Packaging Ordinance of April 2, 2008 (Federal Law Gazette I p. 531).

⁶ <https://www.iwkoeln.de/en/press/iwd/beitrag/environmental-protection-the-fate-of-plastic-bags-315995>

2015). It has been estimated by a study carried out by Intesa San Paolo and Assobiotec (2015) that the whole Italian bioeconomy sector in 2013 (which includes agriculture, forestry, fisheries, food and beverages production, paper, wood and biochemistry) accounted for around 244 billion euros, ranking third in turnover after Germany and France, and roughly 1.5 million employees. According to these estimates, food industries and agriculture contributed to more than half of the total sector's turnover; yet, also bio-based chemistry has gained a central role (Ferrari, 2013)

Bioplastics represent a fast growing part of Italy's bio-based production. According to estimates by Plastic Consult (2013) the domestic bioplastics sector is composed by around 145 companies with total sales amounting to about 370 million euros in 2012⁷. The bio-based plastic bags, including carrier bags and bags for biowaste collection, represent the bulk of production (over 80 percent), while the remainder is basically broken down between accessories for agriculture, catering (such as dishes, cups and cutlery) and food packaging. The Italian bioplastics production capacity was estimated at circa 150,000 tonnes in 2016⁸, representing a share of circa 3 to 4 percent of the global production capacity.

The Italian bioplastics industry consists of SMEs entirely devoted to bio-based production, the largest of which is Novamont, and a number of large chemical producers that have diversified into bio-based plastics, most notably the Mossi and Ghisolfi group and ENI-Versalis, a subsidiary of state-controlled ENI.⁹ In the latter case, bio-based production accounts for only a small share of the overall turnover and represents a diversification strategy, aimed at confronting loss of market share in the wake of the global financial and economic crisis.

4.2.2 Policy objectives, processes and institutional capacities

In Italy there is no strategy specifically targeting bioplastics. Italy has recently launched its own national strategy on bioeconomy, which until then had been supported within the more general context of the "circular economy" and "green economy" (EU Bioeconomy Observatory, 2017). A draft of the Italian Bioeconomy Strategy entitled "Bioeconomy in Italy: a unique opportunity for connecting Environment, Economy and Society" was published for public consultation in November 2016 by the Italian Agency for Territorial Cohesion (*Agenzia per la Coesione Territoriale*) and represents part of the implementation process of the National Strategy for Smart Specialization,¹⁰ in synergy with the Italian National Strategy for the Sustainable Development (Italian Presidency of Council of Ministers, 2016: 2).

The bio-based industry, and in particular bioplastics, has been recognized by the Italian Bioeconomy Strategy as a strategic sector in which Italy has gained an advantageous position in Europe, creating at the same time new jobs all along its value chain (Cebr, 2015). The strategy's core objective is "*to increase our current bioeconomy turnover (of about EUR 250*

⁷ Of the 145 companies, 16 companies supply raw materials, 77 companies are engaged with primary transformation while around 50 companies (estimate), induced secondary transformation.

⁸ Data provided by European Bioplastics.

⁹ The Italian government owns a 30 percent stake in the company in the form of so-called golden shares, giving the government control over major strategic decisions.

¹⁰ Specifically, with regard to its two thematic areas "health, food and life quality" and "sustainable and smart industry, energy and environment".

billion/y) and jobs (about 1,850,000) by EUR 50 billion and 350,000, respectively, by 2030” (Italian Presidency of Council of Ministers, 2016: 38). To achieve this goal, it proposes measures to promote research and innovation in four strategic areas, including the field of bio-based industries, and explicitly focusing on demand-side measures, like waste-related regulation and public procurement. A central aspect of the strategy for bio-based industries is the reanimation of defunct or failing industrial sites also through biorefineries integrated in local areas which are a major feature of the Italian approach to the bio-based industry (De Bari 2011).

During the preparation of the Italian Bioeconomy Strategy, promoted by the Italian Presidency of Council of Ministers under the lead of the Ministry for Economic Development, all main administrations, both central and regional, have been involved. Specifically, the Ministry of Agriculture, Food and Forestry, the Ministry of Education, University and Research and Ministry of the Environment, Land and Sea, as well as the Committee of Italian Regions and the Agency for Territorial Cohesion were actively involved in strategy preparation. Also the private sector and trade associations, such as Assobioplastiche, contributed through their involvement in the cluster initiatives *Spring Cluster* and *AgriFood Cluster*. A broader involvement of the civil society in policy design and implementation emerged as a major objective of the strategy. Moreover, as mentioned above, the strategy was published for public consultation from November to December 2016.

The strategy aims to implement a number of measures to support both horizontal and vertical policy coordination as well as monitoring and review. It proposes a permanent working group on the bioeconomy composed of representatives of relevant ministries, other public administration and national technological clusters involved in the bioeconomy (Italian Presidency of Council of Ministers, 2016: 53). In particular, it highlights the need for coordination for the implementation of European waste-related legislation. In a separate section on monitoring and review, the strategy proposes a set of indicators focused but not limited to economic indicators. Based on the above mentioned study conducted by Intesa Sanpaolo and Assobiotec (2015), a further effort has been made by the Strategy’s working group to provide better estimates of the bioeconomy sector, including also textile from natural fibre, leather and pharmaceuticals.

4.2.3 Policy measures

To date, the bioplastics sector has been largely promoted through the Italian legislation regulating plastic carrier bags. Before introducing this change in the legislative framework, Italy showed one of the highest levels of plastic bags consumption (Bio Intelligence Service 2011). National regulation designed to ban the sale of single-use, non-biodegradable plastic bags was introduced in 2006 (Law 296/2006, 2007 Finance Act) but came into force only from 2011,¹¹ and it has undergone several revisions due to several shortcomings (e.g. Ganapini, 2013). The new Law 28/2012 requires non-reusable shoppers to be biodegradable and compostable as laid down by the standard UNI EN 13432:2002. In 2014, the law was further strengthened by the introduction of penalties for infringements (legislative decree 91/2014) [f].

¹¹ According to art.1 of 2007 Budget Law, the ban should have come into force from 2010. However, due to indeterminacy of the law and to opposing movements the ban has been postponed to 2011.

