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DEMAND, PUBLIC PROCUREMENT AND TRANSFORMATION

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Demand, public procurement and transformation

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1. Introduction

The meaning of demand and demand side policies has been discussed with three major perspectives. First, demand has always been a major feature in economic theories of innovation and market creation. In line with long waves of economic thinking, the meaning of demand and the role of the state to intervene on the demand side has fluctuated over time (Frenkel et al., 2015; Godin and Lane, 2013; Knell, 2012; Miles, 2010; Nemet, 2009) . In the last 10 to 15 years, however, especially innovation economics and innovation theory has turned to demand side much more forcefully again. This debate has reminded us of the bottlenecks and the catalytical effects of demand side behaviour for the creation of markets and for economic and societal benefits emanating from innovations; and subsequently of the necessity and various possibilities of the state to intervene.

Second, demand has been a major feature in a limited number of sectoral policies. Most notably, traditional energy policy has focused on demand measures, on demand side management even, for decades ((Geller et al., 2006; Gillingham et al., 2004; Neij, 2001; Nemet, 2008). This has always been done with the idea that entry and use barriers for energy efficient technologies need public policy support, as the public benefit of the diffusion of those technologies exceeds the sum of individual benefits and as private demand changes are not fast enough to achieve the political goal of new energy markets. Those policies have hardly been linked with innovation or even economic policy consideration, i.e. the effects on innovation behaviour of firms and as to who reaps the benefit on the supply side have not been at the core of this debate.

Third, and in extension of the sectoral policy approaches, transition studies have long stressed that functional systems can only be transformed if consumers, private and public, are ready to change behaviour and adopt and use innovations. It is not so much the inventiveness of suppliers of innovation that enables transformation, it is the broad adoption of innovations that does it. Thus, transition studies have always had great interest in how the behaviour of consumers and citizens influences the direction and speed of transformation (Kivimaa and Virkamäki, 2014; Köhler et al., 2017; Schot

et al., 2016). However, when it comes to policies that seek to support transformation, e.g. through mission oriented innovation policy approaches, in many OECD countries the take up of demand side measures instruments still is "the weakest point" (OECD, 2021b, p. 81).

One particular lever on the demand side is public procurement. With public procurement it is the state itself, state actors, at different levels, that can influence the market directly by demanding something new or absorbing innovations that struggle to take off, but are potentially of broader benefit to societies. This direct influence through public procurement of innovation (PPI) does not infringe market dynamics as competition for tenders is open, and it allows - in principle - the orchestration of institutional change needed to ensure the success of innovation uptake and market development.

However, there are only very few contributions in the literature that discuss and analyse innovation public procurement explicitly in the context of transformation. (Edquist and Zabala-Iturriagagoitia, 2020; Flanagan et al., 2022; Wesseling and Edquist, 2018). More broadly, the various literature strands that discuss the role of demand for innovation and for transformation and the role of the state on the demand side have not really been brought together fruitfully. Given the increased ambition of many states to support transformations, in particular to slow down climate change and increase sustainability of our economies and societies, and given the outstanding meaning of innovations to achieve other ambitious goals, one would expect a more systematic discourse as to how the two demand perspectives relate to each other. Clearly, there are potential synergies as well as tensions between the two as creating and supporting markets for innovations has both economic and transformational effects that may or may not be complementary.

In this article we want to explore the role of the state to influence and support the demand for innovation in the context of transformation with a triple focus. First, we discuss the importance of demand for innovation and transformation. Second, we elaborate the conceptual underpinning of state intervention on the demand side. This In doing so, we link the demand side interventions with both the transformation debate and the innovation based competitiveness of systems debate. We then zoom into the main focus of this chapter, public demand and public procurement practice for innovation and transformation as this is - or can be - a powerful lever to spur both transformation and innovation which is largely underexplored and underused. Here we differentiate different forms of public procurement as well as different functions it can play in different transformation contexts. Rather than elaborating individual instruments and measures to support procurement, which is done in many ways elsewhere, we conclude with a number of high level recommendation for policy and analysis in order to further a debate the value of which has been recognised, but yet which has not materialised in any serious policy strategies for procurement.

2. Transformation, demand and innovation

Transformation has been conceptualised and empirically analysed through various academic lenses such as the Multi-Level Perspective, Technological Innovation Systems, Complex adaptive systems approach, practice theory (Grin, 2016; Hansmeier et al., 2021). Even if the causal explanations and the context and framework conditions conducive to transformation are different in the different approaches: transformation in essence results from the interplay of change in attitude and behaviour, social innovation (new practices) and technological innovations that are adopted widely and diffuse through the system, triggering further spill over and spill back effects to suppliers and thus a positive self-reinforcing dynamic. Accordingly, one of the major failures of systems to transform is demand articulation failure (Weber and Rohracher, 2012) . Weber and Rohracher claimed very early on that the traditional innovation systems failure approach has been very limited to address failures on the demand side, ranging from poor complementary institutional and organisational conditions to a lack of understanding of user needs or their reluctance to use a certain innovation. They concede that many sectoral polices had failed to articulate those demand conditions sufficiently. Since then, however, all major strands mobilised to understand transformation dynamics highlight the importance of demand (for many see (Jacobsson and Bergek, 2011; Kivimaa, 2014; Köhler et al., 2017; Suurs et al., 2010).

As one major dynamics for transformation is the adoption and diffusion of innovations in the market place, it is reasonable to start with a short general discussion on the role of demand for innovation more generally. Economic and innovation studies have long established the importance of demand for innovation (Mowery and Rosenberg, 1979). The reasons are manifold. Product innovations contribute to a firm's market position as it satisfies new needs or existing needs better, process innovation increase productivity and allow cost advantages. At least since Schumpeter, innovation has been regarded as is the engine of competition and constant improvement of performance and efficiency. The nature of demand and the quality of demand conditions for innovations to be generated and diffused is critical for the generation and diffusion of innovation which is an essential component of any transformation that is driven - inter alia - by market forces.

The quality of the demand side has a number of effects on the likelihood of innovations to be produced and diffused. Innovations can be demand driven, i.e. reacting to changing needs of potential buyers. Thus, in innovation systems in which citizens, firms and public bodies are curious, are inclined to seek improved performance or develop new needs and to articulate those novel needs well to potential suppliers, those suppliers are more likely inspired to produce and test innovations. Equally, innovations can be supply driven, whereby firms anticipate markets to take up innovations they have developed. In innovation systems in which citizens, firms and public bodies are open to novelties, are inclined to be early or even lead users and develop the skills to

apply innovations, firms will be eager to produce and test innovations. In those systems, uncertainty for suppliers is reduced, and through user-producer interactions for co-generation or co-adaptation of innovations learning (Malerba et al., 2007; Miles et al., 2009; Rothwell, 1977, 1984) and demonstration effects across the system are more likely to occur.

