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co-creation: embedding companies' innovation practices in innovation ecosystem dynamics

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1. INTRODUCTION

Societal challenges – such as climate change, sustainable production and consumption, demographic change, healthcare (European Commission 2017), and the ongoing digitization – lead companies more often to think about topics and technologies beyond their established research and innovation practices. These challenges not only require societal responsibility to tackle them, but also offer a high potential for transformative innovation. In order to develop such future perspectives and to unlock their potential for innovation, companies need to forsake established innovation routines. Cooperation beyond well-known innovation and value chain partners is required to anticipate and keep up with societal challenges and emerging technological opportunities and to develop transformative ideas and concepts.

Such transformative orientations need to go beyond companies' incumbent innovation ecosystem (IES) (Adner 2006). A recent innovation survey based on almost 700 interviews with European industrial companies (see Box 1 on the Horizon 2020 project, Industrial Innovation in Transition – IIT[1]) shows that companies are very well interlinked with their current innovation environment in order to fill knowledge gaps and to access innovative ideas, new technologies, and advanced, innovative skills. The survey reveals that some companies also actively apply strategies to shape future developments within their IES. The IES concept itself has become very popular among policymakers and managers (European Commission 2016). It holds the promise of enabling companies to become more open and creative, leading to opportunities for radical innovation and facing disruption, and offering more flexibility during the innovation process. Open innovation (Chesbrough 2003) is one way to organize collaborative innovation between ecosystem partners and is a similarly famous concept. The results from the IIT project indicate that open and cooperative innovation strategies are very positively discussed in the scientific literature as a driver of innovation and therefore supported by various policy instruments in EU member states. However, there are wide differences in the surveyed companies' understanding of open innovation. The actual innovation practices of these companies are often organized in a closed and internally focused way rather than in an open and systemic way: bilateral cooperation based on non-disclosure agreements dominates their innovation practices instead of open and flexible knowledge exchange and creation. A strong customer and market orientation in combination with classical stage-gate processes (Cooper 1990) lead to incremental innovation and leave only little space for experimenting and developing transformative ideas.

This raises the question of how the dynamic exchange, the creativity, and the inspiration that innovation ecosystems provide can be captured, extended, and transferred into companies' concrete innovation processes in order to make them more open to transformative ideas and risk-taking. Here, we suggest, public innovation policy could step in more actively. The objective of such policy would be to motivate companies to apply more often this rich set of IES opportunities for their innovation activities and to co-create future developments together with their IES partners. Innovation policy should encourage companies to experiment and anticipate future developments more widely and collectively, linking their market perspectives with societal challenges in order to unlock their potential for future innovativeness.

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The paper aims[2] to develop recommendations for policy measures that foster collaborative, transformative, and inclusive innovation to overcome innovation gaps. The recommendations are based on the analysis of 98 qualitative company interviews about current innovation practices in German and Dutch industry. IES plays a crucial role in analysing innovation practices, innovation gaps, and related policy recommendations.

In section 2, we introduce our insights from the IIT industry survey about the innovation gaps and opportunities of pro-active innovation ecosystem engagement. Section 3 develops a model of a collaborative process to create common future ideas and knowledge. This builds the basis for the policy recommendations in section 4.

2. INNOVATION GAPS AND IES OPPORTUNITIES – RESULTS FROM THE IIT PROJECT

2.1 Innovation gaps: incremental, customer-oriented activities as innovation routine in industry

The results presented in this section are based on the analysis of Dutch (NL) and German (DE) innovative industrial companies from the sectors ICT, manufacturing, biopharma, agri-food, and clean technologies (see Box 1). The sample is a good representation of companies with at least six years of market experience in all size ranges (starting from 10 employees).

Box 1: The IIT European industry survey on innovation

The interview survey was the core activity of the Horizon 2020 project, Industrial Innovation in Transition (IIT) (www.iit-project.eu); the team at the University of Twente conducted the survey in Germany and the Netherlands. In total, the survey comprises almost 700 interviews with industrial companies from eleven European member states. It focused on established and innovative companies from ICT, manufacturing, biopharma, agri-food, and clean technologies.

