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Recommendations for action to improve SMEs' access across Europe to Advanced Technology Centres

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Section 1

1. Introduction

The adoption of Advanced Technologies by companies is seen as a prerequisite for the modernisation of the European industry and the lasting creation of growth and jobs in the EU[1]. The adoption of Advanced Technologies allows to move towards customised high mix, low volume manufacturing, increasing energy efficiency as well as productivity[2]. These are pivotal factors in achieving long-term competitiveness on the market and preserving the natural environment for subsequent generations. Advanced Technologies are increasingly understood as a key driver for the EU economy as they will increase European industries' productivity, agility, and flexibility, keeping up competitive advantage against competitors from emerging countries which are lowering the quality/precision gap[3]. Although the European economy represents a world class research capacity, it still faces important challenges, many of them exacerbated during the COVID19 crisis, such as a lower private investment in research and development (R&D) compared to its largest competitors (e.g. US), the uneven distribution of R&D investments, or the insufficient exploitation of the potential of the single market[4].

At macro level, Advanced Technologies are essential to ensure Europe´s industrial competitiveness, growth and job creation. At the level of companies, the drivers for the adoption of Advanced Technologies go along similar lines, including the improvement of quality of products and services, the improvement of the productivity and efficacy and the reduction of production costs and lead times[5]. More recently, the Advanced Technologies for Industry (ATI) survey[6] showed that the three main drivers for the uptake of these technologies are the interest in fostering the company´s performance (EBITDA, revenues), increasing efficiency and/or reducing costs of processes and operations, and improving the ability to innovate products, services and programmes. However, in spite of these incentives, there is a strong need to accelerate the uptake of these technologies, in particular amongst SMEs. These companies constitute a vital part of the European economic and industrial tissue and, at the same time, face the biggest challenges for the adoption of these technologies.

Currently, many European firms do not yet have sufficient capacities to adopt Advanced Technologies as they lack know-how, human capital as well as organisational and managerial capacity. There is a need for a better Advanced Technologies ecosystem that supports the building of such capacities among SMEs. Also, the study on Access of SMEs to KETs technology centres[7] indicated the existence of mismatches between the demand (SMEs) and the supply side (technology centres).

This report presents the recommendations for action to improve SMEs' access across Europe to ATI technology centres. The recommendations presented in this report are based on the analysis of the information gathered through the following research avenues:

- Data analysis of the technology centres identified within the Advanced Technologies for Industry (ATI) project.
- Desk research on ongoing initiatives at EU, national and regional level concerning the access of SMEs to technology centres.
- The feedback gathered in the workshop 'Moving from technology-based networks to value chain-based networks: how to improve the effectiveness of cross-border networks of ATI

[1] https://ec.europa.eu/growth/industry/policy/advanced-technologies_en
[2] World Economic Forum White Paper (2017). Technology and Innovation for the Future of Production: Accelerating Value Creation.
[3] Izsak, K. et al. (2021). EU Report - Technological trends and policies, European Commission.
[4] World Economic Forum White Paper (2019). Innovate Europe Competing for Global Innovation Leadership
[5] Kroll at al (2016). An analysis of drivers, barriers and readiness factors of EU companies for adopting advanced manufacturing products and technologies. European Commission. https://op.europa.eu/en/publication-detail/-/publication/29e4d66e-dd4a-11e6-ad7c-01aa75ed71a1
[6] This survey includes a series of themes around the uptake of Advanced Technologies, such as their level of adoption, industry-specific use cases, as well as the digital transformation drivers that are sustained by these technologies.
[7] https://ati.ec.europa.eu/reports/eu-reports/study-access-smes-kets-technological-centres

technology centres?' that took place on 24 September 2020, organised within the Advanced Technologies for Industry (ATI) project[8].

This report presents an overview of the roles that technology centres (TC) play with regards to SMEs and the needs of these companies with respect to technology centres. Second, it presents a gap analysis of the available offer for SMEs in Europe. Finally, it presents a series of recommendations for action to improve SMEs´ access across Europe to ATI TC.

Definitions

Advanced Technologies (AT) comprise several technologies that are key for the European industry to maintain and increase their levels of innovation and competitiveness.

The following 16 Advanced Technologies have been identified in the ATI project:

- Advanced Manufacturing Technology
- Advanced Materials
- Artificial Intelligence
- Augmented and Virtual Reality
- Big Data
- Blockchain
- Cloud Computing
- Connectivity
- Industrial Biotechnology
- Internet of Things
- Micro- and Nanoelectronics
- Mobility
- Nanotechnology
- Photonics
- Robotics
- Security

ATI technology centres (TC) are defined as public or private organisations carrying out applied research and close-to-market innovation (Technology Readiness Levels TRL 3 to 8, not necessarily the whole range but including at least one TRL >5) in Advanced Technologies.

Networks of technology centres refer to networks providing technology facilities, services and expertise to SMEs in the field of AT. The network acts as a single-entry point ('one-stop shop') for SMEs willing to get access to the technology services and facilities available from the technology centres in the network.

[8]The report presenting the conclusions of the workshop is available here : https://ati.ec.europa.eu/events/moving-technology-based-networks-value-chain-based-networks-how-improve-effectiveness-cross

Section 2

2. Technology centres and their relevance for SMEs

ATI technology centres are defined as public or private organisations carrying out applied research and close-to-market innovation (Technology Readiness Levels TRL 3 to 8) in Advanced Technologies. These centres have the required expertise, infrastructure and equipment to help SMEs to develop their own R&D projects and support them in the uptake of new technologies that can improve their sustainability and competitiveness. The European landscape of technology centres offers a very rich picture of technology expertise and infrastructure which is not always known by SMEs that could benefit the most from interacting with them.

At EU level, a series of initiatives include technology centres as main actors. The role of technology centres in these initiatives focuses on the maximisation of the services these entities can provide to industry as key actors in the innovation process. The table below shows a selection of relevant initiatives including technology centres, as well as an indication of their main objective, technology focus, services, degree of maturity and the types of organisations that are involved in them. While all these initiatives share the objective of better connecting industry to technology centres and their expertise, they do so through different configurations and mechanisms[9]:

- **Digital Innovation Hubs (DIHs)** are ecosystems that consist of SMEs, large industries, start-ups, researchers, accelerators and investors. They aim to create the best conditions for long-term business success for all involved[10]. The S3 website defines DIHs as "one-stop-shops that help companies to become more competitive with regard to their business/production processes, products or services using digital technologies"[11]. The DIHs catalogue is presented as a 'yellow pages' of hubs that comply with the following 4 criteria: 1) Be part of a regional, national or European policy initiative to digitise the industry; 2) Be a non-profit organisation; 3) Have a physical presence in the region and present an updated website clearly explaining the DIHs' activities and services provided related to the digital transformation of SMEs/Midcaps or industrial sectors currently insufficiently taking up digital technologies; and 4) Have at least 3 examples of how the DIH has helped a company with their digital transformation, referring to publicly available information. The Digital Europe Programme will increase the capacities of selected DIHs to cover activities with a clear European added value with a focus on the networking between hubs and promoting transfer of expertise. The list of DIHs to be supported by the Digital Europe Programme will be based on a selection of hubs made by Member States (and referred to as European Digital Innovation Hubs, EDIHs).
- **ATI technology centres** "help SMEs cross the 'Valley of Death' and go from lab to market to develop and produce new AT-based products. They help companies reduce the time-to-market for new innovation ideas[12]". ATI technology centres are public or private organisations carrying out applied research and close-to-market innovation (Technology Readiness Levels TRL 3 to 8, not necessarily the whole range) in Advanced Technologies for Industry. Technology centres provide technology-related services to SMEs and they need to comply with three qualitative criteria: 1) To provide services to industry and SMEs; 2) To be active in at least one Key Enabling Technology; and 3) To be active in the higher Technology Readiness Levels (TRL) - have activities in TRL5, TRL6, TRL 7 or TRL 8. The centres need to comply with a set of quantitative criteria as well to show that they have a sufficiently solid background in the provision of services to industry and to SMEs[13]. These criteria are based on the technology centres´ self-declaration.