In addition, there is a positive feedback effect on firms and their inclination to innovate in the future. The effects of market conditions conducive to early user-producer interaction, early uptake and fast diffusion on the innovation activities of firms is well established in the literature. A number of studies have shown that the positive effects of demand side conditions and policies are considerable for innovation activities of firms (Edler, 2016; Guerzoni and Raiteri, 2015).

Those dynamics have in particular been analysed for public demand. Mowery and Rosenberg (1979) conclude a long term analysis of the US in the last century that public demand has had more effect on innovation and growth in the US than supply side policy measures such as R&D subsidies. Similarly, Shin et al. have shown that public demand can play a very specific role for market creation (Shin et al., 2020). They recently conceptualised and analysed market creation and in particular the diffusion effect of public demand of innovation. Applying an innovation system perspective, they demonstrate direct and indirect PPI effects in a comprehensive fashion, backed by evidence of existing studies and underpinned by a modelling approach in the electric vehicle (EV) sector in Korea. In particular, they demonstrate a number of positive spill over effects throughout the sector delivering the innovation and its supply chains (Shin et al., 2020). They assert that PPI can have a considerable effect on accelerating the diffusion of innovation, including the shift of corresponding supply chains and interacting economic sectors. These multiple dynamics the authors call "indirect demand pull effects triggered by PPI" (ibd. 197). Further, Guerzoni and Raiteri (2015) show in their econometric analysis the power of PPI to stimulate innovation in the private sector. They show that while the combination with other demand side and supply side policies is important, PPI as an isolated instrument is a major lever for the innovation activity of supplying firms. They go even one step further, indicating that public demand inspires more private R&D and may spill over in private markets (ibd. p. 275) and by definition has a market formation effect.

Similarly, knock on effects on firms are confirmed by Czarnitzki et al. (2020) and Aschhoff and Sofka (2009))showing that innovative public procurement has a considerable effect on innovation generation in firms. Czarnitzki et al. (2020)specifies that the innovation effect is particular relevant for incremental innovation, while Aschhoff and Sofka find that innovation procurement is particularly important for SMEs and for firms in weaker regions, and that the effect is most pronounced for technological and distributional services. They explain this effect by the fact that public procurement offers immediate sales opportunities and - in contrast to R&D subsidies often does not require additional R&D efforts (Aschhoff and Sofka, 2009, pp. 1243–1244).This means

the innovation effect, again, is more incremental, but the innovation effect spreads more broadly, which benefits a broader market formation and triggers innovative activities very broadly, underpinning a broader diffusion of innovation. At city-regional level extensive case work has shown the effect of demand for the development of innovative products in the circular economy (Alhola et al., 2019).

More comprehensive knock on effects on supplying firms are shown by Edler et al. (2015). In a survey of 800 firms supplying to the public sector in the UK they find that firms supplying an innovation to the public sector benefit in other markets. Almost 80% of all firms in their sample supplying an innovation to a public body first subsequently sell this innovation to other public customers, 55% to customers in the private market, and 25% to customers overseas. This is a clear indication for the lead user argument, both in domestic and export markets, a strong argument for innovation diffusion triggered by public demand. Therefore, for innovations conducive to transformation that are politically intended, there is a potential win-win situation. Economic competitiveness and additonal exports for a system coupled with fast diffusion of innovation.

In sum, the effects of innovation demand, and of public demand in particular, on innovation dynamics and on broader economic benefits, and thus potentially on transformation, are immense. This is at the core of the argumentation for a state playing an active role as regards innovation demand. Given this importance of demand conditions, and given the aspiration of states, at various levels, to accelerate transformation, we now turn to public policies on the demand side before zooming into public procurement as the most direct lever of state action, and one of the most neglected.

3. Demand side policies

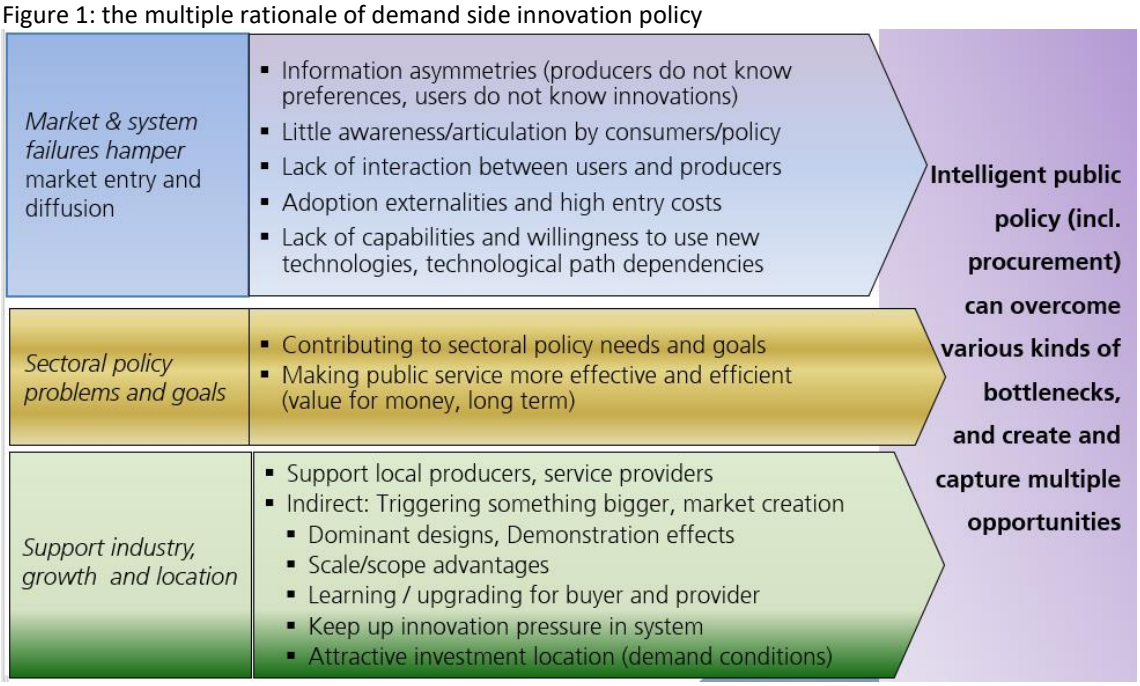
3.1 Demand side policies as innovation policy

In the last 15 years or so, demand side has come back strongly in the innovation policy discourse (Edler, 2016; Edler and Georghiou, 2007; Edquist, 2019; Weber and Truffer, 2017; Zabala-Iturriagagoitia, 2022). This was due mainly to a realisation that the innovation policy measures had a strong focus on enhancing the capabilities of the system to produce knowledge and innovation. The direction of those innovation activities and the satisfaction of demand was, in terms of economic and innovation policy, to a large degree left to the market, and in parts - as highlighted above - to sectoral polices. However, despite considerable efforts to strengthen and broaden the innovation policy toolbox (Polt et al., 2021), many OECD states failed to improve competitiveness and innovativeness markedly. Exacerbated by the financial and economic crisis of the late 2000s, the EU certainly did not succeed in becoming the most competitive region in the world. Consequently, the attention turned to an additional legitimation for innovation policy, a shift towards a challenge discourse. The new, or more pronounced, imperative for innovation policy towards societal challenges forced policy makers and

politicians in all policy areas to focus policy much more on contributing to solve the associated problems, and to become more directional. This development led to OECD wide national strategies for demand side policies (OECD, 2011).