Italy's ban on non-reusable plastic bags remains in place, despite legal challenges from European competitors on the grounds that it violates the European Union's principle of free movement of goods (e.g. IK, 2011). The law has received further support from a European directive approved in 2015 on the reduction of the use of single-use plastic carrier bags. The new Directive (EU) 2015/720 recognizes that marketing restrictions, such as bans in derogation of Article 18 of Directive 94/62/EC, are to be considered acceptable provided that they are proportionate and non-discriminatory (EU 2015) [f].

According to Novamont, one of the largest Italian industrial players in the sector, the legislative framework on plastic bags reduced the consumption of single-use carrier bags by as much as 50 percent and has created a high-demand acceleration of bioplastics, allowing for the creation of a sizable value chain (Bastioli 2012) [d]. However, it should also be noted that in the last few years, there has been an increased diffusion of counterfeit shopping bags that, according to a study conducted by Legambiente (2016), amounts to over 50 percent of the total number of shoppers in large supermarket chains. As a result, the production of bio-based shoppers has experienced a sharp decrease in production starting from 2016 (Plastic Consult, 2016). This has spurred additional steps towards stabilizing the market, such as the progressive banning of ultra-lightweight plastic bags for fruit and vegetables¹² [f].

As observed by Hermann et al. (2011), green public procurement represents another important instrument to support bio-based materials in Italy. Some initiatives have already been taken both at national level (e.g. large scale catering) and at regional/local level such as in the case of Milan city during EXPO 2015 (EXPO, 2014). As mentioned above, green public procurement, to be applied by a large range of public bodies, has gained momentum in the Italian Bioeconomy Strategy and has been identified as one of the most effective tools from all interviewed stakeholders.¹³ This view is shared by the Conference of Regions and Autonomous Provinces (2016), who has proved willing to support the demand of bio-based products through public procurement [f].

Over the past few years, there have been a number of measures to promote knowledge development and diffusion. A key measure has been the promotion of the technology cluster SPRING, which plays a key role in connecting SMEs and large companies with the main public research centres, such as the Italian National Research Council (CNR) and the Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA). It aims at building capacity throughout the Italian green chemistry sector (see OECD, 2016). Further, companies have benefited from tax credits on R&D expenditures and funding opportunities for R&D under the National Sustainable Growth Fund and the National Research Programme 2015-2020 R&D dedicated green chemistry area (Ministry of Education, University and Research 2015) [a,b]. Nevertheless, all stakeholders interviewed for this paper reported the absence of strong support policies for promoting R&D and

¹² The Italian government has submitted a draft Legislative Decree implementing Directive (EU) 2015/720 amending Directive 94/62/EC as regards reducing the consumption of lightweight plastic carrier bags. The text is available at <http://ec.europa.eu/growth/tools-databases/tris/it/index.cfm/search/?trisaction=search.detail&year=2016&num=601&mLang=EN>

¹³ See *Law 28 december 2015, n. 221* available at: <http://www.gazzettaufficiale.it/eli/id/2016/1/18/16G00006/sg>. The Ministry of the Environment and Protection of Land and Sea launched the National Action Plan for Green Public Procurement (PAN GPP), available at: http://www.minambiente.it/sites/default/files/archivio/allegati/GPP/all.to_21_PAN_GPP_definitivo_EN.pdf

technology development. At the European level, Horizon 2020 research and innovation programming is one of the most important funding opportunities for Italian R&D.

Complementing R&D funding opportunities, the government has supported initiatives to mobilize larger scale investments. Often this has been aimed at the conversion and revalorisation of failing industrial sites in the petrochemical sector. Two such examples are two large biorefinery projects Patrica in the Lazio region, with an annual production capacity of approximately 100,000 tons of bio-based materials, and Matrica in Sardinia, with a projected capacity of 350,000 tons and an estimated investment of 500 million euros. Both projects are joint ventures between Italy's technology leader in bioplastics, Novamont, and leaders of Italy's traditional chemical industry, Mossi and Ghisolfi and ENI Versalis, respectively. Large investment projects aimed at the reconversion of defunct or failing industrial sites can benefit from the above mentioned Sustainable Growth Fund. To this objective, investments of over a billion euro have already been made in Italy through public funding (SPRING, 2015). In addition, SMEs and start-ups engaged in bio-based production can benefit from a package of measures launched under the Italian Startup Act, including "streamlined, free-of-charge access to public guarantees by 80 percent on bank loans amounting up to EUR 2.5 million" (OECD, 2016: 26). Going forward, the Bio-Based Industries Joint Undertaking, a public-private partnership model supported by the European Commission, will play an important role for the mobilization financial resources. Its initial flagship project, FIRST2RUN, coordinated by Novamont in partnership with a Dutch, British, Slovakian and Novamont's own Matrica has been awarded 17 million euros of European funding. New financial instruments that encourage long-term investment will be identified within Cohesion Policy Funds by the Italian Bioeconomy Strategy implementation group [e].

Italy has also started to provide some incentives for the production of bio-based feedstock for the chemical industry, ensuring that these do not compete with food crops and with particular attention to regeneration of marginalized lands. The government's "Strategic Plan for Innovation and Research in Agriculture, Food and Forestry, 2014-2020" (Mipaaf, 2016) includes a dedicated agenda for supporting biomass for bio-based material production [e].

Despite advanced market formation, public awareness regarding bio-based products is not considered to be high by the interviewed stakeholders, and no systematic awareness-raising strategy has been developed by the national government. Existing initiatives have been taken forward by the Italian regional governments with support from the European Union's Cohesion Policy, such as in Basilicata (FEARS, 2016). In addition, the industry (e.g. Novamont, 2015), trade associations, such as Assobioplastiche, and non-profit organizations, such as the Kyoto Club and Legambiente, have promoted a number of initiatives. In 2016, a new information campaign promoted by Assobioplastiche, the National Packaging Consortium (CONAI), the Italian Composting Association (CIC) and the Italian Consortium for the Collection, Recycling and Recovery of Waste Plastic Packaging Materials (COREPLA) has been launched to improve public understanding of the characteristics and distinctions between conventional plastics and bioplastics, with the aim of improving bioplastics' separate collection. It is worth noting that the Ministry of the Environment has supported most of these initiatives, stressing at various occasions (e.g. EXPO Milan 2015) the importance of bio-based products and bioplastics in particular [g].