[9] More information on recent initiatives at EU, national and regional level including technology centres is available in the Commission staff working document on Technology Infrastructures here: https://op.europa.eu/s/ovdy
[10] Joint Research Centre (2018). Digital Innovation Hubs and Smart Specialisation Strategies. http://publications.jrc.ec.europa.eu/repository/handle/JRC113111
[11] http://s3platform.jrc.ec.europa.eu/digital-innovation-hubs
[12] https://ati.ec.europa.eu/technology-centre/mapping
[13] Technology Centres have to comply with at least 2 additional quantitative criteria among the following 4:
- More than 10 projects with SMEs in the last two years.

- **Open Innovation Test Beds (OITB)** refer to sets of "entities, established in at least three Member States or Associated Countries, providing common access to physical facilities, capabilities and services required for the development, testing and upscaling of nanotechnology and advanced materials in industrial environments". The objective of the Open Innovation Test Beds is to advance from validation in a laboratory (TRL 4) to prototypes in industrial environments (TRL 7) projects in the fields of nanotechnologies and advanced materials. One of the main features of these projects is that "any interested user, from Europe and beyond, can access the test beds' facilities, capabilities and services independently of whether this user is part of an Open Innovation Test Beds Horizon 2020 consortium or not"[14]. Access to these tests beds is given at "fair conditions and pricing and with transparent and mutual obligations with regards to, for instance, security, safety and intellectual property rights". The users of these tests beds can be individuals, teams and institutions from public and private sectors, including SMEs[15].

Table 1: Initiatives at EU level where technology centres play a role in the provision of services to SMEs

Dimensions	ATI Technology centres	Digital Innovation Hubs	Open test beds
Main purpose	Direct access to Advanced Technologies related services for the industry	Ecosystem building (Informal) one-stop shop access	Formal one-stop shop access
Technological focus	Advanced Technologies	Digital technologies	Nanotechnologies and Advanced Materials
Services	Only technologically related services	Wide range of services: technological services, Intellectual Property Rights (IPR), internationalisation, business development, etc.	Mostly technologically related services
Maturity	- Operating - TRL5- TRL 8	- Operating - In principle, all TRL are accepted	- Operating - TRL4-TRL7
Type of actors involved	Only technology centres	Only non-profit organisations, but any type of organisation (clusters, regional agencies, technology organisations, universities, etc).	Only technology centres ('physical facilities')

Source: IDEA Consult

In addition to this landscape of EU initiatives, there are a series of initiatives funded under the European Commission´s successive framework programmes (e.g. FP7, H2020) that have been established over the years with similar aims and, often, with a more specific technological approach. An example of this type of initiative is the Pilots4U Database[16] which maps all existing open access pilot and demo-infrastructures across Europe, with the aim of creating one visible and easily accessible network for the European bioeconomy to help companies and research institutions operating in the bio-economy sector to gain easier access to testing facilities. Some of these initiatives have benefitted from successive forms of public support and are now well-known in their respective communities. An example is ACTPHAST4.0 and ACTPHAST4R, two initiatives focusing on photonics that are the result of the experience acquired over time in previous projects (ACTPHAST and ACTMOST)[17].

At national and regional level, there is also a burgeoning landscape of initiatives trying to foster the access of industry to technology centres. There is, however, a large heterogeneity in the ways through which this access is promoted. Some initiatives focus on facilitating the financial support[18], others look

- More than 2 major investments in equipment for close-to-market R&D activities with industry in the last 3 years. The Centre should provide a short description of these investments (type, functionality and investment amount)
- At least 15% from industrial funding in the total annual funding of the Centre in the last 2 years.
- At least 7% from projects with SMEs in the total turnover of the Centre in the last 2 years

[14] https://ec.europa.eu/research/participants/data/ref/h2020/other/guides_for_applicants/h2020-im-ac-innotestbeds-18-20_en.pdf
[15] ibid
[16] https://biopilots4u.eu/database
[17] https://www.actphast.eu/en
[18] See, for instance, the innovation vouchers system set up by Tampere Region (Finland).

at the establishment of long-lasting networks of technology centres, while others put more emphasis on facilitating the access of specific types of companies to technology centres by developing methodologies that facilitate this access[19].

This report provides recommendations on the mechanisms through which the access of SMEs to technology centres and their services can be fostered. These mechanisms are heavily dependent on the type of SMEs as not all of them face the same challenges and needs. The following section analyses the needs of different types of SMEs before presenting in more detail a framework covering different mechanisms tailored for each type of need and company.

This framework of mechanisms to support SMEs can be applied for several purposes:

- From the perspective of policy makers: it can be used to map and assess the needs of the companies in their own thematic or geographical domain. It can help policy makers to assess the extent to which their policy instruments address the needs of the companies they target. It can support the design of future policy actions with a more targeted approach and streamline the support provided by different policy instruments.
- From the perspective of technology centres and other innovation actors designing new collaborative initiatives: the framework can help them to better define the scope of their initiatives and look for complementarities with other ongoing initiatives.
- From the perspective of the end-users (SMEs) and those organisations in close contact with them (clusters, trade associations, the Enterprise Europe Network, etc.): the framework can help them to identify the type of service they are looking for and the initiatives that are available.

[19] See, for instance, the cases of Made Different or the competitiveness clusters in Belgium, or the Spanish HADA and Activa Crecimiento tools promoted by the Industria Conectada 4.0 initiative.

Section 3

3. Access of SMEs to technology centres: defining the support needs

An SME is defined in terms of staff, turnover or balance sheet by the European Commission.[20] However, for the purposes of formulating recommendations, a more precise definition is required since the needs of SMEs might vary from a specific technical expertise on high-tech equipment to economic and financial services. In this study, we differentiate between the following three types of SMEs:

- A first type of SMEs are **technology-supplier SMEs**. Their role in the value chain tends to focus on high-technology material, components and/or equipment suppliers. These companies are highly specialised, tend to be small and not inclined to grow rapidly. The technology-supplier SMEs do not have a large macroeconomic role but can have a relevant contribution to the innovation potential in Europe as they enable the downstream industry to innovate.
- A second type of SMEs are **technology start-ups**. These companies are often founded by technology experts as a spin-off company from universities or research organisations. These companies tend to be strongly linked to the regional technology community. From a macroeconomic perspective, these companies are expected to become technology-supplier SMEs in the future, particularly if they focus on high-technology materials, components and equipment.
- A third type of SMEs are **downstream SMEs**. These companies operate in various sectors and often have no specific technological expertise. They can obtain a relevant competitive advantage by integrating high-technology materials or components.