To understand the broader policy context of public procurement, a short recollection of the broad conceptual rationales to underpin demand side innovation policy measures is needed. Figure 1 displays three major bundles of rationales. [1] The first is a set of market and system failures. There are a number of characteristics of demand for innovation that restrain or slow down potential demanders from asking for or buying and using an innovation. This has to do with uncertainty and lack of information about the added benefit of an innovation, poor communication between potential suppliers and demanders, high entry costs, a reluctance to bear learning costs from which subsequent demanders benefit (adoption externalities) and various adoption costs (learning, change of behaviour, complementary investments etc.). A second rationale of demand side innovation policies has to do with sectoral policy goals. If the market forces are too slow for diffusion, the roll out through supply and demand means becomes a political prerequisite. This of course is at the heart of sectoral policies and can be at the heart of transformation oriented demand side measures. And third, as research on lead markets has shown (Beise, 2004; Quitzow et al., 2014), improving demand condition, positioning a market as lead market can be a means of competition policy, as the generation of innovation is often close to lead users and markets. This anticipates positive feedback loops to supplying companies as outlined above.

Figure 1: the multiple rationale of demand side innovation policy



1 For a more detailed conceptualisation of demand side policy rationales see Edler 2010A. Clarke (2005); Edler and Georghiou (2007); OECD (2011).

Source: own elaboration, partly based on Edler 2010, (Edler, 2016)

The tool box of demand side *innovation* policies to overcome those failures and achieve sectoral and innovation related goals can be categorised into measures(OECD, 2011):

- to reduce the entry costs of an innovation (subsidies or tax incentives for the purchase of an innovation),
- to increase awareness and reduce uncertainty (information, labelling, regulation),
- to improve the ability of potential users through training,
- to support the articulation of needs into market demand.
- and direct purchase by the state (public procurement) as a deliberate innovation policy tool.

There are considerable challenges in policy design, implementation and evaluation in demand side policies First, the various bundles of justification for public action and the instrument deployed are not free from tensions and target conflicts. Most notably in the context of this article, the sectoral policy goals, or transformation goals for that matter, may not be in line with the innovation policy goals. If, for example, innovations that are supported by demand side policies are being imported to speed up transformation, the competitive balance between firms in different countries may shift in ways that might be seen as detrimental for firms in the importing country. The example of photovoltaic technologies is telling here. Despite a clear early technological lead in Europe in the 1980s, it were mainly Chinese producers who delivered for the mass deployment of photovoltaic devices to speed up energy transition in the last 20 years. This, however, was often supported by demand subsidies in Europe and particular in Germany (feed-in tariffs in particular), whereby in response to the market formation success in Germany actors in Germany were "increasingly concerned that the large PV deployment program of the feed-in tariff is benefiting Chinese PV manufacturers at the expense of the development of German industry and at high costs for German electricity consumers" (Grau et al., 2012) . The share of European producers in the production of photovoltaic devices in 2020 was down to 1,8%, with Chinse producers claiming almost 70%[2].

A second challenge of demand side policies is to understand if a market or system failure exists, and if the scope is big enough to be targeted with a demand side measure, and which measure is the most effective, is far from trivial. Further, the timing is critical. Applied too early, a demand subsidy may push an innovation in the market despite it being technologically not mature yet. Applied too late or too long, demand side subsidies may result in windfall gains for suppliers, leading to inefficient allocation of resources (see also Fan et al. (2022)). In both cases, the result may be a deceleration of

2 IEA (Photovoltaic Power Systems Programme) (2022).

further innovation activities as pressure for innovation is taken out of the market place. The design of demand side innovation policy measures supported by ex-ante evaluations is characterised by high level of uncertainties due to a range of unpredictable behavioural developments and spill overs in supply and demand side of the market[3].

3.2 Demand side policies and PP in the context of transformation.

The discussion as to the role of demand side intervention for policy missions has started three decades ago. Very early conceptualisation of "new style" mission policies already stressed the importance of demand (Soete and Arundel, 1993). Soete and Arundel defined a paradigm in which technological and non-technological innovation were to be supported to tackle broad societal, sustainability and economical challenges that are politically defined into policy problems and potentially missions. Those policy problems were distinguished from old style missions, that are focused on governmental functions, often have to do with large scale technological developments and concern a limited group of actors (Köhler et al., 2019; Mazzucato and Penna, 2016; Mowery et al., 2010; Penna et al., 2022; Soete and Arundel, 1993). While this distinction is meanwhile well established, it is important to stress here because it puts so much emphasis on demand, on public and private demand, with diffusion of results being "the central goal of policy (Soete and Arundel, 1993). Consequently, demand conditions as a context condition or even enabler for transformative policy is critical.

Table 1: Old vs. new missions

Old: Defense, nuclear, and aerospace	New: Socio-environmental challenges
Diffusion of the results outside of the core of participants is of minor importance or actively discouraged.	*Diffusion of the results is a central goal and is actively encouraged.*
The mission is defined in terms of the number of technical achievements, with little regard to their economic feasibility.	*The mission is defined in terms of economically feasible technical solutions to specific societal problems.*
The goals and the direction of technological development are defined in advance by a small group of experts.	*The direction of technical change is influenced by a wide range of actors including government, private firms and consumer groups.*
Centralised control within a government administration	*Decentralised control with many agents involved.*
Participation is limited to a small group of firms due to the emphasis on radical technologies.	*Emphasis on the development of both radical and incremental innovations in order to permit many firms to participate.*

Source: Version by Mazzucato and Penna (2016) of table 5 in Soete and Arundel (1993, p. 51).