In Germany and the Netherlands, we visited almost 100 companies and spoke with CTOs, CEOs, and innovation managers about their innovation practices and strategies. The openly structured interviews were based on an interview guideline covering crucial topics for innovation, such as open innovation, innovation management, future mapping, and innovation ecosystems.

As non-innovative companies were not involved in the IIT study, a high level of innovative competences can be expected from the results. However, despite this focus on innovative companies, concerns and opportunities remain for improvements and policy involvement.

New customer requirements and their demands are often the most important drivers of innovation by companies. Two-thirds of Dutch and German companies indicate the importance of their customers for initiating innovation processes, rather than ideas generated by their R&D department or employees.

> *"We do not need to search for problems and ideas with brainstorming or stuff like this. Our customers know already quite well what they want. For us it's rather challenging to fulfil their requirements."* (R&D manager, large manufacturing company)

Companies' strong focus on linking their innovations directly to specific customer requirements is in line with the **dominance of incremental developments** that improve existing products rather than introduce radical novelties. Our analysis shows that more than 80% of the German and Dutch innovative companies in the sample apply incremental changes that support current processes and

[2] The paper was prepared in the context of the project "AntEx" (Offene Innovationskulturen schaffen. Kollektive Antizipation und Experimentieren als Herausforderung und Möglichkeit für Innovationspolitik) which was funded by the German Federal Ministry of Education and Research.

markets or develop next product generations. Only half of the companies implement new core technological competences.[3]

The timing and content of innovation processes follow rather narrow paths along customer and market requirements and are very often closely related to immediate customer needs:

> *"Well, innovation has something to do with novelty. However, innovation is based on customers' unsolved problems that we observe. Either something very concrete related to a customer or something that we discovered in the market as an unsolved problem."* (Innovation manager, large ICT company)

The rationale behind focusing *primarily* on customer and market needs has a lot to do with the **speed to market logic** that pushes the daily innovation activities within the companies. Every second German company reports faster innovation rates and shorter product life cycles. The Dutch companies mention a more stable situation.

> *"Of course, the trend – same as in life – everything is becoming faster. Customers demand quick solutions. With every new order we get, we have less time for its realization."* (R&D manager manufacturing company)

Companies need to respond immediately to customer and market requirements; time for creative thinking and failure is rare in short innovation cycles. **Time pressure** also causes mistakes, as the R&D manager from the manufacturing SME above explains.

In order to cope with risk, time, and cost pressure and fast idea realization, **classical stage-gate processes dominate the innovation projects** in 69% of the German companies (only 35% NL). Only one-third of the German and Dutch innovative companies in our sample offer more flexible and agile procedures for managing innovation. The milestone-based processes and progress criteria indicate that classical **stage-gate processes do not leave much space for creative and experimental developments** (see also Meyer & Tucker 2010).

> *"and accordingly we have milestone plans almost ranging from the beginning [of an innovation project] to the market introduction. And those plans are tenaciously processed."* (Innovation manager, pharmaceutical company)

Although **failure** is generally accepted in the process, it is often not perceived as an opportunity to learn and experiment but rather as a reason to stop the development project. **Kill early – kill cheap** is one of the prevailing principles to get rid of ideas that do not meet the stage-gate criteria. Getting permission to continue with a rather risky project depends very often on internal support from higher management.

> *"Well, we try to interlink gates and gate reviews with so-called technology readiness levels from one to nine. And we seek to develop these reviews from one technology readiness level to the following in a way that we can say, 'okay, go ahead' or 'we stop the project here'."* (Innovation manager, large multinational industrial company)

Open Innovation (OI) is often applied in order to access relevant external knowledge and technologies. Once a cooperative innovation project has been initiated, **non-disclosure agreements** build the **basis for exchange**. Cooperation, which is often bilateral, is strongly fixed on a contractual

[3] A rough comparison with German and Dutch data from the Community Innovation Survey 2014 (CIS 2014) confirms the tendency identified by the IIT survey, especially for the German results. We took the CIS manufacturing data as a basis as most of the IIT companies are located within the manufacturing industry, except for ICT trade and services and few agricultural subsectors. Product innovations that were new to the market were introduced by 47% of the German and 62% of the Dutch product innovative companies, and 88 % of the German and 60 % of the Dutch companies developed incremental innovations that were only new to the firm.

basis and often applied at a **pre-competitive stage**, which all in all leads to a rather pragmatic usage of OI practices.