In general terms, SMEs have difficulties in accessing technology centres due to limited human resources, financial capacities and/or lack of awareness. However, the needs vary depending on the type of SME. Table 2 shows the various requirements for support services that each of the aforementioned types of SMEs have from technology centres.

Table 2: Types of SMEs and their requirements for support services from technology centres. The darker the colour, the more important the need is.

Types of SMEs according to the required support services	Technology-supplier SMEs	Technology start-ups	Downstream SMEs
Equipment			
Specific technological support			
Generic technological knowledge and support			
Economic advice			
Financial advice			
Training			

Source: IDEA Consult

Note: Darker colours in the table indicate that the type of service is more relevant.

[20] See: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

The table presents the following support needs:

- **Equipment:** this refers to access to concrete technologies and/or infrastructures that are typically available in technology centres for demonstration and validation (proof of concept and lab testing, prototype development and testing, pilot production and demonstration, pilot lines, pre-series, product validation and certification etc). The companies that present these needs in a more acute way are those that are dedicated to the development and commercialisation of new technology (technology-supplier SME and technology start-ups) and are less relevant for downstream SMEs.
- **Specific technological support:** This category refers to the knowledge and expertise that is available at technology centres (or other organisations that are closely related to them). It is related to the knowledge areas that are necessary to the development and commercialisation of new technologies, such as Intellectual Property (IP) support.
- **Generic technological knowledge and support:** This category gathers the support provided to companies in finding technological solutions that might be applied to solve specific needs to improve their business operation. The objective of this support is not the development of new technologies but rather the uptake of these technologies to improve factory and business operations.
- **Economic advice:** This refers to support areas for the growth of technology-related innovations aiming at a successful commercialisation. Finding application areas, matchmaking with other companies, knowledge brokerage, market analysis, life-cycle analysis and similar services would be part of this category.
- **Financial advice:** in general terms, access to finance is the most prominent issue for downstream companies and technology start-ups. The latter need to finance the steps between ideation and commercialisation and ensure the viability of their business model. Downstream companies, on the other hand, need support in finding funding for their projects, most often from public sources.
- **Training:** SMEs sometimes lack the required in-house competencies to embark on R&D projects or to assess their innovation needs and find the most appropriate external support. In this sense, technology centres are well placed to address this need as they have the required infrastructure, equipment and expertise to act as agents of knowledge transfer towards SMEs and help them be better prepared for their innovation challenges.

In general terms, the competitiveness of SMEs is diminished not only by limited in-house resources, but, more importantly, due to a poor overview of know-how and services, which are sometime readily available in Europe[21]. This information myopia leads to a concentration on services in close neighbourhood[22], as the local context is usually best known, although it may be a suboptimal solution. Exploitation of opportunities in other Member States and beyond seems to be limited (see e.g. Flash Eurobarometer on the internationalisation of SMEs[23]). Moreover, limited absorptive capacity of SMEs is another hindering factor[24]. User-friendly, handy and instant advice is therefore crucial for SMEs.

Finally, access to technology centres (and the uptake of technologies that would be derived from it) might also be hindered when:

- **The expertise needed is located abroad** as this might entail a higher cost (travels), more difficult communication (language or cultural differences) or more restricted options for public funding (as regional or national public funding do not often allow for the services to be delivered outside the country borders).

[21] See main finding of the study "Promoting the access of SMEs to KETs TIs": "In 60% of EU Member States, SMEs are not likely to find the KETs TI services they need. European SMEs need a pan-European access to KETs TI services, a majority of European regions is not able to deliver KETs knowledge and services as needed by SMEs." (page 7, see: https://op.europa.eu/en/publication-detail/-/publication/7ec88c88-8c2c-11e5-b8b7-01aa75ed71a1/language-en)

[22] See main finding of the study "Promoting the access of SMEs to KETs TIs": "Regional financing instruments facilitate cooperation or contract research. Therefore, it is clear that SMEs and KETs Technology Infrastructures prefer regional collaborations to transnational cooperation." (pages 7-8, see: https://op.europa.eu/en/publication-detail/-/publication/7ec88c88-8c2c-11e5-b8b7-01aa75ed71a1/language-en)

[23] Only 6% of the EU28 SMEs indicated to have worked with a partner based abroad for research and development (R&D) purposes : https://ec.europa.eu/growth/content/flash-eurobarometer-internationalisation-smes-now-available-0_en

[24] A detailed study on the barriers for industrial modernisation (and the adoption of advanced manufacturing technologies in particular) can be found here : https://op.europa.eu/en/publication-detail/-/publication/29e4d66e-dd4a-11e6-ad7c-01aa75ed71a1

- **The SME project requires the combination of equipment and services from various technology centres** (for instance, when moving across the TRL stages). The coordination of more than one technology centre is challenging for those SMEs as there are higher coordination costs and the SME personnel might not be sufficiently trained for this.

Section 4

4. Landscape of ATI technology centres

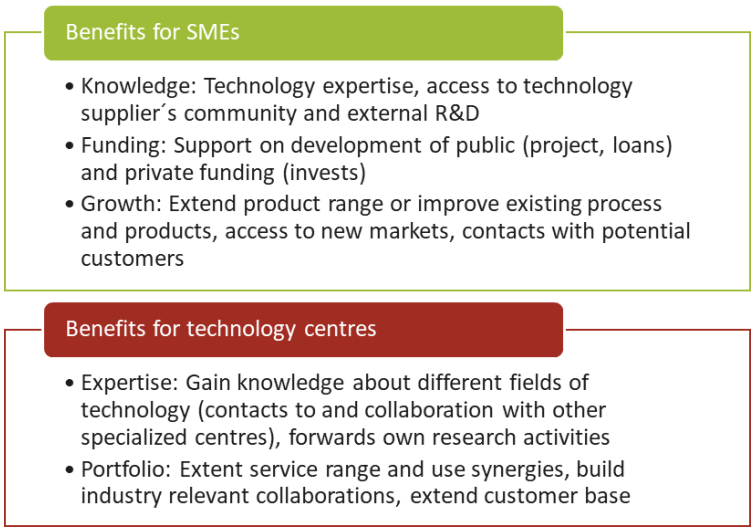
The findings from ongoing initiatives to support the access of SMEs to ATI technology centres bring valuable lessons on 1) the needs indicated by companies and 2) the mechanisms put in place to address these needs. They show that technology centres (and networks thereof) can be a useful tool to address the needs of different types of companies (technology-supplier SMEs, technology start-ups and downstream companies) and that the services provided to them need to be aligned with their needs. Companies, and SMEs in particular, are being increasingly challenged to get access to the competences and resources necessary to be competitive. Innovative solutions can contribute significantly to this and technology centres, as individual organisations and as part of cross-border networks, can be instrumental in this sense.