3 For a more elaborated analysis of demand side policy design see Edler 2016.

While transformational, cross sectoral policies along the lines outlined by Arundel and Soete, with a stronger focus on demand conditions, did not feature strongly in policy debates for 2 decades, demand side policy play a transformative role in sectoral policies. First, in many sectoral policies a mix of the demand side measures mentioned above have been standard policy tools to push for certain sectoral policy solutions. Most notably, energy efficiency policies or energy management policies have long relied heavily on demand side measures (Geller et al., 2006; Gillingham et al., 2004; Neij, 2001; Nemet, 2008). In particular, demand side management involved a conscious and explicit mix of measures to support the diffusion of energy efficient technologies. This rather "old" approaches are worth remembering. With them, energy policy makers for example took decisions on what kinds of functional requirements they sought to pull in the market place for specific functions around different electrical appliances. They took the effort to analyse the specific supply and demand situations for those applications, co-generated specifications and then put together a demand side policy mix, often with public procurement as its core. This was very much about speed and scale, less about searching for the next generation of those appliances. Those policies were introduced with the main driver of pushing diffusion, and thus transforming the related functional systems. The evaluation of those bundles of measures was largely very positive, diffusion accelerated, energy consumption was reduced and supplier companies were further incentivised to innovate (Edler, 2016; Neij, 1998, 2001; Nemet, 2008; 2009).

With regard to transformation policies that aim for comprehensive change beyond diffusion of incremental innovation, the picture is more complex. While energy demand side policies as described above simply seek to speed up the diffusion of already existing efficient solutions or for isolated incremental innovations, the ambition and scope for innovation and transformation are often higher in transformative policies. The latter seek to support the formation and growth of markets for niches and subsequently the shift of entire regimes. As the transition literature has shown in the last two decades, for those broader, ambitious regime changes most often substantive institutional and behavioural change are needed, and complementary skills and further technologies may have to be developed (Köhler et al., 2017). Thus, policy for transformation - and within it demand side policy - is considerably more challenging than policy to support the diffusion of incremental innovations in largely stable market constellation.

A number of studies have analysed the role of policy, and policy mixes, for transformation of systems (Falcone et al., 2017; Rogge et al., 2020; Scordato et al., 2018). Figure 2 below is an example of one typology among a number of typologies to indicate the range of instruments mobilised for transformation. Note that here, demand policies play a major role, and ex post analyses of policy mixes for transformation has highlighted the complex interplay of supply and demand side measures. Public procurement is mentioned as one tool among many. In the following we will zoom into public procurement in the context of transformation.

Figure 2: One example of a policy mix for transformation

Table 2
Type-purpose instrument typology (with instrument examples).

	PRIMARY PURPOSE		
PRIMARY TYPE	Technology push	Demand pull	Systemic
Economic instruments	RD&D* grants and loans, tax incentives, state equity assistance	Subsidies, feed-in tariffs, trading systems, taxes, levies, deposit-refund-systems, public procurement, export credit guarantees	Tax and subsidy reforms, infrastructure provision, cooperative RD&D grants
Regulation	Patent law, intellectual property rights	Technology/performance standards, prohibition of products/practices, application constraints	Market design, grid access guarantee, priority feed-in, environmental liability law
Information	Professional training and qualification, entrepreneurship training, scientific workshops	Training on new technologies, rating and labelling programs, public information campaigns	Education system, thematic meetings, public debates, cooperative RD&D* programs, clusters

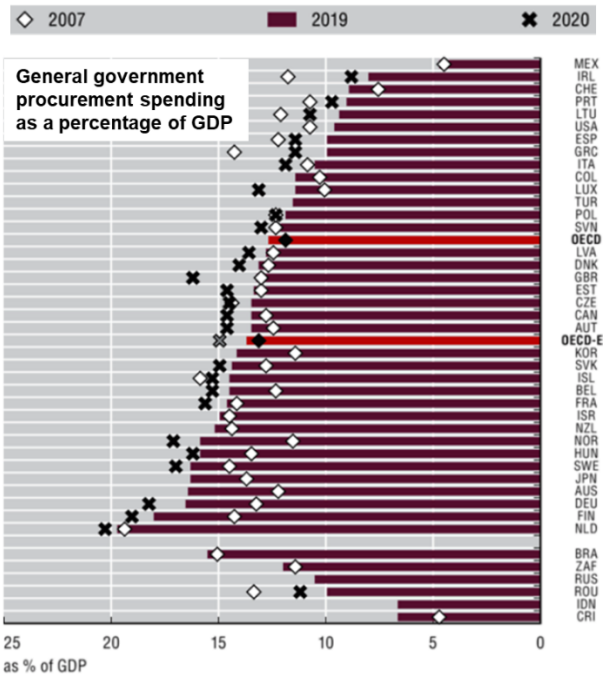
Source: Own elaboration (based on del Río González, 2009a; Edler and Georghiou, 2007; Hemmelskamp, 1999; Hufnagl, 2010; IEA, 2011b; Mowery, 1995; Rammer, 2009; Rennings et al., 2008; Smits and Kuhlmann, 2004; Sterner, 2000; Wieczorek and Hekkert, 2012).

Source: (Rogge and Reichardt, 2016)

4. Zooming into public procurement for transformation

To understand how public procurement can support transformation strategies we first need to remind us of the sheer volume of public procurement. Public procurement accounts on average for 15% of GDP in EU countries, and during the pandemic this figure has slightly increased (figure 3). In comparison, EU countries on average roughly spend 1% public money for R&D. The leverage for innovation is considerable.

Figure 3: Public Spending on procurement as % of GDP



Source: https://www.oecd-ilibrary.org/sites/18dc0c2d-en/index.html?itemId=/content/component/18dc0c2d-en

Second, we need to distinguish two established modes of public procurement that are both developed in order to serve purposes beyond the immediate need of the buying organisation: green, or sustainable, procurement and procurement of innovation. Following the EU Definition, green public procurement (GPP) is "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life-cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission, 2016).

Green public procurement has long been a tool for public policy organisation to support environmental sustainability (OECD, 2015; PricewaterhouseCoopers, 2009). In the last decade in particular, green public procurement has been expanded to sustainable public procurement (SPP), defined as a "process whereby public organisations meet their needs for goods, services, works and utilities in a way that achieves value for money on a whole lifecycle basis in terms of generating benefits not only to the organisation, but also to society and the economy, while significantly reducing negative impacts on the environment"[4] (UNEP, 2021). In principle, green or sustainable public procurement is about buying established products in the market place that meet certain sustainability standards. In terms of transformation, sustainable public procurement would accelerate the diffusion of products or services for which an initial market is already established and standards are set and performance criteria established. This is the major difference to the procurement of innovation.