> *"We predominantly see the opportunity to apply open innovation within the pre-competitive space. This means in the very early development phase or discovery. At this time, patenting of process technology or products is not a relevant topic; it is more about developing a general understanding. At this stage, we can collaborate very well and this holds also for open innovation. We become very sensitive once IP [intellectual property] matters and then we will protect our rights."* (R&D manager pharma company)

Advanced forms of more open innovation are considered very sceptically, as the dominant concern is loss of special knowledge and competitive advantage.

> *"For us, open innovation is not a big topic. […] In the end, it is also important to achieve uniqueness, and, for this objective, open innovation as an instrument is less attractive for us."* (R&D manager large German industrial company)

Efficient, competent, customer-oriented, and incremental innovations are the important pillar for the success and competitiveness of the innovative Dutch and German companies. Clearly defined and contractually fixed cooperation with customers, suppliers, and research institutes additionally contributes to their success. The interviews reveal companies' worries about losing existing core knowledge and newly developed innovative knowledge when they open up to external partners. Our results also show companies' interest in scheduling, controlling, and steering innovative procedures in stage-gate processes as much as possible. This might be also related to the fact that, in most companies, innovation strategies are focused on urgent customer and market requirements to which companies need to respond quickly. Taking high temporal, financial, and technical risks is not in the interest of customers. Under these conditions of time pressure and high market orientation, incremental rather than radical innovations are more likely and occur in fact more often.

The importance of this pillar should not be neglected, as it builds a strong and stable basis for the companies' development and competitiveness. However, if uncertainties and risks are kept at a low level, it becomes difficult to develop transformative future-oriented innovation. In addition to a strong, stabilizing, supporting leg, a free leg is required to develop and experiment on future-oriented visions. At least some large companies, usually large multinationals, have introduced or strengthened their internal corporate research units. Such departments have more freedom to develop creative ideas than customer- and market-oriented development departments. However, it is questionable whether they sufficiently use their strong innovative environment for innovation. In addition, SMEs seldom have sufficient financial and human resources to invest in independent R&D units.

Sections 2.2 and 2.3 show how innovative and therefore advanced companies strategically move and position themselves within their innovation ecosystem in order to fill knowledge gaps, to access relevant information, and to shape IES developments.

2.2 Opportunities of IES engagement: managing uncertainties

It is a common belief among innovation policymakers that companies' innovation activities are embedded in, and related to, their respective national innovation system (NIS) (Nelson 1993, Freeman 1995, Lundvall 1992, OECD 1997). The NIS comprises the set of institutions such as education, laws, regulations, and established routines that constitute the institutional landscape in which a company operates. The NIS provides the institutional and therefore stable basis for innovation and

technological development. However, in their daily business, companies have to deal with changing and dynamic environments (Zhang, Wang, & Gao 2017). New market requirements and upcoming technologies offer opportunities but entail at the same time uncertainty about the future. To deal with changes, innovative industrial companies in Europe have built up strong IES (see Box 2). For their innovation activities, they are very well interlinked with their external – often international – environment, such as value chain companies (about 67% include suppliers, 73% involve customers), start-ups, associations, consultancy, research institutes, policymakers, and financial investors. IES can go far beyond classical value chain partners and beyond sectoral, regional, or national borders. Applying too narrow a focus on their IES companies would result in missing opportunities for innovation.

Innovation ecosystems are defined as "collaborative arrangements through which firms combine their individual offerings into a coherent, customer facing solution […]. When they work, ecosystems allow firms to create value that no single firm could have created alone" (Adner 2006, 98ff.).