SMEs embarking on R&D support projects with technology centres avoid the need of spending too many resources on internal R&D, including human resources with highly specialised technical skills. These centres can also support SMEs on finding the right partners, from technology providers to funding organisations. Once an SME collaborates with technology centres, it is not unusual to continue the collaboration in other domains or for other purposes.

A wide offer of technological and support services is available in Europe. However, this offer is not always used by industry, for two main reasons:

- First, the technological offer throughout Europe is often only known and accessible to a narrow community, e.g. the local ecosystem of a pilot line, but not to geographically or thematically more distant organisations.
- Second, the offer from ATI TCs, collaborative networks of technology centres and similar initiatives often addresses only one aspect of innovativeness at one single point of a value chain but does not provide solutions on other aspects of the value chain (like financing, business development or regulation).

Figure 1: Key benefits of the collaboration between SMEs and technology centres (TCs) and related networks



Source: Van de Velde E., et al.[25]

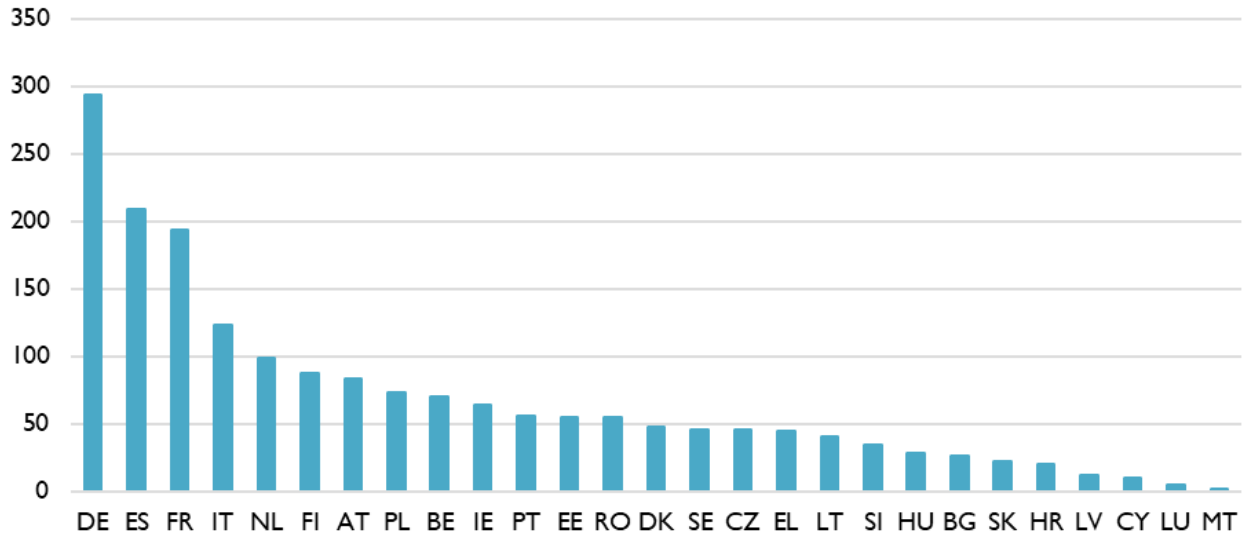
[25] https://ati.ec.europa.eu/reports/eu-reports/study-access-smes-kets-technological-centres

This section provides an overview of the services currently provided by ATI technology centres (TCs). The aim of this section is to present the expertise that can be found among European ATI TCs as well as to identify and analyse the gaps in the services offered. Two types of data sets have been analysed and are presented and compared below. The first data set includes the 1978 TCs from the inventory of ATI TCs[26]. The second list of centres includes the centres that were published in the mapping of ATI technology centres on the 12th of March 2021[27]. The section analyses the distribution of centres by country, technology focus, sectors of activity and TRLs.

Geographical distribution

The geographical distribution of the TCs in the inventory across Member States shown in Figure 2 reveals that the number of centres per country varies between 2 and 294. Germany, Spain, France, Italy and The Netherlands are the countries hosting the largest number of TCs. Malta, Luxembourg and Cyprus can be found on the opposite side of the distribution. The most evident factor explaining the differences in the number of centres per Member State is country size. Furthermore, there are important differences between EU-13[28] and EU-14[29] countries in terms of the number of TCs. EU-13 countries tend to have a lower number of TCs, with exception of Poland, Estonia and Romania, which have a higher number of TCs. This finding is coherent with previous reports highlighting the lower research and development expenditure and lower innovation levels of these countries compared to EU-14 countries[30].

Figure 2: Distribution of TCs in the inventory per country



Source: IDEA Consult based on the inventory

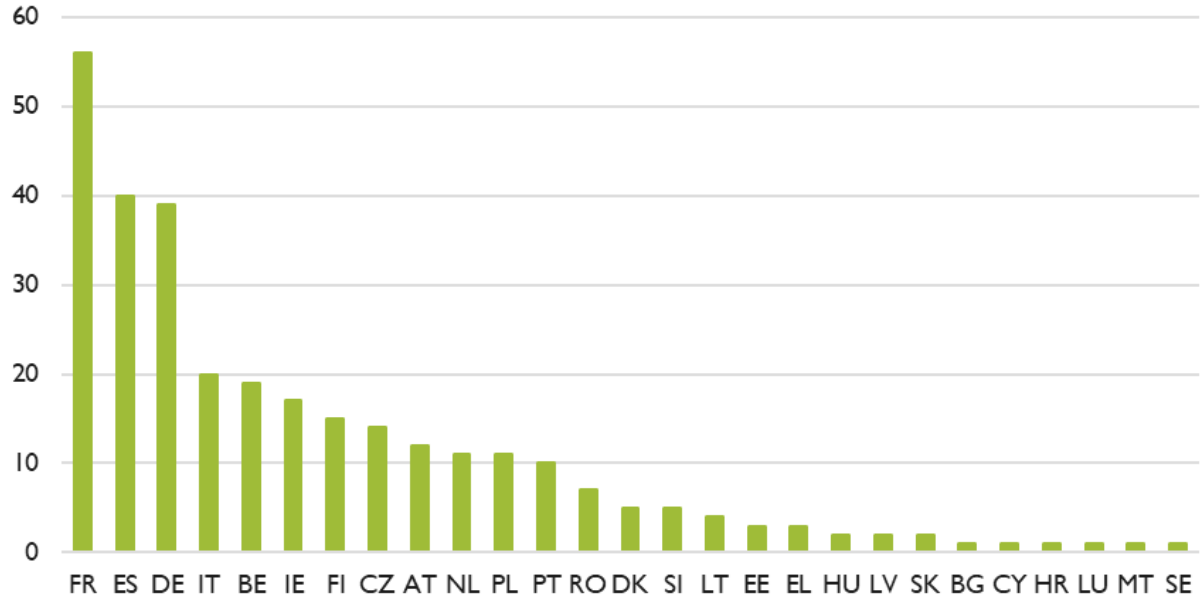
A similar trend is observed in Figure 3 which shows the distribution of technology centres published in the ATI mapping across countries. Furthermore, similar observations can be mentioned regarding the distribution and the relationship with the country sizes, as well as between EU-13 and EU-14 countries. There are however some differences between the mapping and the inventory that are related to the methodological approach followed for each of them. This is related to the fact that the inventory was compiled following a desk research-based approach that aimed to include the centres that could potentially be part of the mapping, while the information included in the mapping itself is the result of the centres´ self-declared information. This is for instance the case of Sweden. This country has a lower number of centres in the ATI mapping (Figure 3) than in the inventory (Figure 2) because one of the largest networks in the country (RISE) appears as an unique centre in the mapping, while the individual centres belonging to RISE are included in the inventory. In the mapping, the network is published as