Recently, the call to use GPP or SPP for transformation have become louder. The public procurement agenda has broadened now globally, or at least the ambition to mobilise public procurement for societal goals. Green public procurement has been established in many countries as a tool in environmental policy (Larrue, 2021; Peñate-Valentín et al., 2021; PricewaterhouseCoopers, 2009), according to a recent OECD survey, all 28 countries surveyed have a framework to mobilise public procurement for environmental purposes (OECD, 2021a). . At UN level, it is now seen as one critical instrument to drive the SDGs (Gutiérrez-Goiria and Amiano-Bonatxea, 2022). While the UN logic is not one of concrete missions or concrete transformation pathways, it nevertheless indicates a number of very concrete sub-goals and how public procurement can be mobilised to achieve them (Gutiérrez-Goiria and Amiano-Bonatxea, 2022).

However, while the authors recognise the potential to mobilise SPP to "really make progress worthy of the title of the UN declaration (Transforming our world)" and to "promote development with a local and socially responsible vision", they concede that the instrument is not given enough importance (ibd., p. 13). While a number of good practice exist (e.g. Green Purchasing Network Malaysia, 2017; UNEP, 2021), national governments are far from mobilising SPP for transformation (Gutiérrez-Goiria and Amiano-Bonatxea, 2022; Hansen, 2020). GPP and SPP do not live up to their potential. Taking the example of Germany, we see that green public procurement lacks ambition. A number of encouraging individual examples cannot disguise the fact that the role of GPP and SPP in the sustainability strategy of the country is minor. In fact, the examples mentioned are recycled paper and modernising the vehicle fleets, without any clear target or push for next generation technologies. Action plans are focused on support measures, rather than procurement strategies, let alone innovative procurement

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4 UNEP - UN Environment Programme (2022) https://www.unep.org/explore-topics/resource-efficiency/what-we-do/sustainable-consumption-and-production-policies, accessed September 9.

(Bundesregierung, 2021) [5]. Overall, across the world, the United Nations Environmental Programme (UNEP) has conceded, it is necessary to "wake up the sleeping giant" (UNEP 2021).

A range of barriers appear to inhibit a broader roll out of GPP or SPP, at the individual, organisational and political level. Those include lack of integrating GPP and SPP in broader policy strategies and high level managerial commitment, higher transaction cost of purchasing and of using sustainable products, higher purchasing costs, lack of expertise and general awareness (Brammer and Walker, 2011; Milios, 2018; Ntsondé and Aggeri, 2021; Sönnichsen and Clement, 2020).

As stated above, public procurement of innovation (PPI) is the purchase of a product or service by a public organisation that is new to the organisation. It is important to distinguish different modes for the sake of conceptual clarity. Public procurement of innovation may be targeted at products and services that

(a) may be already developed but have not found yet a first buyer or sufficient number of users to trigger market formation, what Edquist and Zabala-Iturriagagoitia (2012) have labelled diffusion oriented or adaptive procurement (APPI),

(b) are inspired by the needs formulated by the buying organisation and thus are developed on demand, with the expectation that a market for it can be developed.

Importantly, for the latter two specific modes have been developed and tested in recent years. First, with so called "*functional procurement*" (Edquist et al., 2015; Edquist and Zabala-Iturriagagoitia, 2020) a buying organisation specifies functionalities which go beyond what existing products or services can perform. The necessity to innovate is thus built into the specification, while the public body needs to develop a conscious process to define the articulation of its need, or together with the public define the articulation of the need of the public. If complex new functionalities are requested that cannot be formulated easily by buying organisations, specific *pre-commercial procurement* (PCP) schemes can be applied (Rigby, 2016). Those schemes allow a step - wise competition for innovative solutions, whereby first multiple R&D service contracts are tendered with various competing providers. This may happen in several rounds, with decreasing number of competitors. The result of this step wise competition is then the starting point for a regular procurement.[6] This approach furthers experimentation, interactive learning between buyer and suppliers, and is a means to reduce

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5 The author has presented some analysis of the German procurement practice to the German Council for Sustainability in September 2021, with the Council being concerned about the lack of ambition of public procurement for sustainability transformations.

6 In a yet more holistic approach, the innovation partnership, the buying organisation does not have to tender for a regular procurement after the competition, but can assign the final procurement contract to the winner of the competition right away.

uncertainties and risks (Rigby, 2016). Both schemes offer processes to articulate demand, to engage in experimentation and learning, to support niche creation in combination with the uptake of an early market.

However, public procurement has not fulfilled its potential as an enabler for markets for innovations. Both buying something that is new for an organisation and buying a market novelty face a whole range of institutional, organisational and political challenges. Organisationally, there is fragmentation of there is poor division of labour. In the context of innovation policy, defining PPI as a tool to support the innovative activity of firms and : lack of conviction and backing at the leadership level, general lack of awareness, inappropriate incentive structures for those responsible (risk aversion) and for those affected internally (learning costs), lack of technical knowledge about possible procurement procedures and supplier markets, poor interaction between public buyers and the supply side and limited understanding of life-cycle cost and benefit considerations (Edquist and Zabala-Iturriagagoitia, 2020; Georghiou et al., 2014; Obwegeser and Müller, 2018; Rainville, 2021; Uyarra et al., 2014)

Strangely, public procurement of innovation in its various variations has not been analysed empirically very much as yet. This is true already for the analytical frame of strategic niche management, which in a way represented a first kind of deliberate transformation policy attempt in the late 1990 (Kemp et al., 1998). This concept postulated that it is not enough so support the generation of a technological innovation that is socially desirable. Rather, the condition for a market to emerge, the institutional and behavioral changes needed, need to be supported. As those technologies are in their infancy with no or little demand, the creation of learning opportunities and market expectations is critical. In strategic niche management, the state has multiple roles to play beyond supply sided subsidies. Interestingly, although creation of positive market expectations supported by the state are defined to be important, the original approaches of niche management did not develop the potential of public procurement of innovation strongly.

As to existing examples, Palm and Backman (2017) analyse two Swedish municipalities which sought to speed up transformation of the automotive transport system by supporting the procurement of electric vehicles. They mobilised the relative purchasing power of the municipalities to make a difference in the market and they understood that a short term financial loss had to be accepted in order support the broader goal of transformation. The strategy in both municipalities was to let the municipal organization act as role models, create buying power and develop a second-hand market for EVs. The strategy to speed up diffusion within the municipal organization was through information and test-driving and in dialogue with the administration solve problems that arise. A potential improvement of the diffusion process would be to find ways to share the extra cost of an EV. The authors also point to the fact that the need to bundle demand, to create a bigger incentive for suppliers and to speed up diffusion is highly challenging. Despite shared goals, the routines, financial and political framework

conditions and the acceptance of paying a higher price differs between different procuring agencies and municipalities.