Box 2: The innovation ecosystem concept

The innovation ecosystem (IES) concept models complex dynamics around a product or technology based on flows of resources such as knowledge, capital, humans, and materials. In doing so, it goes beyond an industry sector or a specific region, as implied by concepts such as sectoral, regional innovation systems or clusters (Malerba & Orsenigo 1997, Braczyk, Cooke, & Heidenreich 1998, Porter 1998). Hence, the ecosystem of a company comprises all the strong and weak ties to organizations involved in the process of value creation, often led by a focal company (Buciuni, Coro, & Micelli 2013, Adner & Kapoor 2010). In this process, not only suppliers and customers, but also competitors or research institutes, financial investors, policymakers, and regulators are involved (see also Bowonder & Miyake 2000). The interactions within an ecosystem are not limited to economic transactions. Moore (1993, 76) highlights the mutual development or co-evolvement of capabilities; this is an important point, as it speaks against a simple reduction to a linear top-down process from large high-tech companies to their smaller or less innovative partners (see also Robertson & Smith 2008).

From the results of our European industry survey (see Box 1), the main motivations for innovative companies to engage in their IES are: gaining knowledge, shaping IES developments, and developing technologies. At the same time, the companies' interlinkages with their IES stakeholders are often well established and well organized. About 75% of the Dutch and 65% of the German sample companies indicate a high relevance of IES for their innovation activities.

As discussed above, an IES consists of various stakeholders and is not limited to the immediate value chain only. Our research shows that innovative companies are interlinked very well with actors relevant for current and future innovation. They report about their engagement in associations and on regulation committees; and they describe how they involve customers and suppliers in the innovation process. Almost every innovative German company from our sample (92%) and three-quarters of the Dutch companies collaborate with research institutes to advance their innovation projects. However, as described above, these collaborations are often at a pre-competitive stage (which means far removed from the actual market introduction of an innovative idea) and/or highly confidential contract research related to fixing a specific problem.

The results of the IIT industry survey show a high variety of external innovation inputs that help companies to understand current and future challenges and developments. About 96% of the German and 85% of the Dutch companies in the sample try to identify future innovation opportunities, often based on formal methods such as road mapping or market and patent analysis. At least one-third of the German companies (24% NL) conduct future mapping with partners from their IES. Such

collaborative forms might be well-organized meetings with associations to develop sectoral roadmaps or events with customers or suppliers, but also publicly funded research projects in which companies get ideas about future technologies.

This means in practice that companies educe insights about technological opportunities from suppliers, develop knowledge in collaborative research projects, access information about future regulation, engage in collaborative foresight, and try to understand as much as possible about their customers' needs.

> *"Yes, indeed, one future mapping perspective is technology strategies. The basis from which they emerge are for example customer innovation workshops. We state our claim and ask the customers for their next milestone. It doesn't make sense to simply set a milestone for technology development. The direction in which our customers are going is important." (*Innovation manager, large manufacturing company)

In addition, companies do not only use their innovation environment as a source of knowledge and information; they also shape its development through communicating their (future) needs to policymakers and regulators or through developing a common idea of the future with partners (see collaborative future mapping above).

2.3 Innovation ecosystem dynamics: roles and mutual dependencies of IES stakeholders

The interlinkages within IES range from loose, occasional meetings to strong and established cooperation. Active engagement in IES is not limited to large focal companies or dominant technology leaders. On the contrary, **an IES consists of a large variety of actors contributing and adding value with their specific roles, knowledge, and competences**. Companies can go alone but also co-create knowledge within their IES. They do not need to take a leading role or follow a pro-active strategy. Followers with a rather reactive strategy can also be important IES stakeholders when participating in initiatives of other IES partners and in doing so contribute to a well-functioning IES. Analysis of the German interviews reveals four main company roles. Figure 1 shows the "ideal/core" position of the specific company along the two axes "go alone to knowledge co-creation" and "pro-active to reactive strategy". In reality, companies might deviate from this ideal position.