Finally, actions supporting skill enhancement have been increasing over time. The first Master Degree dedicated to Bioeconomy, in collaboration between University of Milano-Bicocca, University of Naples Federico II, University of Bologna, University of Turin, Intesa Sanpaolo, Novamont, GFBiochemicals and PTP Science Park of Lodi, was launched in 2016 [b, e].

4.3 Links to the European level of policy making

The German and Italian bioeconomy strategies are both linked in different ways to the European bioeconomy policy framework. Germany represents one of the frontrunners in the development of its national bioeconomy strategies. Indeed the German NFS 2030 was adopted well ahead of the European Union's Bioeconomy Strategy, adopted in 2012, and Germany is viewed by stakeholders as one of the drivers of the EU strategy process. Like the NFS 2030, the EU strategy, entitled *Innovating for Sustainable Growth* and led by DG Research and Innovation, has a central focus on promoting European research and innovation but goes beyond this. This broadened agenda, in particular the promotion of policy coherence and dialogue with society, is then partially mirrored by Germany's Policy Strategy. The EU strategy, however, places stronger emphasis on mobilizing investment and market creation via mechanisms like labelling and public procurement.

Italy's Bioeconomy Strategy was developed at a significantly later stage than Germany's and was developed in response to the EU strategy, which calls on European member states to develop national strategies. Moreover, Italy's policy strategy builds heavily on EU programming and funding opportunities. The Bioeconomy Strategy is an official part of its Smart Specialization Strategy, which represents the basis for accessing funding within the framework of Europe's Cohesion Policy. Moreover, the EU's Horizon 2020 programming for research and innovation was noted as a key source of research funding by Italian stakeholders. In addition, Italy has actively defended its national ban on conventional plastic bags against the resistance from other European countries, and it was able to introduce the needed language in the Directive (EU) 2015/720 to ensure the conformity of Italian legislation with European law.

5. Comparative analysis and discussion of key findings

Although Germany and Italy are both frontrunners of Europe's bioeconomy, the policy strategies in the two countries reveal fundamental differences (see table 2 and figure 1 for an overview). The German policy strategy, composed of the NFS 2030 and the Policy Strategy that followed, has been developed by the government, with the Ministry of Education and Research as the initial proponent. The strategy is highly formalized and has included the developing of institutional capacities for horizontal policy coordination, stakeholder engagement, monitoring and review and acquisition of strategic knowledge. The strategy is centred strongly on the federal public administration and places little emphasis on active coordination with subnational actors. It builds on a long-term vision for the transition towards a bioeconomy and aims at positioning Germany as a strong location for research and innovation in this future growth market.

It lacks a strong framework for supporting market development in the bio-plastics sector and investment in productive capacities. This is partly related to an ambiguous relationship to the bio-plastics sector from the chemical industry, on the one hand, and environmental NGOs and the environmental bureaucracy, on the other. The former is still strongly invested in the

existing petroleum-based regime, while the latter has articulated strong reservations regarding the improved environmental performance of bio-based plastics compared to conventional plastics. Overall, the strategy can be characterized as a deliberate, formalized government strategy developed in a top-down manner. Rather than pushing short-term steps towards a transition, it prepares the ground for a future transition via investments in R&D and involving an increasing spectrum of actors in and outside of government over time. The German strategy is relatively similar in nature to the formalized strategy processes in the European Union, which it helped stimulate and relies strongly on the Bioeconomy Council as a source of expert knowledge and legitimation.

The Italian policy strategy, on the other hand, is strongly emergent in nature and has been characterized by a bottom-up, stakeholder-driven strategy process. Rather than a formalized strategy process, the cornerstone of the Italian policy strategy has been legislation favouring bio-based plastic bags, which has helped stimulate the formation of Europe's leading market for bio-plastics. Upholding this legislative approach against the resistance of other EU countries has also been a centrepiece of Italy's – ultimately successful – European engagement. Another key component of the strategy has been support for investment in biorefinery projects on failing industrial sites, in an effort to confront the crisis of Italy's traditional chemical industry. Support for R&D and cluster development has also taken place, but stakeholders cite a relatively high reliance on European research and innovation programming. The more formalized strategy process launched in 2016 is also formally linked to its Smart Specialization Strategy under the European Cohesion Policy and represents a vehicle for accessing related funding opportunities.

In a nutshell, the Italian policy strategy represents an emergent strategy driven by industrial stakeholders with a strong emphasis on market development, while Germany has pursued a government-led, top-down strategy focused on knowledge development and innovation. Having characterized the policy strategies in this way, we can now link them to the broader dynamics of the transition processes under way in the two countries. In Germany, the government is seeking to prepare the transition towards bioeconomy within the context of its well-established and successful chemical sector. Industry represents both a partner and target group for this long-term vision of a bio-economy, but it does not represent an active proponent or driver of this. Sustainability concerns represent an additional barrier for more ambitious measures aimed at promoting markets for bio-based plastics. In part, these concerns relate to path dependencies of the existing industrial regime in the form of more advanced recycling systems for conventional plastics (Umweltbundesamt, 2013). The overall transition process resembles what Geels et al. have labelled a *transformation pathway*, consisting “of gradual reorientation of the existing regime through adjustments by incumbent actors in the context of landscape pressure, societal debates and tightening institutions.” (2016: 898). This approach is advanced by Germany's top-down policy strategy aimed at incremental steps towards transition via the expansion of the knowledge base rather than more rapid, disruptive changes.

The Italian policy strategy, on the other hand, has been devised in the context of a struggling chemical sector, where bio-based plastics represent a short- to medium-term option for diversification and reanimation of failing industrial sites. Moreover, with a less advanced recycling sector, bio-based plastics have long represented an alternative strategy for mitigating the environmental impacts of plastic waste and are supported by Italian

environmental NGOs. It thus resembles a *reconfiguration pathway*, where “niche-innovations and the existing regime combine to transform the system’s architecture”, involving “new alliances between incumbents and new entrants” (Geels et al., 2016: 899). It is important to note in this context that this reconfiguration pathway is supported not only by environmental pressures but by other weaknesses in the existing regime. The crisis of Italy’s struggling chemical regime, on the one hand, and the less-established waste management regime, on the other, have favoured the emergence of new actors and alliances who are driving Italy’s emergent policy strategy.