Further examples with explicit focus on public procurement of innovation and transformation is presented by Edquist and Zabala-Iturriagagoitia (2020) and Wesseling and Edquist (2018). Edquist and Zabala-Iturriagagoitia (2020) They offer a number of case studies that distinguish different contexts and purposes of public procurement to highlight various ways in which public procurement can contribute to solving societal problems. The value of their approach is the differentiation of procurement modes and a detailed analyse of concrete procurement practice. They did not, however, put their analysis in the broader frame of transformation and market acceleration. Wesseling and Edquist (2018) made this move. They put public procurement firmly in the context of transformation. Using one specific case study, they developed tentative suggestions as to multiple benefits of public procurement in the context of transformation needs. Recently, Flanagan et al. (2022) discuss the role of public procurement of innovation as a regional industrial policy tool that could be mobilised to support societal challenges at the regional level.

Despite those isolated examples, in the literature on policies for transformation in general, public procurement does not play a prominent role, both in the academic conceptualisation and in the empirical analysis and findings. It appears that the transition literature has not focused on the role of the public sector as buyer for transformative and solution oriented technologies. This is mirrored in an empirical overview of mission oriented policies in OECD countries (OECD, 2021b) where demand side measures are "the weakest point" (ibid, p. 81) and public procurement is only mentioned in passing in very few selected examples.

It is worth noting transition studies who look at procurement, but do not exploit it sufficiently. Kivimaa and Kern (2016) develop a framework to understand transition in low energy fields in the UK and Finland. They mobilise and extend the Technological Innovation Systems (TIS) framework and apply the policy mix approach across all relevant policy domains. They explore the build-up of a functional TIS around a transformational technology and processes to build up and support a new niche and to support the destruction of the incumbent regime (ibid., p. 208-209). Their policy mix approach then mirrors policies and instruments against the various TIS functions and in relation to steps towards destabilisation: (1) Knowledge creation and diffusion, (2) market formation, (3) price performance improvements, (4) entrepreneurial experimentation, (5) resource mobilisation, (6) support form powerful groups and legitimation, (7) influence on the direction of search. They find a wide range of instruments applied in both countries, with some focus on niche creation rather than destabilisation. The main point, however, is that there is no mentioning of systematic, deliberate inclusion of procurement policies. Rather procurement is mentioned only as a complementary generic policy tool supporting entrepreneurial experimentation (ibid., p. 212). Operationally, this is limited to energy efficiency guidelines for procurement. Similarly, (Kivimaa and Vir-

kamäki, 2014) analyse the transition policies in transportation in Finland. They also apply the TIS framework and match it with policy instruments. Again, public procurement plays a minor role, mentioned only a few times in passing without any further elaboration.

The example of the wood based bioeconomy that is presented by Purkus et al. (2018) is a further case in point. Again using the TIS framework, they analyse policies to support those functions. They find that improving demand conditions can accelerate the diffusion of innovations that are conducive to the wood based bio-economy. They concede the critical role the public sector could play in encouraging wood as a construction material in public buildings through public procurement of innovation. However, in their own conceptualisation they reduce PPI to the market formation function while empirically, they do not find public procurement as a major policy approach at all.

A final example is an analysis of the strategic innovation programme in Sweden. Grillitsch et al. (2019) show that even a novel, systemic and transformation oriented programme did not manage to re-balance the relationship between demand and supply side measures, and public procurement for innovation has not been a major element in implementing the programme. As for procurement, this programme focused on the competencies of procuring organisations, neglecting the deeper institutional framework conditions and governance challenges that go far beyond competencies and capabilities. In their policy implications, while talking of the need for institutional change and entrepreneurship, the authors do not really reflect on how to support the demand side and what specific role the state may have to play, including through public procurement (Grillitsch et al., 2019, p. 1058). And their case study confirms the lack of proper market creation focus despite the broader claims.

This neglect of the potential and effects of public procurement of innovation for broader diffusion in transformation studies is also apparent in a synthesis of the evaluation of public procurement as an *innovation policy tool* a couple of years ago (Uyarra, 2016). The effects of public procurement on the diffusion of innovation more broadly are hardly explored. This is of note as the literature on the evaluation of demand side measures more broadly (for an overview see Edler et al., 2016) is rich on the question how demand side measures *in general* can boost diffusion. However, public procurement of innovation, while having become increasingly important as a an instrument to improve public services and boost innovation activity in the economy (Edquist, 2019; Inter-American Development Bank, 2019; Obwegeser and Müller, 2018; OECD, 2011), it is not sufficiently recognised as a catalyst for broader market formation and diffusion.

This finding is puzzling. Policy and policy mix analyses of transformation, be it as strategic niche or transition management, in the tradition of MLP or in the TIS framework, puts more emphasis on the demand side then traditional innovation studies in the last 2-3 decades. In doing so, transition studies differentiate demand side policies more

than innovation studies. Due to the nature of diverse technological systems and economic sectors as well as the focus on diffusion we see an extended set of tools as compared to the traditional innovation policy tool box (Edler et al., 2016; Edler and Georghiou, 2007). This encompasses feed-in tariffs for electricity from renewable energy or deposit refund systems (see figure 2 above). Still, the enormous power of the public purse is not high on the agenda.

This is striking, as market formation is critical, and as in many markets the lead of the public sector would make a substantive immediate and a symbolic indirect difference. The main point here is the lack of comprehensive transformation strategies that design policy mixes and assign public procurement a role in market formation. If policy making, at all levels, had those strategies in place and if public procurement was a recognised tool to support transformation, taken really seriously for transition policy, support measures and positive feedback loops would be in place that would incentivise public organisations to adjust their procurement practice.

Against this background, we finish this chapter with some first thoughts towards a conceptualisation of *transformational public procurement* that would combine logics of green (GPP), sustainable public procurement (SPP) and public procurement of innovation (PPI) with its various modes, i.e. adaptive (APPI), pre-commercial (PCP), and functional procurement.