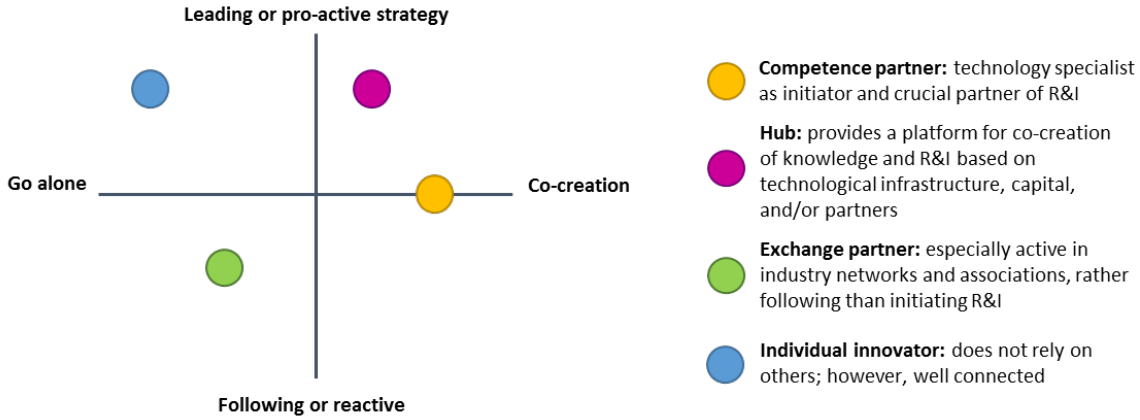
1. The **competence partners** are technology specialists. They initiate and participate in research and innovation projects as crucial experts bringing in specific technological competences and knowledge.

2. The **exchange partner** is a real networker and therefore primarily engaged in industry networks or associations. Usually, this type of company is rather a follower and more internally focused than a regular participant in collaborative innovation processes.

3. The **hub company** provides a platform for exchange, infrastructure, or capital in order to bring different IES stakeholders together and to initiate exchange and common knowledge creation. Providing this platform secures also power and opportunities to steer the innovation process. Therefore, this actor has at least a certain interest in leading (parts of) the IES.

4. The **individual innovator** might be well connected, but, for innovation, these companies rely on their own competences and do not share this with others.

Figure 1: IES roles of established industrial companies



Identifying different company types from the analysis indicates the richness of the IES but also the **mutual dependence of companies**. Given the different roles companies can have within IES, it becomes apparent that an IES needs more than just one company type as exchange partners or hub. In fact, it is rather unlikely that an IES will contain more than one hub. The core stakeholders of an IES are those who are experienced or at least willing to co-create futures and innovation and take an active part in these processes. Companies that do not belong to this pro-active IES part can develop strategies and should be supported to change in this direction. For example, an individual innovator could become more open by temporarily providing a platform for exchange with partners, at least for specific projects. In that way, the former individual innovator can maintain its leading position and control how much it opens up and at the same time gain advantages from the co-creation of ideas and contribute to the IES. A public policy role here could be to support those companies in their change process and to keep these different roles in mind when innovation policies are being conceptualized (see section 4).

2.4 Missed opportunities

From their contacts and information exchange within their IES, companies have a solid basis from which to recognize and respond quickly to ongoing changes and market requirements. The exchange of knowledge and the sharing of information are not limited to focal hub companies of an IES but include other IES actors such as **exchange** or **competence** partners. In addition, companies do not only receive or exploit information and IES knowledge. They can also push their requirements for regulation and public support or mobilize their partners to develop innovative knowledge in common. IES stakeholders can shape their environment on the very concrete level of innovation cooperation. Furthermore, changes on the meso-level of a sector or value chain as well as new regulations on the macro-level of the institutional landscape can be initiated and pushed by the companies and their IES partners. IES engagement can be applied as a strategic instrument that helps with both managing current challenges and creating ideas and conditions for future developments. This decreases the complexity and uncertainty of a dynamic and constantly changing environment while paths and points for orientation are emerging. **Companies' engagement in their IES can help them to handle the challenge of a constantly changing, dynamic, socio-technical environment and the need to overcome uncertainties about future developments. However, there are still many examples in which the richness and dynamics of the IES and potential IES partners are not actively used in the actual innovation process.** In the Community Innovation Survey (CIS 2014), only 43% of the Dutch and

25% of the German innovative companies reported being engaged in concrete innovation collaborations.