[26] This inventory was carried out for DG GROW in the framework of the previous mapping of KETs technology centres and updated for the creation of the new mapping of ATI technology centres: https://ati.ec.europa.eu/technology-centre/mapping
[27] https://ati.ec.europa.eu/technology-centre/mapping
[28] The EU13 group refers to Cyprus, Czechia, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria, Romania and Croatia.
[29] The EU14 group includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxemburg, the Netherlands, Portugal, Spain and Sweden
[30] See, for instance, Pazour, M. Et al (2018). Overcoming innovation gaps in the EU-13 Member States. European Parliament. IP/G/STOA/FWC/2013-001/LOT 8/C4

one centre with different institutes and therefore is misleading with respect to the total number of centres in the country.

The large differences across countries on the number of TCs points at the need to reinforce and support initiatives contributing to foster SMEs´ cross-border access to expertise, infrastructure and equipment to maximise the use of the available offer across Europe.

Figure 3: Distribution of published TCs per country[31]



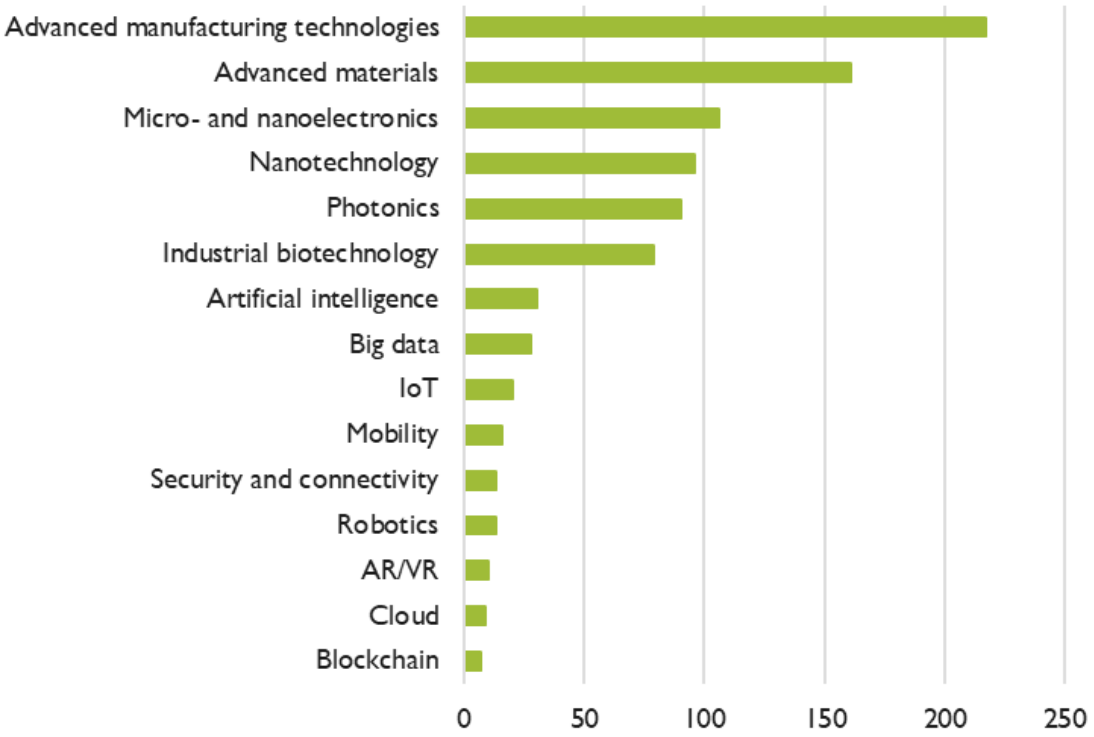
Source: IDEA Consult based on the list of TCs published in the ATI mapping

Technology focus

The technology scope of the published centres in the mapping is presented in Figure 4. The centres included in the ATI mapping focus mainly in providing services in Key Enabling Technologies, of which Advanced Manufacturing Technologies, Advanced Materials and Micro- and Nano-electronics are the most frequent. The most frequently mentioned digital technologies are Artificial Intelligence, Big Data and Internet-of-Things. The difference between the number of centres focusing in KETs and in digital technologies might be explained by the fact that the ATI mapping is the successor of the former KETs mapping and that not all centres included in the KETs mapping have updated their profile to include the digital technologies they work with. The information included in the inventory of ATI TCs indicates that the number of TCs active in digital technologies might be higher than the current mapping indicates, especially with regards to Internet-of-Things, Artificial Intelligence, Robotics and Big Data, which are related to Advanced Manufacturing Technologies. The latter is the technology with the largest number of centres in the mapping so it seems reasonable to indicate that many of these centres might work at least partially with some of these digital technologies.

[31] Based on the list of TCs published in the ATI mapping

Figure 4: Distribution of published TCs per technology focus



Source: IDEA Consult based on the list of TCs published in the ATI mapping

The data indicates that more than 50% of the technology centres is concentrated in five countries, which are the larger Member States such as Germany, France, Italy or Spain. Smaller Member States with a high investment in R&D are also well represented in the analysis, such as the Netherlands, Ireland or Finland. Denmark is a remarkable exception as the data reflects a lower number of centres (both in KETs and in digital technologies) than what would be expected given its degree of investment on R&D. The fact that the mapping and the inventory does not take into account the size of the centres might explain this difference[32]. The analysis also shows a prominent role of some technologies including Cloud, Blockchain, AR/VR, Mobility and Robotics in certain countries, such as Czech Republic, Poland and Slovakia. Moreover, the findings indicate that the activities in Blockchain and Cloud technologies are concentrated in a few countries such as Czech Republic, Finland, The Netherlands, France, Germany, Ireland and Slovakia. About 55% of the published centres working in Cloud or Blockchain are located in these countries. Actions promoting the access of SMEs to technology centres could consider this heterogeneity of the distribution of technological expertise across Europe.