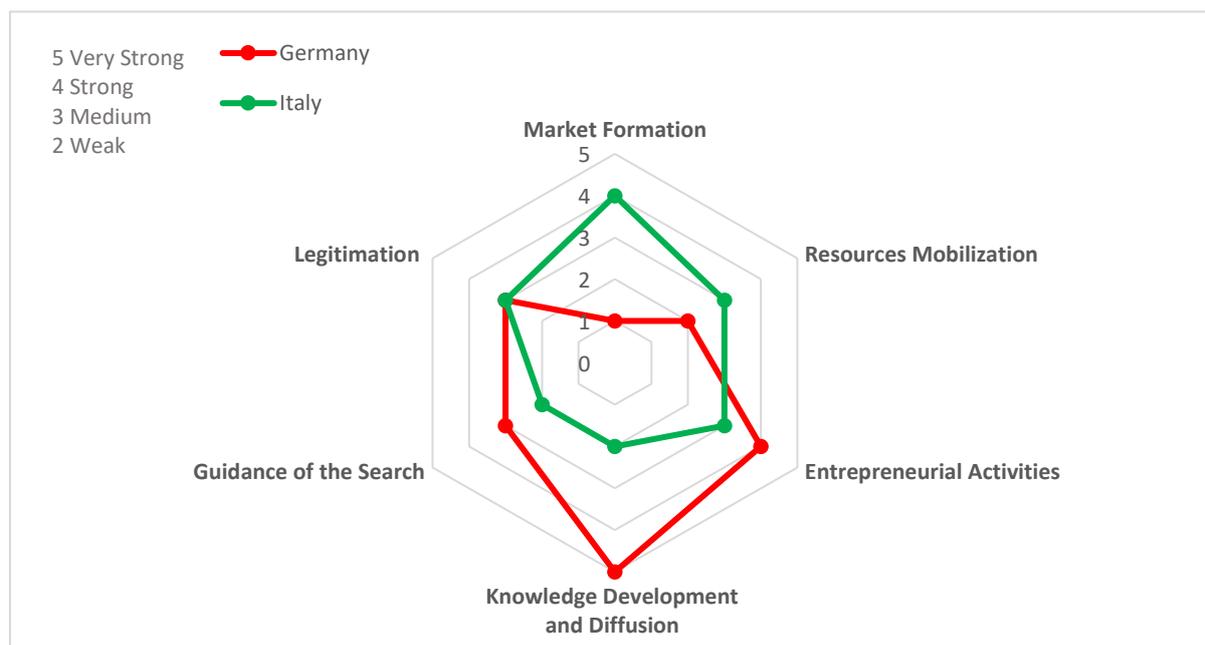
Moreover, these strategies are intertwined via policy making at the European level. Both Germany and Italy have successfully promoted their strategy model at the European level – via the European Bioeconomy Strategy and relevant European legislation, respectively. This is having important reinforcing effects for Europe’s bioeconomy as a whole. The promotion of a European, innovation-centred strategy is providing needed funding opportunities for Italian industrial players, such as Novamont, via the Bio-Based Industries Joint Undertaking, Horizon 2020 as well as European Cohesion Policy. At the same time, Italy’s pioneering ban on plastic bags in favour of bio-based alternatives has been institutionalized at the European level in form of Directive (EU) 2015/720. This appears to have motivated other countries to follow suit with France announcing a similar ban in 2016, planned to go into effect in 2020. These advances are likely to place pressure on Germany’s chemical industry, which risks falling behind in the sector.

Table 2: Comparison of the Italian and German policy strategies in support of a bioeconomy

	Italy	Germany
Type of Policy Strategy	Emergent, bottom-up	Deliberate, top-down
Central actors	Industry with support from civil society	Federal Ministry of Education and Research, Federal Ministry of Food and Agriculture
Policy Objectives / Focus	Boost employment and turnover in the bioeconomy	Support innovation, competitiveness and technological leadership in the bioeconomy
	Revalorisation of failing industrial sites	Prepare the structural transition to a biobased economy
<i>Time Horizon</i>	2030	2030
<i>Quantitative Targets</i>	Additional 50 billion EUR turnover and 350.000 jobs	None
Policy Process		

<i>Launch of formal strategy</i>	2016	2009
<i>Policy coordination</i>	Vertical and horizontal coordination of all relevant ministries and public entities, including Agency of Territorial Cohesion	Progressive broadening of horizontal coordination from BMBF to all relevant ministries
<i>Stakeholder engagement</i>	Involvement of central and regional governments; industry and civil society as a central actors	Progressive broadening of stakeholder engagement from research and industry to civil society and the broader public
<i>Monitoring and review</i>	Formalized monitoring review to be established	Formalized monitoring review established
Institutional Capacity	Inter-ministerial and stakeholder working group to be established	Bioeconomy Council and Inter-Ministerial Working Group established

Figure 1: Comparison of Policy Measures in Support of System Functions in Germany and Italy



Source: Authors. Based on author's own assessment of policy measures.

6. Conclusions

The comparative perspective on policy strategies advanced in this paper has added several new dimensions to the analysis of policy mixes for sustainability transitions. Firstly, the paper has demonstrated the added value of the proposed analytical framework for advancing a comparative perspective on policy strategies. It provides a comprehensive framework for comparing the policy approaches in the two countries, helping to distil key differences between the countries. The two ideal types of a deliberate, top-down strategy, on the one

hand, and an emergent, bottom-up strategy also prove useful categories for distinguishing the two approaches of the two countries. Rather than favouring one approach over the other, the picture that emerges is of two different frontrunner strategies, based on differing drivers and country-specific institutional paradigms. While the analysis in this paper has mainly focused on the former, an important avenue for future research might be the exploration of how country-specific institutional arrangements shape the development of policy strategies.