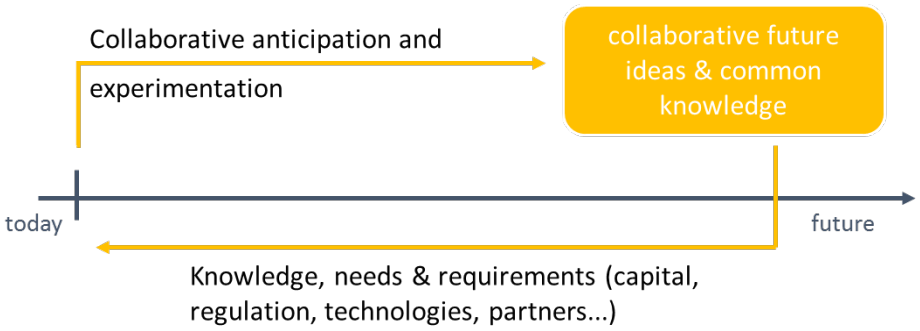
We observed that the companies are very well interlinked with their IES but, when it comes to concrete innovation projects, they rely on their internal competences (see CIS data above) and on a selected set of trusted partners. This is of course very understandable, as companies want to protect their knowledge and gain competitive advantage through innovation. However, the dynamics, the exchange of the broader IES, and their related opportunities or technological developments decrease if they maintain established collaboration patterns. The challenge is to transfer the broad and more collaborative IES dynamics into the companies' specific innovation strategies and concrete innovation projects to foster more dynamic innovation initiatives. Suggestions on how to support this process are introduced in sections 3 and 4.

3. CONSIDERATIONS: COLLABORATIVE CREATION OF FUTURE IDEAS AND SHARED KNOWLEDGE

Reacting **just in time** to customer requirements and ideas bears the risk of focusing too much on current, available knowledge and competencies within the company. Strictly organized innovation processes, closed (bilateral) collaborations, and highly protected knowledge are the consequences of these short-term innovation practices with their main objective of keeping short- to medium-term competitiveness (see 2.1).

In order to leave this narrow path and include transformative ideas, a company can foster creative thinking internally, for example by applying specific design-thinking methods and establishing corporate research and innovation centres that facilitate thinking in broader terms and longer time frames. **However, internally focused strategy adjustments do not necessarily change common IES practices. Instead, knowledge and ideas that are relevant for future innovation need to be created as shared knowledge and common future understanding by involving various IES stakeholders** (Figure 2).

Figure 2: Anticipating and experimenting with futures as collaborative approach



More IES stakeholders beyond the usual value chain should be invited to participate and to discuss specific needs at the very beginning. Policymakers can initiate and moderate the anticipation and development of transformative ideas. Regulators might provide crucial information on future requirements and start-ups, or research partners might contribute with creative new ideas, inspiration, and different ways of problem solving. Investors or consultants can also already be supportive at this early stage to ensure a continuous progress. A future idea with a highly

transformative character might also require the involvement of NGOs in order to anticipate and discuss possible tensions and risks. These forms of collaborative future creation can be applied for fast-track innovations, e.g. in the form of open innovation, as well as for long-term transformative perspectives. The latter in particular opens opportunities and probably also the need for active policy engagement. At this time, policymakers should take over as '**concertators**' of IES and lead and initiate debates and learning processes focused on both market requirements and societal challenges (Kuhlmann & Rip 2017).

Such commonly anticipated future ideas and developed knowledge can be referred back and contextualized to current innovation and IES activities (Figure 2). Once the knowledge and the relevance of projects are created as shared knowledge from the beginning, it will remain shared knowledge for future innovation processes. Questions about ownership and individual competitiveness remain untouched. Future options have been developed as a collaborative project that creates a common context for further and more competitive innovation efforts.