5. Public procurement as a tool for transformation - towards a conceptualisation

To conceptualise procurement for transformation, we build on an established, simplified, dichotomy of transformational policies, distinguishing between the state as initiator of transitions and the state as supporting emergent transformation, in combination with the relative size of public demand (see table 1 below). In a narrowly defined mission oriented innovation policy approach prominent throughout the EU and OECD (Fisher et al., 2018; Larrue, 2021; Mazzucato, 2018) it is the state, through various means of consensus finding and participation, who initiates and governs missions. In this approach public procurement of innovation and even pre-commercial procurement of innovation can have critical roles. Mission oriented innovation policies are, after all, still innovation policies. While this focus in itself can be problematic, for the purpose of this article it is a reflection of the fact that missions are selected for which innovation, most often technological innovations, are deemed to be essential. The development and deployment of innovation, most often technological innovation is the key. Therefore, it is highly likely that in many of those missions the clear articulation of needs, the investment in innovation development based on this articulation and its first use are essential. Therefore, pre-commercial public procurement or functional procurement can be major approaches here. Both necessitate an explicit process to formulate a need. Both also lead to experimentation and variety. While creating choice, they lower uncertainty and reduce risk for the first user. Further both ap-

proaches provide the opportunity for co-generation of solutions with suppliers and joint learning.[7] The elaborated, inter-active process of PCP or functional procurement also increase the likelihood of developing e necessary skills or change of social practice (social innovation) at the side of the users. PCP and functional procurement can thus play a major role both in developing solutions for missions and in supporting the roll out in both public and private markets. This is particular obvious in constellations in which the public sector has a considerable share of the market. However, even in markets with a minor share of public demand, especially for complex solutions PCP and functional procurement can result in signaling and demonstration effects, support the legitimacy of new solutions and help to improve performance.

In a second mode of transformational policies, policy supports transformations that are emerging, that have emanated through societal dynamics (Molas-Gallart et al., 2020; Schot and Steinmueller, 2018). Here, very often new needs have already been expressed and first niche solutions have already been created. The role of public procurement would much more be focused on diffusion, on supporting market enlargement of existing innovations. This would by default call for broad diffusion procurement such as green or sustainable procurement. However, absorptive public procurement of a novelty that struggles to find first buyers (APPI) can play a role to absorb new niche solutions and to also make the public sector transform itself.

Table 1: The role of public procurement in transformational policies

		Relative (potential) market share of public demand *	
		Minor	Major (or catalyst for private market)
Transformation	emergent	Limited procurement action (regulation, private demand support actions)	SPP, GPP (APPI) acceleration of early markets
	initiated by state (missions)	If possible isolated demonstration projects and early use	APPI, PPC, support demand driven creation of innovation, lead market

Further, different forms of public procurement can support important niche management function (Kemp et al., 1998), such as joint articulation of needs into demands (through functional procurement and PCP), learning between users, producers and those affected (especially PCP), identifying user side bottlenecks in terms of training and awareness (PPI) and finally the creation of a niche or "protected space" (ibid 186) for a first application, and subsequent signaling of concrete market potential to suppliers and scaling up through broad diffusion (all forms of procurement).

7 Edquist and Zabala-Iturriagagoitia (2020). have strongly highlighted the importance of interactive learning in public procurement of innovation.

We can further broaden this functional conceptualisaion of procurement by mobilising the Technological Innovation Systems framework. As shown above, this framework has been used to analyse not only system change, but also policies to support system change. It is focused on system change around certain key technologies for which by default public procurement can be highly relevant. Table 2 below indicates seven functions of technological innovation systems. This stylised functional differentiation is an eye opener as to the various roles public procurement can play for the emergence or deliberate change of a technological system. It further shows again, that different kinds of public procurement serve different functions. Public procurement has a major role in all of those functions, not only in the most obvious, i.e. market formation. Rather, across all functions it can support major knowledge coordination mechanisms and help reduce market risks and thus increase legitimacy. Analysing public procurement through an evolutionary lens, Bleda and Chicot (2020) have shown how different stages of the procurement process support, in principle, all necessary knowledge coordination function to create *and* diffuse innovation. Importantly, they highlight the importance of early phases of the innovation procurement process - for which especially the PCP scheme is designed - for the adoption and diffusion of innovations

Table 2: the potential of strategic public procurement as part of a transition policy mix.

TIS functions[8]	**GPP**	**RPPI**	**PCP***
Knowledge creation and diffusion		**X**	**XX**
Market formation	**X**	**XX**	**X**
Price performance improvements	**XX**	**XXX**	
Entrepreneurial experimentation		**X**	**XX**
Financial and human resource mobilisation			**X**
Support from powerful groups and legitimation	**XX**	**XX**	**X**
Influence on the direction of search		**X**	**XXX**

* and functional procurement

We can argue that differentiating various basic forms of public procurement can further sharpen the application of public procurement for the support of system transformation. Green public procurement would very much contribute to price performance improvements through enabling fast scaling of innovations and could mobilise support of public organisations to signal the value of an innovation. Pre-commercial or functional procurement, at the other end of the scale, would in particular support the direction of search as it asks for specific functionalities to be provided in line with transformations and missions that are to be supported, and it would mobilise stakeholders to turn to specific problems. It allows entrepreneurial experimentation as it reduces risk and offers an initial market. And it would in particular support joint

8 This version of the functions is based on Kivimaa and Kern (2016).

knowledge production and learning as a basis for adoption and diffusion in later stages.

6. Conclusion: some basic policy considerations

This chapter has shown the importance of demand conditions and of the lever of public demand when it comes to a major condition for transformation, i.e. to ask for need driven innovations, to create early markets (niches), to support learning conditions and to subsequently provide conditions for diffusion in public and subsequently private markets. Transformation policy and transition scholars have long somewhat neglected the enormous lever of public procurement as learning, coordination and diffusion mechanisms. Beyond a few noteworthy exceptions public procurement has mainly been mentioned as one of many policy instruments, with recommendations to buy more and better.

To conclude, we do not want to outline all the various recommendations to better design, implement and support individual green public procurement or innovation procurement processes. The major institutional problems are well known and have been listed above. Meanwhile, there are numerous guidelines and handbooks available to support practice in public organisations[9], and both for green public procurement and for innovation procurement directives and legal approaches have been developed that strongly encourage both processes[10], and number of policy tools have been devised to tackle those obstacles (Georghiou et al., 2014) , including defining new roles for intermediation to support all stages in all types of public procurement (Edler and Yeow, 2016; Rainville, 2021). All those individual measures to tackle bottlenecks in innovation and green procurement do not need repeating here.

The main point is this: as states, at all levels, now increasingly seek to support transformation in a concerted and holistic effort, they need to develop transformative procurement strategies defined as the ensemble of all procurement approaches (GPP, SPP, APPI and PCP/functional procurement) that start of and accelerate transformation. This chapter has tried to outline the various ways in which procurement can lever transformation. The effects of intelligent sustainable and innovation procure-

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9 For innovation procurement see e.g. https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/innovation-procurement_en.htm; https://procure2innovate.eu/fileadmin/user_upload/Documents/KOINNO_PublicProcurementofInnovation.pdf , for green or sustainble procurement see https://sustainable-procurement.org/fileadmin/user_upload/layout/Documents/Buying-Green-Handbook-3rd-Edition.pdf

10 However, some legal scholars argue that the existing framework for green public procurement still leaves too much uncertainty for procuring organisations. and ask for a more mandatory approach (Melon 2020).

ment on the supply side, the demand side and thus on transformation of systems has been demonstrated. This win-win dynamics need to be exploited much more systematically.