Secondly, the analysis reconfirms the argument made in Quitzow (2015a) that a critical perspective on the concept of policy coherence is needed. The case of Germany's and Italy's policy strategies show that indeed incoherent approaches with regard to the promotion of markets for bio-based plastics may be beneficial in Europe's advance towards a sustainable bioeconomy. While Italy's strong promotion of markets for bio-based plastics is providing an essential testing ground for the industry, Germany's strongly research-based and more critical approach to the sector is equally important in this early stage of market development, providing a crucial element of diversity to the innovation process.

This should not be interpreted as a criticism of the concept of policy coherence *per se*. It remains an important dimension in the assessment of policy mixes. However, it needs to be weighed against the advantages of diversity in experiments and approaches. From a policy perspective, this essentially represents a question of timing. While diversity is essential in early stages of a transition process, policy coherence becomes essential as technological options mature. Along with the emergence of dominant designs and related standardization, it is a component of the emergence of a new technological regime. Promoting coherence too early in the process, however, risks early lock-ins in unfavourable technology options (for a related discussion of standardization and innovation see Blind (2013)).

A third contribution to the literature is the paper's focus on the multi-level nature of policy making and the inter-linkages between the Germany and Italian policy strategies. By providing a framework for linking the two policy strategies to each other, the European system of multi-level governance supports what Flanagan et al. have called a gradual process of "mutual adjustment between a variety of actors and systems" (2011: 704). Taking this a step further, we argue that this process includes important elements of reinforcement, as suggested by Jänicke and Quitzow (2017) for the field of climate and energy governance. As elements of the two strategies are "uploaded" to the European level, they offer opportunities for diffusion and reinforcement via various EU policies and programs. As highlighted, this is enabled by the European Union's hybrid system composed of both rules-based elements and political compromise. In the absence of conclusive arguments for or against a more widespread use of bio-based plastics across Europe, this system has yielded an arrangement – at least for the moment - which allows for a diversity of approaches for tackling plastic waste. Rather than a weakness of the European system, we propose that this constitutes an important advantage in the search for of sustainable bioeconomy.

Annex

Classification of interviewed stakeholders

Country	Number of interviewed stakeholders	Group category	Gender distribution	Role of interviewed in respective organisations
Germany	11	European institutions	M (5) F (6)	Policy officer
		Research centres (public, private and academia)		Head of policy department, Professors, Head of department.
		Private companies		Head of strategic planning, managing director.
		Trade associations		Head of the association
		Government and non governmental organisations		Public officers with expertise on bioeconomy and innovation including members of the Bioeconomy council; Referent for sustainable biomass.
Italy	7	European institutions	Female (3)	Policy officer, European Commission Research and Innovation DG
		Research centres (public, private and academia)		Head of Industry Research; Head of research
		Industry		Head of Strategic Planning and Corporate Communication
		Trade associations	Marketing manager	
		Government and non governmental organisations	Male (4)	Public officer with expertise on bioeconomy and innovation

Source: *own elaboration*

References

- Bastioli, C., 2012. Il potenziale anti-crisi della Bioeconomia e l'Opportunità di Rilancio della Chimica Italiana. Available at: http://www.statigenerali.org/cms/wp-content/uploads/2012/12/1.3_A_Bastioli1.pdf
- Bio Intelligence Service, 2011. Assessment of impacts of options to reduce the use of single-use plastic carrier bags, Final report prepared for the European Commission- DG Environment. Available at: http://ec.europa.eu/environment/waste/packaging/pdf/report_options.pdf
- Bioökonomierat, 2016. Further Development of the "National Research Strategy BioEconomy 2030. Available at: http://bioekonomierat.de/fileadmin/Publikationen/empfehlungen/BOER_Empfehlungspapier_ENG_final.pdf
- BiPRO/CRI, 2015. Assessment of separate collection schemes in the 28 capitals of the EU, Final report, November 2015.
- BMBF, 2010. National Research Strategy BioEconomy 2030. Available at: http://www.bmel.de/SharedDocs/Downloads/EN/Publications/NatPolicyStrategyBioeconomy.pdf?__blob=publicationFile
- BMBF, 2014. The new High-Tech Strategy Innovations for Germany. Available at: https://www.bmbf.de/pub/HTS_Broschuere_eng.pdf
- BMBF, BMEL, 2014. Bioökonomie in Deutschland Chancen für eine biobasierte und nachhaltige Zukunft. Available at: http://www.bmbf.de:8001/pub/Biooekonomie-in-Deutschland_001.pdf
- BMEL, BMBF, BMU, BMWi, 2012. Biorefineries Roadmap as part of the German Federal Government action plans for the material and energetic utilisation of renewable raw materials. Available at: https://www.bmbf.de/pub/Roadmap_Biorefineries_eng.pdf
- BMEL, 2014. National Policy Strategy on Bioeconomy. Available at: http://www.bmel.de/SharedDocs/Downloads/EN/Publications/NatPolicyStrategyBioeconomy.pdf?__blob=publicationFile
- BMEL, 2016. Fortschrittsbericht zur Nationalen Politikstrategie Bioökonomie. Available at: https://www.bmel.de/SharedDocs/Downloads/Broschueren/fortschrittsbericht-biooekonomie.pdf;jsessionid=2BB7EA13AE1B294B6112CEC67C050984.2_cid385?__blob=publicationFile
- BMEL, 2016. Stand der Umsetzung sämtlicher Maßnahmen der Nationalen Politikstrategie Bioökonomie -Anhang zum „Fortschrittsbericht zur Nationalen Politikstrategie Bioökonomie“. Available at: https://www.bmel.de/SharedDocs/Downloads/Landwirtschaft/Bioenergie-NachwachsendeRohstoffe/einzelmassnahmen-biooekonomie.pdf;jsessionid=2BB7EA13AE1B294B6112CEC67C050984.2_cid385?__blob=publicationFile
- Borrás, S., Edquist, C., 2013. The choice of innovation policy instruments. Technological Forecasting and Social Change 80, 1513–1522.
- Cebr, 2015. The future potential economic impacts of a bio-plastics industry in the UK, A report for the Bio-based and Biodegradable Industries Association (BBIA). Available at: <http://bbia.org.uk/wp-content/uploads/2015/11/BBIA-CEBR-Report.compressed.pdf>