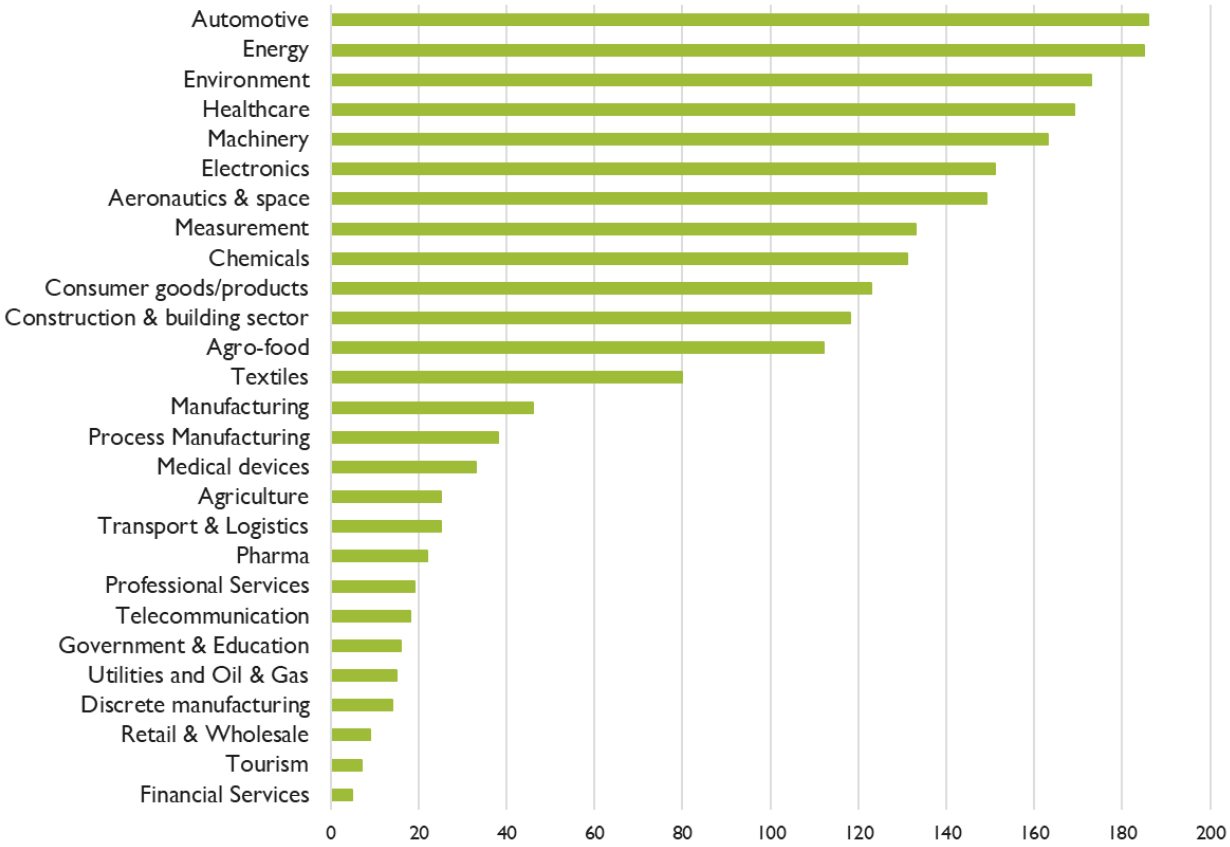
The analysis of the geographical distribution of the technological expertise also confirms that small countries tend to have fewer centres operating in the various technologies (e.g. Luxembourg, Malta, Croatia, Cyprus). Furthermore, the available offer in these countries tends to concentrate on Key Enabling Technologies, and to a lesser extent on digital technologies. In addition, EU-14 countries as a group are also found to have on average a lower number of technology centres operating in each technology. In Member States where fewer technology centres are located, initiatives are needed to stimulate SMEs to reach out to TCs that are located abroad in order to develop their ideas and business further.

Sectorial distribution

The technology centres published in the mapping provide explicit information on the sectors in which they work. Figure 5 shows how many centres are active in each sector. Sectors such as automotive, energy, environment, healthcare and machinery have more than 160 technology centres active in the mapping. Sectors that are less presented among the centres included in the mapping are rather focused on services (financial services, tourism, retail and wholesale, or government and education).

[32] Large and small TCs have the same weight in this analysis. The size of TCs might be contingent upon the country in which they are located as large TCs might be more frequent in some countries than in others.

Figure 5: Distribution of published TCs per sector of activity



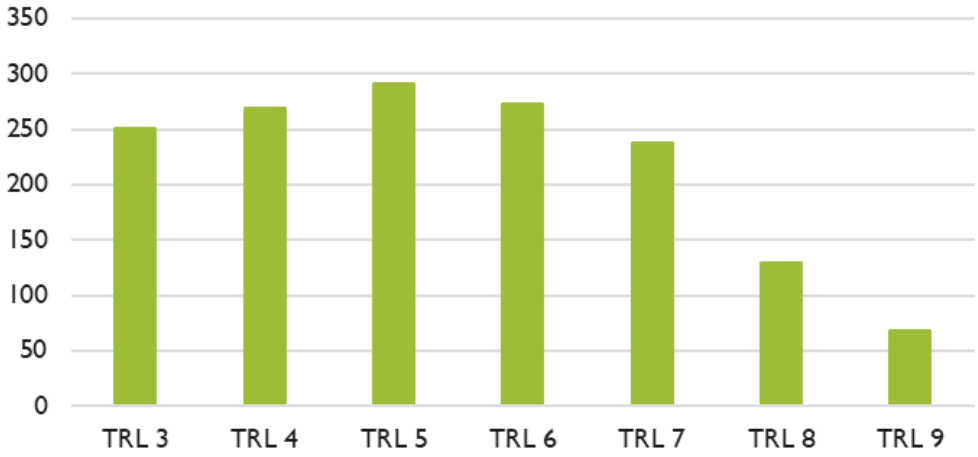
Source: IDEA Consult based on the list of TCs published in the ATI mapping

TRL scope

The technology centres that are part of the ATI mapping are operating in the entire TRL range, as shown in Figure 6 [33]. Overall, the services provided are homogeneously distributed across all TRLs up to TRL7 while a lower number of centres are operating in TRL8 and TRL9. Furthermore, the analysis of the TRL scope by geographical origin of TCs reveals some interesting insights. For each TRL, between 50% and 60% of the activities are concentrated in five countries. The cumulative percentage of the top five countries with the largest number of centres per TRL show that larger countries are slightly more overrepresented in higher TRLs than in lower TRLs – this is the case of countries such as Germany, France or Italy. In general, these three countries, together with Spain and Belgium, are the countries with the largest number of centres across TRLs. In addition, Finland and Ireland have a large number of centres operating at TRL3. Poland stands out for the number of technology centres working in TRL8 and TRL9. A similar trend is visible when looking into the group of EU14 countries. The highest TRLs are also less frequent among this group of countries and the distribution across TRLs is like that of EU27 countries.

[33] One of the eligibility criteria for TCs to be accepted to the mapping is to cover at least TRL5 to TRL8, not necessarily the whole range.