A change of mind-set: factoring in societal benefits

What is missing, therefor, is a change in mind set. Currently, the cost - benefit ratio of innovations are calculated for the buying organisation. In more advanced approaches, this is done with a life cycle cost approach, thereby factoring in future savings through buying a more expensive innovation now. However, this still does not capture the wider benefits of buying an innovation. First, there are additional future benefits in better services that may not materialise in cost savings, but in higher satisfaction of citizens or civil servants. Those soft benefits are hard to factor in. More importantly, however, any public buying organisation has to limit its cost-benefit considerations to its own organisation. We have seen, however, that there are wider systemic benefits through multiple feedback loops. This is the very motivation for considering public procurement as an innovation policy too. Those wider benefits, societal cost savings or broader benefits for society, be it economic or in terms of sustainability, currently cannot be factored into the consideration of a public buying organisation. They are often very indirect and hard to comprehend, and rest on a number of ex ante assumptions. Thus to conduct PPI beyond the immediate need of the buying organisation is highly challenging in the context of innovation or transformational policy. Nevertheless, a step change towards a societal cost-benefit analysis in transformational pubic procurement is needed.

Additionally, if public procurement shall turn into a means for transformative policy, and not only a means to improve the ability of the public sector to perform its immediate task, an integration of procurement strategies into broader policies would be needed, going far beyond those existing which support individual organisations and their internal processes. Additional support would have to help justify the purchase of innovations within the organisation and vis-à-vis the wider public, cover some of the additional costs as well as risks, support good practice across the public sector. In short, public policy for transformation needs to co-fund and systematically support transformational public procurement. Beyond some - limited - mobilisation of green public procurement for environmental policy, this link hardly exists.

Creating critical mass

Supporting market creation through procurement is about mobilising actors and creating opportunities for scale. Tested procurement procedures such as co-operative procurement and catalytic procurement (Edquist and Zabala-Iturriagagoitia, 2020; Flanagan et al., 2022; Hommen and Rolfstam, 2008; Rolfstam, 2006) can support those dynamics. In co-operative procurement buying organisations cooperate to bundle demand and approach suppliers together, whereas in catalytic procurement public or-

ganisations buy an innovation with the main or explicit additional aim to catalyse buying by other (Rolfstam, 2006). In the former case, public organisations share a need and realise an increased incentive for suppliers to invest in innovation by bundling their demand. In the latter case, public organisations have "intrinsic needs" for the innovation. But here they also support broader societal needs, the satisfaction of which is, for various reasons, slow or hampered because of a lack of adoption and diffusion of innovation. In both cases, the procurement process needs coordination between public organisations as well as between public organisations and firms and citizens.

Mobilising place based dynamics, scaling up and scaling out

A further dimension to consider for the issue of public procurement for transformation is place and scale. There is emerging literature on the value of missions and solution oriented industrial policy at regional or city-regional level (Flanagan et al., 2022). This starts form the assumption that social acceptance and appropriateness of innovative solutions are often highly context specific. This insight is in itself not novel. Already in 2002, Meyer-Krahmer (2002) has highlighted geographical proximity, the purposeful networking of regional actors as the best level of experimentation with novel solutions. Coordination of actors, from the articulation of needs to the specification of solutions, their testing and roll out, is easier at regional or city-regional level. Recently, Zabala-Iturriagagoitia (2022) has demonstrated, how public procurement can support learning at regional level, both on the supply and the demand side and can be a means for regional growth strategies that are problem oriented. In a similar vein, Flanagan et al. (2022) conceptualise market formation processes as a result of interactive, networked framing and valuation processes that benefit from local proximity, joint exposure to problems and the prospect of concrete solutions to problems defined together and thus a higher level of social acceptance. They conclude that regional industrial policy, rather than oriented towards industrial competitiveness should thus be problem-oriented, to support a positive relation between economic development and problem solving.

In this line of reasoning, public procurement of innovation can be a means for the definition and deployment of place based solutions with high social acceptance. Problem-oriented industrial policy that aims at market formation can be supported by public procurement of innovative solutions to serve economic and societal needs with a high level of legitimacy. The more interactive and transparent this process is organised, the better citizens, civil servants, and suppliers are engaged, the higher the likelihood of problem specific solutions being developed and rolled out.

However, place specific solutions are exactly that, place specific. Similar problems might be tackled differently in different places or framed differently in different places. Because of the idiosnycracies in each region or city-region, one can argue, scaling up in the sense of transferring certain problem definitions and solution and their implemen-

tation mode in other contexts is not likely to yield success easily. The more contextualised a problem and a solution is, the harder it is to transfer between regions.

Therefore, cross-place coordination, learning and networking for scaling up are to be mobilised. For this coordination to happen, a range of options are available. For co-operative or coordinated procurement, network of public organisations can be activated. One concrete example is the Accelerating Carbon Neutrality Public Procurement project funded by the European Commission, bringing together six European cities and public procurement organisation to explore PCP schemes (ICLEI, 2022), enlarging the network with a number of further preferred partners to engage and learn. The idea here is to conduct joint PCP projects that then lead to further purchasing by those preferred partners and potentially other cities. This thus is a combination of co-operative and catalytic procurement to develop targeted sustainable AI solutions and roll them out quickly.

A further example with a high potential for co-operative and catalytical strategic procurement is the covenant of mayor for climate and energy (Diercks et al., 2019). This network aims at a "scaled implementation for urban innovation" (ICLEI 2015, quoted in Diercks et al 2019) as part of a comprehensive, interactive transformation strategies within and across cities in a "learning, going, using" mode (Diercks et al., 2019) with public organisations at its heart.

Towards a triple win dynamics

This chapter has tried to argue and show that more attention to the demand side is critical for transformational policies. Ample empirical evidence exists as to the positive dynamics of advance public purchasing beyond the needs of the buying organisation. The positive dynamics that can be set in motion are threefold and intertwined, in sum pushing strongly for transformation. Innovations are induced and markets created and accelerated for innovations that are conducive for transformations and thus societal benefit, supplying industries are incentivised to invest more and can realise lead market benefits and finally public organisations improve their performance and transformation contribution. Given the enormous power of the public purse, and the enormity of our societal challenges, and given that we - in principle - know how to overcome the institutional challenges of complex procurement procedures, it is indeed about time to "wake up the sleeping giant" (UNEP 2021).

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