- Centre for Economics and Business Research, 2015. Future potential economic impacts of a bio-plastics industry in the UK. A report for the Bio-based and Biodegradable Industries Association (BBIA). Available at: <http://bbia.org.uk/wp-content/uploads/2015/11/BBIA-CEBR-Report.compressed.pdf>
- Conference of Regions and Autonomous Provinces, 2016. Documento delle Regioni e delle Province autonome di posizionamento sulla bioeconomia in attuazione della strategia nazionale di specializzazione intelligente (nsi). Available at <http://www.regioni.it/newsletter/n-3057/del-28-11-2016/la-bioeconomia-nella-strategia-nazionale-di-specializzazione-intelligente-15961/>
- Davies S., L. Griestop, H. Vironen, J. Bachtler, V. Dozhdeva, Michie, R., 2016. Promoting stakeholder engagement and public awareness for a participative governance of the European Bioeconomy: Case study of national Bioeconomy strategies in Finland and Germany. Available at: http://www.bio-step.eu/fileadmin/BioSTEP/Bio_documents/BioSTEP_D3.1_Case_studies_of_national_strategies.pdf Last accessed: 27/02/2017
- De Bari, I., Current status of Biorefineries in Italy: R&D activities, IEA BIOENERGY, Task 42 on Biorefineries, 9th Task meeting (ITALIAN STAKEHOLDERS), Chemtex, Italy, 4 April 2011. Available at: https://www.iea-bioenergy.task42-biorefineries.com/upload_mm/f/c/1/2f4b4979-e609-4354-a38f-ea1106d49848_I%5B1%5D.%20De%20Bari%20-%20Current%20status%20of%20biorefineries%20in%20Italy
- del Río González, P., 2007. The interaction between emission trading and renewable electricity support schemes. An overview of the literature. Mitigation and Adaptation Strategies for Global Change 12, 1363–1390.
- Deutsche Umwelthilfe, 2014. Biodegradable plastic bags. Available at: <http://www.biodeg.org/German%20NGO%20says%20Compostable%20plastic%20has%20no%20significant%20advantage%20-%20Mar%202014.pdf>
- Ernst & Young, 2016. Im Schatten von Leuchttürmen Potenziale besser ausschöpfen Deutscher Biotechnologie-Report. Available at: [http://www.de.ey.com/Publication/vwLUAssets/EY-Biotech-Report-2016-Im-Schatten-von-Leuchttuermen/\\$FILE/EY-Biotech-Report-2016-Im-Schatten-von-Leuchttuermen.pdf](http://www.de.ey.com/Publication/vwLUAssets/EY-Biotech-Report-2016-Im-Schatten-von-Leuchttuermen/$FILE/EY-Biotech-Report-2016-Im-Schatten-von-Leuchttuermen.pdf)
- EU, 2015. Directive (EU) 2015/720 of the European Parliament and of the Council of 29 April 2015 amending Directive 94/62/EC as regards reducing the consumption of lightweight plastic carrier bags. Official Journal of the European Union, L 115, 6 May 2015
- European Bioplastics, 2016a. Bioplastics facts and figures. Available at: http://www.corbion.com/media/203221/eubp_factsfigures_bioplastics_2013.pdf
- European Bioplastics, 2016b. The benefits of separate organic waste collection. Available at: <http://www.european-bioplastics.org/the-benefits-of-separate-organic-waste-collection>
- European Commission, 2012. Bioeconomy Strategy: Innovating for Sustainable Growth: A Bioeconomy for Europe. Available at: http://ec.europa.eu/research/bioeconomy/pdf/bioeconomycommunicationstrategy_b5_brochure_web.pdf
- EU Bioeconomy Observatory, 2017. National bioeconomy profile, Italy. Available at: <https://biobs.jrc.ec.europa.eu/sites/default/files/generated/files/country/National%20Bio>

conomy%20Profile%202014%20Italy_0.pdf

- EXPO, IEFE, 2014. Green Procurement Guidelines. Available at: https://www.google.it/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0ahUKEwixu-vL77DSAhWTSxoKHaa2DxAQFggrMAI&url=http%3A%2F%2Fwww.rfp.expo2015.org%2Fsystem%2Ffiles_force%2Favvisi%2Falleghi%2Falleghi_3a_green_procurement_guidelines_april_2014_0.pdf%3Fdownload%3D1%26download%3D1&usg=AFQjCN_G2h0zy_aAO4N1QhdjaSTectPGstQ&bvm=bv.148073327,d.d2s
- FAO, WFP, and IFAD, The State of Food Insecurity in the World 2015. FAO, Rome (2015).
- FEARS, 2015. Strategia di comunicazione, informazione e pubblicità del programma di sviluppo rurale (psr) fears della regione basilicata 2014-2020. Available at: http://europa.basilicata.it/fear/wp-content/uploads/2016/09/Strategia_di_comunicazione_definitiva_1.pdf
- Ferrari, D., 2013. The chemical approach to bio-based economy opportunities. Bruxelles. Available at: https://www.kyotoclub.org/docs/Bruxelles_060313_Bioplastics_Ferrari.pdf
- Flanagan, K., Uyarra, E., Laranja, M., 2011. Reconceptualising the “policy mix” for innovation. Research Policy 40, 702–713.
- FNR, 2014. Bioplastics. Available at: http://mediathek.fnr.de/media/downloadable/files/samples/b/r/brosch.biokunststoffe-web-v01_1.pdf
- Foray, D., Mowery, D. C., & Nelson, R. R. (2012). Public R&D and social challenges: What lessons from mission R&D programs?. Research Policy, 41(10), 1697-1702.
- Ganapini, W., 2013. Bioplastics: A case study of Bioeconomy in Italy. Edizioni Ambiente.
- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research Policy 31: 1257-1274.
- Geels, F., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylana, J., Neukirch, M., Wassermann, S., 2016. The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990–2014). Research Policy 45, 896–913.
- Gunningham, N., Grabosky, P., 1998. Smart Regulation: Designing Environmental Policy. Oxford University Press, New York.
- Hekkert, M.P., Suurs, R. a. a., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change 74, 413–432.
- Hermann, B., Carus, M., Patel, M., Blok, K., 2011. Current policies affecting the market penetration of biomaterials, Biofuels, Bioprod. Bioref. 5, 708-719. Available at: <http://onlinelibrary.wiley.com/doi/10.1002/bbb.327/epdf>
- IK Industrievereinigung Kunststoffverpackungen, 2011. Plastic carrier bags – Germany is not Italy, Press release. Available at: http://www.kunststoffverpackungen.de/plastic_carrier_bags_germany_is_not_italy_4814.html?langfront=en
- Intesa San Paolo, Assobiotec, 2015. La bioeconomia in Europa, 2 Rapporto. Available at: https://www.researchitaly.it/uploads/14174/Bioeconomia_%20Labioeconomiaineuropa