Figure 6: Distribution of published TCs per TRL



Source: IDEA Consult based on the list of TCs published in the ATI mapping

Section 5

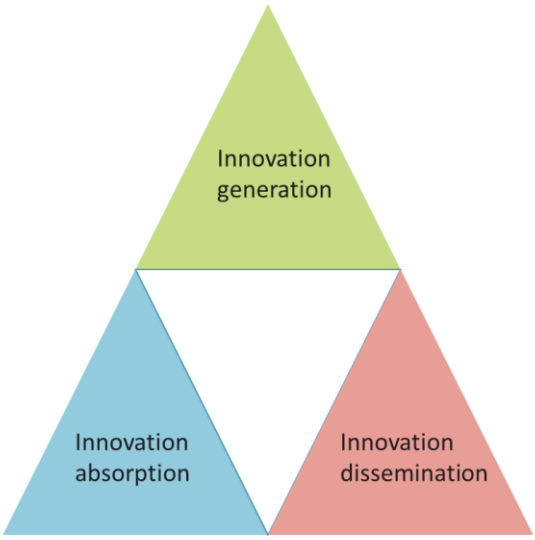
5. Models for SMEs to access ATI technology centres

Companies as potential customers of technology centres have diverse backgrounds and demands. The question of how technology centres could better provide services to SMEs is an issue that is largely dependent upon the type of SME. For this, we suggest applying a framework to address innovation that was recently developed by Henry Chesbrough (2019), the father of the concept of 'Open Innovation'. This framework is based on three facets: generation, dissemination and absorption (Figure 7). These three facets were brought by Chesbrough into a new paradigm for managing R&D and bringing new technologies to market[34]:

- **Innovation generation** refers to the research and development of new technologies and solutions.
- **Innovation dissemination** refers to the process through which for these technologies become known by companies, stakeholders and the broader public.
- **Innovation absorption** refers to the process through which these new technologies and solutions are effectively used and applied by industry and other end-users.

It could be argued that technology centres' primary focus is innovation generation. However, the impact of technology centres can be further modulated and amplified in combination with the other facets. The three facets in this triangle (see Figure 7) can be seen as the core of policy actions, aiming to foster the access of industry and SMEs to technology centre. The extent to which they pay more attention to some angles of the triangle depends on the characteristics of the ecosystem (stakeholders and their needs) and the complementarities and synergies between the actors. The way these facets interact with each other to optimise impact on business innovation and better serve SMEs´ needs is further described in the next section.

Figure 7: Chesbrough's framework



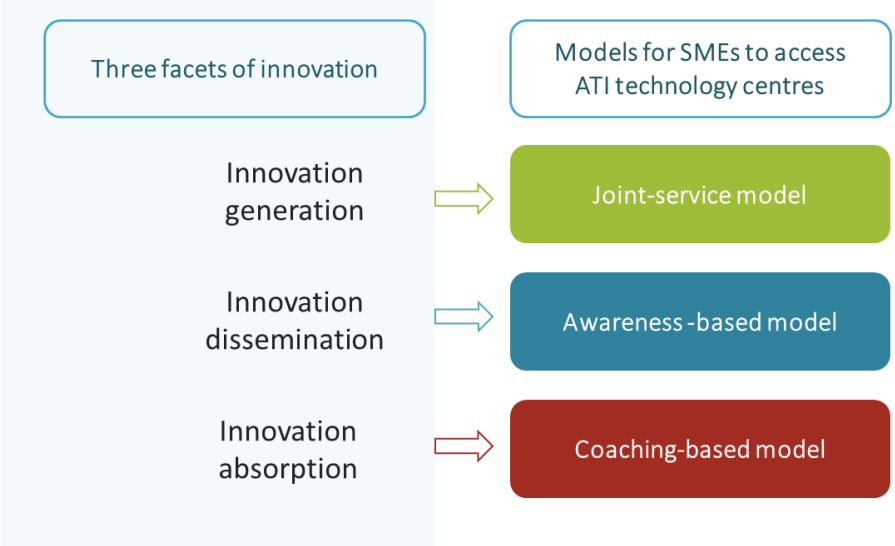
Source: Chesbrough, 2019

Three models for the access of SMEs to technology centres are derived from Chesbrough's framework. Each model has its own mechanisms and scope to facilitate the access of SMEs to technology centres. The three models are presented in Figure 8 and offer complementary approaches to support SMEs. It is

[34] Chesbrough, H. (2019). Open Innovation Results. Berkeley Haas.

important to note that these models do not constitute pure approaches from which one needs to be selected or prioritised. Rather, these models are different and, in many ways, interrelated options that can be combined into single initiatives or policy actions to maximise the service offering to the companies. For analytical purposes, each of these models is associated to specific types of SMEs: this does not entail that the model or the solutions covered by it are not interesting for other types of companies, but rather that the type of SME identified is the one that is expected to benefit the most from each model of collaboration.

Figure 8: Three models for SMEs to access ATI technology centres



Source: IDEA Consult

The three models for SMEs to access ATI technology centres are the following:

- **The joint-service model:** The primarily target of the **joint-service model** are SMEs that have a previous understanding of their technological needs. This includes technology-supplier SMEs, technology start-ups and some downstream SMEs if they have the knowledge on the type of technological solution they need. This model refers to the provision of joint services to companies, hence increasing their offer to companies by complementing it with that of other centres in the network. In so doing, this model also facilitates the access to services required when these are located in another country. In addition to this, this model can ensure the streamlining of the innovation process across different technology centres or other service providers as the project moves up the TRL ladder. This diminishes the costs for the SME and lowers the barriers of access as it is clear from the beginning of the project which technology centre can develop/work on which part of the project requested by the SME.
- **The awareness-based model:** It targets primarily SMEs that are looking for a certain technological solution. The main difference with the former model is that this kind of networks mainly focus on making the available offer visible. It is up to the companies to find the service providers that are better suited to their needs. There is hence no streamlining of the services along the innovation chain across different technology centres (i.e. no joint services).
- **The coaching-based model** can be seen from two perspectives depending on the type of company that is addressed:
  - First, coaching-based models can focus on downstream SMEs, which are those SMEs that require more support in 1) identifying the challenges that could be addressed through technology development or uptake, and 2) determining the priorities in terms of development or investments. This model is best placed to provide support in coaching the SMEs to start the innovation process by helping them identify and prioritise their

needs and deriving them to the most appropriate 'joint-service' or 'awareness-based' network.

- Second, the coaching-based model can also focus on the provision of coaching to technology start-ups. This type of company has special coaching needs that can be key for their success and sustainability. Examples of topics on which these companies present coaching needs are IPR negotiations, access to finance, pitching or commercialisation.

In order to better understand the three models for the access of SMEs to technology centres, Box 1 presents a fictional example of the path that could be followed by a downstream SME.

Box 1: Fictional example of the path followed by a downstream SMEs across the different models

An SME specialised in the manufacturing of furniture located in Valencia would like to modernise their factory floor but does not have the required skills or know-how in-house to determine which technologies they could apply or develop. They contact a technology centre in their region to establish a first contact and look for help.

If the technology centre has an appropriate infrastructure to address this demand, the service provision can start. However, what would happen if the technology centre does not have an appropriate focus or infrastructure?

If the logic behind these three models would be applied, the process could work as follows: If the technology centre is part of a 'coaching-based' network, the centre would then have access to a methodology that can help the company to identify and prioritise its needs in terms of technology and innovation. Once these priorities are defined, the technology centre can direct the SME to the network depending on the type of model/service provision that they have. It can be 1) a 'joint service' network if the project requires a complex process involving at least two technology centres; or 2) an 'awareness-based' network if the company knows the exact type of solution that they are looking for.