4. POLICY RECOMMENDATIONS: HOW CAN POLICY SUPPORT TRANSFORMATIVE INNOVATION PROCESSES?

Policy recommendations based on the analysis and insights from the IIT industry survey can be provided with two foci: one on the specific role that policymakers should undertake within this IES and the other on more concrete examples of specific policy instruments. The overall objectives are primarily to strengthen the innovation ecosystem engagement of companies in general and, secondly, to transfer these IES dynamics and knowledge to concrete, transformative, and inclusive innovation projects.

- **Creating common visions for future innovation**
    - Policymakers could strive for "deliberate concertation of old and new actors, facilitating assemblage of heterogeneous capacities and capabilities, including social innovation" (Kuhlmann & Rip 2017). As 'concertators', they would act as **initiators and moderators** for bringing forward transformative ideas within IES and introducing relevant partners from economy and society. They should **initiate debates and learning processes** about future developments, combining both societal and market requirements. This would also help companies not only to broaden their perspectives but also to **increase the variety of IES stakeholders, including user groups, civil society organizations, and so on.** Policymakers should bring in their organizational and infrastructural competences to provide **platforms**. Platforms are not primarily understood in a technological sense but **rather as spaces for exchange, experimentation, and learning with the IES** and its different IES stakeholders.
    - One opportunity to involve IES stakeholders actively in the development of future ideas and knowledge is processes of **co-creative future anticipation** (section 3). This is more about anticipating and creating futures in common within the respective IES context than studying complex foresight reports.

- **Overcoming value chain thinking and introducing an innovation ecosystem perspective**
    - **Support IES with various roles and stakeholders instead of classical value chain constellations**

Germany, for instance, already offers a high number of various networks and initiatives. The existing opportunities to exchange, such as *Spitzencluster* and publicly funded research projects, can be used as a basis for the abovementioned co-creative processes. However, actor constellations and topics should be critically re-considered. Instead of demanding primarily collaborations along the value chain or focusing on including SMEs, policymakers should look for actors with various roles (section 2.2).
An example: a project to develop future opportunities may involve a heterogeneous set of actors, among other things to overcome the distance between a primarily technological invention and its implementation in the market and society:

- start-ups or a partner from another sector to introduce creative and new ideas
- established SMEs as technology and process specialists
- large companies as hubs that provide exchange platforms or infrastructure
- NGOs or user organizations to anticipate and discuss possible tensions of the innovation
- regulators or legal support to identify and articulate legal problems arising
- investors to make the development more interesting and transparent for additional investments

- The IES perspective holds for IES initiatives with various spatial expansions. On the local and regional level, small IES can be created as niches for developing new technologies. Larger IES on the national or international level can also be initiated and designed to collaboratively develop future visions and concepts. Initiatives around the Industry 4.0 topic are for example first steps in the direction of a collaborative future creation between various IES stakeholders beyond the traditional value chain.

5. OUTLOOK

Many innovative Dutch and German companies are very well interlinked with their external environment, profiting from access to knowledge, skills, and finance within their network, while actively shaping its future developments (see sections 2.2 and 2.3). However, when innovating, the interviewed companies collaborate with a rather narrow set of partners. From our perspective, they do not profit enough from the opportunities, broad knowledge bases, and relations of their wider IES, for example for developing radical innovation and exploring transformative opportunities for medium-term innovations addressing societal challenges. Future innovation is not only about bringing value chain partners together and linking them with research, but also about thinking beyond well-known paths and taking responsibility for societal challenges. This requires the involvement of a broader variety of partners from the very beginning of future innovation projects in order to create shared knowledge, understanding, trust, and orientation. The creation of common, shared – rather than individual – knowledge between relevant IES partners at this early stage is a crucial component and starting point of this idea. Policymakers can go for pro-active concertation, i.e. act as initiators and moderators of transformative ideas, bringing together societal and economic actors to initiate co-creation of technological innovation and change.

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