[dicembre2015.pdf?v=f9b7468](#)

- Italian Presidency of Council of Ministers, 2016. Bioeconomy in Italy: A unique opportunity to reconnect economy, society and the environment (2016), Draft consultation. Available at: http://www.agenziacoessione.gov.it/opencms/export/sites/dps/it/documentazione/NEWS_2016/BIT/BIT_EN.pdf. Jänicke, M., Lindemann, S., 2010. Governing environmental innovations. *Environmental Politics* 19, 127–141.
- Jänicke, M., Quitzow, R., 2017. Multi-Level Reinforcement in European Climate and Energy Governance: Mobilizing economic interests at the sub-national levels. *Environmental Policy and Governance* in press.
- Kaeb, H., F. Aeschelmann, L. Dammer, M. Carus (2016), Market study on the consumption of biodegradable and compostable plastic products in Europe 2015 and 2020, 2016. Available on line at: http://bio-based.eu/?did=49444&vp_edd_act=show_download
- Kern, F., Howlett, M., 2009. Implementing transition management as policy reforms: a case study of the Dutch energy sector. *Policy Sciences* 42, 391–408.
- Kharas H., (2010) *The Emerging Middle Class in Developing Countries*. OECD Development Centre, Working Paper No. 285, Research area: Global Development Outlook, OECD, Paris.
- Kivimaa, P., Kern, F., 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Research Policy* 45, 205–217.
- Ladu, L. and R. Quitzow (2017). *Bio-Based Economy: Policy Framework and Foresight Thinking*. in: P. Morone, F. Papendiek and V.E. Tartiu (eds.), *Food Waste Reduction and Valorisation*, Springer International Publishing, Forthcoming.
- Legambiente, 2016. Sacchetti illegali, i risultati della campagna di monitoraggio di Legambiente sul rispetto della legge sulle buste di plastica nella Grande distribuzione organizzata. Available at: https://www.legambiente.it/sites/default/files/docs/sacchetti_illegali_2016_dossier.pdf
- Ministry of Education, University and Research, 2015. National Research Programme 2015-2020. Available at: <https://www.researchitaly.it/en/national-research-programme/> and http://www.istruzione.it/allegati/2016/PNR_2015-2020.pdf
- Mintzberg, H., 1989. *Mintzberg on Management: Inside Our Strange World of Organizations*. Free Press, New York.
- Mintzberg, H., Ahlstrand, B., Lampel, J., 2009. *Strategy Safari. Your Complete Guide Through the Wilds of Strategic Management*. Financial Times Prentice Hall, London.
- Mipaaf, 2016. Piano strategico per l'innovazione e la ricerca nel settore agricolo alimentare e forestale 2014-2020. Available at: <https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/9065>
- Morone, P., 2016. The times they are a-changing: Making the transition toward a sustainable economy, *Biofuels, Bioprod. Bioref.* 10: 369–377.
- Morone, P., Tartiu, V.E., Falcone, P., 2015. Assessing the potential of biowaste for bioplastics production through social network analysis, *Journal of Cleaner Production*, 90, pp. 43-54.
- Müller, W. 2014. The Role of Government Research Funding in the German Industrial Biotechnology Sector. *JSM Biotechnol Bioeng* 2(1): 1021.

- Novamont, 2015. Sustainability Report, the results of a constant commitment, Vol 1. Available at: http://www.novamont.com/public/RdS/RdS_VolumeI_ENGLISH.pdf
- OECD, 2013. “Policies for Bioplastics in the Context of a Bioeconomy”, OECD Science, Technology and Industry Policy Papers, No. 10, OECD Publishing. Available at: <http://dx.doi.org/10.1787/5k3xpf9rrw6d-en>
- OECD, 2016a. Building a sustainable bioeconomy: a framework for policy. Available at: http://ibqp.org.br/wp-content/uploads/2016/12/DSTI_STP_BNCT201614.pdf
- OECD, 2016b. Key Technology Indicators. Available at: Available at: <http://www.oecd.org/sti/inno/keybiotechnologyindicators.htm>
- Peuckert, J., Quitzow, R., 2016. Acceptance of bio-based products in the business-to-business market and public procurement: Expert survey results. *Biofuels, Biorefining, Bioproducts* 11, 92–109.
- Plastic Consult, 2013. The Italian market of compostable biodegradable bioplastics, Prepared for Assobioplastiche, available at: <http://www.assobioplastiche.org/wp-content/uploads/2013/10/The-Italian-Market-of-Compostable-Bioplastics.pdf>
- Plastic Consult, 2016. Lo sviluppo dell’industria dei manufatti in materie plastiche compostabili, in "Towards the low carbon society: the opportunities offered by the industry of bioplastics", Conference held in Rome on November the 30th 2016. Available at: <http://www.assobioplastiche.org/wp-content/uploads/2016/11/Lo-sviluppo-dellindustria-dei-manufatti-compostabili-20161130-Roma-finale.pdf>
- Purkus, A., Hagemann N., Bedtke N. and Gawel E., 2016. “Towards a sustainable innovation system for German wood-based bioeconomy: implications for policy design”, Paper prepared for presentation at the 20th ICABR Conference “Transforming the bioeconomy: behavior, innovation and science” Ravello (Italy): June 26 - 29, 2016.
- Quinn, J.B., 1980. *Strategies for Change: Logical Incrementalism*. Irwin, Homewood, IL.
- Quitow, R., 2015a. Assessing policy strategies for the promotion of environmental technologies: A review of India’s National Solar Mission. *Research Policy* 44, 233–243.
- Quitow, R., 2015b. Dynamics of a Policy-Driven Market: The Co-Evolution of Technological Innovation Systems for Solar Photovoltaics in China and Germany. *Environmental Innovation and Societal Transitions* 17, 126–148.
- Rayner, J., Howlett, M., 2009. Introduction : Understanding integrated policy strategies and their evolution. *Policy and Society* 28, 99–109.
- Reichardt, K. and Rogge, K.S., 2016. How the policy mix impacts innovation: Findings from company case studies on offshore wind in Germany, *Environmental Innovation and Societal Transitions*, 18: 62–81.
- Rogge, K., Reichardt, K., 2016. Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy* 45, 1620–1635.
- Rogge, K.S. and Reichardt, K., (2015) *Going Beyond Instrument Interactions: Towards a More Comprehensive Policy Mix Conceptualization for Environmental Technological Change* (No.12) SPRU Working Paper Series.
- Rogge, K.S. and Reichardt, K., (2016) *Policy mixes for sustainability transitions: an extended concept and framework for analysis*. *Research Policy*. ISSN 0048-7333
- Ronzon, T., Santini, F., M’Barek, R., 2015. The Bioeconomy in the European Union in

- numbers. Facts and figures on biomass, turnover and employment. European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Spain, 4p. Available at: https://ec.europa.eu/jrc/sites/default/files/JRC97789%20Factsheet_Bioeconomy_final.pdf
- Russo, V., 2009. Alimentazione, sostenibilità e multiculturalità. Azioni, riflessioni e temi di ricerca. Arcipelago Edizioni. Available at: http://www.academia.edu/179310/Alimentazione_Sostenibilit%C3%A0_e_Multiculturalit%C3%A0
- Sanglimsuwan et al. (2012). A framework for assessing the willingness to pay in reducing plastic bag use. 1st Mae Fah Luang University International Conference. Available at: http://mfuic2012.mfu.ac.th/electronic_proceeding/Documents/00_PDF/O-SC-D/O-SC-D-007.pdf
- SPRING, 2015. The biobased chemical industry towards an Italian strategy of Bioeconomy. Position paper. Available at: http://www.clusterspring.it/wp-content/uploads/uploads-news/20151103-Position-paper-SPRING-su-Bioeconomia_versione-finale_eng.pdf
- Steurer, R., 2007. From Government Strategies to Strategic Public Management: an Exploratory Outlook on the Pursuit of Cross-Sectoral Policy Integration. European Environment 17, 201–214.
- Umweltbundesamt, 2013. Study of the Environmental Impacts of Packagings Made of Biodegradable Plastics. Available at: <https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/4446.pdf>
- Verband der Chemischen Industrie e.V. (VCI), 2013. Daten und Fakten Rohstoffbasis der chemischen Industrie. Available at: <https://www.vci.de/vci/downloads-vci/top-thema/daten-fakten-rohstoffbasis-der-chemischen-industrie-de.pdf>
- Veugelers, R., 2012. Which policy instruments to induce clean innovating? Research Policy, 41 (10), 1770-1778.
- Wilson D. and Dragusanu R., 2008. The Expanding Middle: The Exploding World Middle Class and Falling Global Inequality. Goldman Sachs Global Economics Paper No. 170, Goldman Sachs, New York.

Short CV of authors

Enrica Imbert, works on topics related to sustainable development. Specifically, her research focus is on small and medium-sized enterprises by applying innovative tools such as Social Network Analysis. She obtained a PhD in ‘Economic Development, Finance and International Cooperation’ at Sapienza University in 2015. She is currently conducting an internship at Unitelma-Sapienza working on economic policy of waste management, reduction and valorisation.

Luana Ladu has gained over ten years of experience in research and in international development cooperation in the fields of bioeconomy, sustainability, education, labour market policy and ICT for development. She has strong quantitative analytical skills, and broad international experiences gained in Brazil, Argentina, West Bank / Gaza, Armenia, Mauritania, Morocco, Kenya, Tanzania, Egypt, Germany, Belgium and the US. Currently she is a Research Fellow and PhD Candidate at TU-Berlin, Chair of Innovation Economics. She is working on several EC funded research projects (e.g. STAR4BBI; Open-Bio and StarProBio). Her PhD focuses on conducting a regulatory foresight for selected value chains of the bio-based sectors.

Piergiuseppe Morone is an economist with an interest in evolutionary theory applied especially to sustainable innovation studies. He was trained at SPRU-Sussex University where he received in 2003 his PhD in Science & Technology Policy with a thesis on innovation economics, investigating the relation between social network architectures and speed of diffusion of knowledge and innovations. He is now a Professor of Economic Policy at Unitelma Sapienza – University of Rome with a strong interest in green innovation and sustainability transitions pushing his research at the interface between innovation, bioeconomy and green chemistry, an area of enquiry that has attracted growing attention among social scientists over the last decade. His work regularly appears in prestigious and highly impacted innovation and environmental economics journals. He is Coordinating the STAR-ProBio H2020 project on ‘Sustainability schemes for the bio-based economy’; he is an Editor of *Open Agriculture* - by De Gruyter Open; acts as Guest Editor for the *Journal of Cleaner Production* and as section editor for *Current Opinion in Green and Sustainable Chemistry* (section on: *New business models, ethics, legislation and economics*).

Dr. **Rainer Quitzow** is a senior research fellow and lecturer at TUB and a post-doctoral researcher at IASS. His research focuses on sustainable innovation and industrial policy and the market- and innovation effects of environmental regulation. He also conducts research on the internationalization of emerging green industries and the changing role of emerging economies in this context. He regularly engages in policy-oriented advisory work for both German and international clients. Before his career as a researcher, Rainer Quitzow worked in the field of international development with a focus on governance, environmental and trade policy. At the World Bank in Washington, DC he conducted governance and policy impact analysis for the preparation of development programs in Latin America and Africa.