Source: IDEA Consult

5.1 Examples of existing approaches

The degree to which existing technology centres and networks can improve their response to industry needs depends on their industry scope, technology focus and governance structure. To illustrate this, four different models of existing networks of technology centres are presented below: the ADMA initiative, the KET4Clean Production project, the 3DP Pan EU platform and the PITCCH project. These four models are used to illustrate the models and recommendations presented in this note. The position of these networks in the three models was discussed during the workshop '*Moving from technology-based networks to value chain-based networks: how to improve the effectiveness of cross-border networks of ATI technology centres?*' which took place on 24 September 2020 within the Advanced Technologies for Industry (ATI) project.

Box 2: The ADMA Initiative

The ADMA Initiative	**Model:** Coaching-based model **Target:** Downstream SMEs

The European Commission (EASME, DG GROW) launched in 2018 a project to establish a European Advanced Manufacturing Support Centre to help SMEs assess the possibility of adopting advanced manufacturing solutions and transforming their organisation towards next-generation factories with more competitive, modern and sustainable production. This project is now coming to an end; it has been carried out over 36 months by a consortium formed by members coming from 9 countries. The ADMA Initiative has developed and upscaled the methodology initiated by Made Different in Belgium[35] by:

- Updating and further developing the transformations that companies need to follow to become Factories of the Future;
- Testing the concept in a large range of countries with a view towards the further development of the initiative after the end of this project to all EU28 countries and even associated countries;

[35] Made Different is an initiative led by Agoria, Belgium's largest industry association, and Sirris, its associated technology centre.

- Organising for the first time the Factories of the Future awards at EU level showcasing successful examples of transformations and showing other companies the path towards innovation

The European ADMA Support Centre focuses on facilitating the access of SMEs to technological, organisational, financial as well as business model expertise available within the consortium and their broader ecosystem. This support features a **methodology** that addresses the digitalisation of companies from a holistic perspective. The methodology has **seven transformations**: Advanced Manufacturing Technologies, Digital Factory, ECO Factory, End-to-End Customer Focussed Engineering, Human Centred Organisation, Smart Manufacturing and Value Chain Oriented Open Factory.

The methodology and the associated transformations are the basis for the **short and long scans** that the ADMA initiative has developed for companies to be able to have a more in-depth view of their needs and to assess their investment priorities in their efforts to become a Factory of the Future. On the basis of the outcome of these scans, a **'transformation plan'** is drafted with the help of an advisor and relying upon a transformation plan template and guidelines, made available by the initiative. Finally, a selected number of SMEs received support from coaches in order to draft an '**implementation plan**'. The picture below shows in a synthesis how the methodology works.

One of the key aspects of the European ADMA Support Centre is that the core of its activities aims at being self-sustainable in the medium term. The Centre was designed in a way that it provides comprehensive services to SMEs through a one-stop shop access to a large range of services in different European countries. It aims at ensuring an excellent coverage of technology and expertise in the field of advanced manufacturing. Technology centres, by aligning with the ADMA methodology and the scanning activities, have access to a wider market (SMEs that until then have never considered to hire their services). They are hence more willing to invest part of their budget in scanning/auditing companies. The ADMA methodology is therefore open to supporting organisations: it can also be applied by external organisations (clusters, research and technology centres, etc.) in their activities to support small and large companies.

During the ADMA Initiative, more than **60 companies** have benefited from the support of coaches in short-term actions and **20 companies** have benefited of a more long-term support to develop their implementation plans to become a Factory of the Future. In addition, several Learning Network Events have gathered **CEOs and CTOs of advanced SMEs across Europe**. The objective of these events was to foster peer-learning and sharing good practices to tackle with the challenges of manufacturing nowadays.[36]

This project was therefore conceived as a pilot project for the development and fine-tuning of an appropriate methodology to reach these objectives. The roll-out of the initiative will be supported through an INNOSUP call[37].

Source: ADMA Initiative

[36] An overview of the achievements of ADMA can be checked in the aftermovie of the ADMA Final Event : https://www.youtube.com/watch?v=F0sTbMR0n7U. Other videos are also available at www.adma.ec

[37] INNOSUP-08-2020 : Pan-European advanced manufacturing assistance and training for SMEs.

Box 3: KET4CleanProduction

KET4CleanProduction	**Model:** Joint-service model and awareness-based model **Target:** Downstream SMEs

KET4CleanProduction is an ongoing Coordination and Support Action funded by Horizon 2020 and launched in January 2018. The objective of the project is to help SMEs to overcome challenges related to clean production. It will enable the enterprises to achieve sustainability, innovation and to become more competitive. To achieve a higher innovation capacity, SMEs need to integrate key enabling technologies (KETs). This will result in higher productivity, less waste and a better pollution management[38]. The project is divided into three phases (see Figure 9).

During the pilot phase, the services were provided exclusively by consortium members. The consortium is composed of 13 KET technology centres[39] (TCs) and 7 members of the Enterprise Europe Network (EEN). In total, the ecosystem assembles three large groups of stakeholders: manufacturing SMEs, KETs TCs and EEN partners. Currently, 17 additional KET-TCs have joined and also offer their services through the project. The objective for the sustainability phase (2024) is to expand the network to a total of 100 KET-TC members, 180 EEN partners and more that 300 SMEs enquiries.

Figure 9: KET4CleanProduction timeline

Source: KET4CP

The first two phases aimed:

- To facilitate the connectivity of SMEs to TCs through joint project proposals for micro grants
- To establish an automatic matching wizard interconnecting SMEs with the best-matching TC[40]

In the third phase, these objectives will contribute to the development of a self-sustainable ecosystem in 2021 and of a single-access point that will serve as reference for European manufacturing SMEs. Building such an ecosystem will enable innovation with the objective of achieving clean production processes. To achieve self-sustainability, KET4CleanProduction developed a matching tool that would bring together SMEs and KET TCs. Furthermore, during the third phase, a business plan was developed to determine other financing possibilities for the service provision to SMEs.

Furthermore, KET4CleanProduction aims at promoting the use of KETs among manufacturing SMEs, at improving the capabilities of TCs by enhancing collaboration between TCs located in different countries and at facilitating the collaboration of SMEs with partners from another region or country.

The project has developed different tools to achieve its aim of facilitating clean production processes though innovative solutions. These tools include a map, training and micro-grants.

[38] https://www.ket4sme.eu/about-ket4cp

[39] The project focuses on Key Enabling Technologies (KETs). The centres known as KET technology centres are now referred to as ATI technology centres, because the mapping covering this type of organisations now covers not only KETs but also digital technologies. More information is available here: https://ati.ec.europa.eu/technology-centre/mapping

[40] To improve the efficiency between KET TCs and SMEs, web-based matching tools will be used.

- Map: An overview of the ecosystem is exposed on a map. This visual support facilitates SMEs´ search for partners according to their business needs. In the map, a general introduction, the contact details as well as the location of each TC and EEN partner can be found
- Training: The training is targeted at EEN members willing to keep their clients and attract new ones. Furthermore, EENs will become more competitive as they enter the project network
- Micro Grants: KET4cleanProduction offers grants for projects of cross-border cooperation between SMEs and at least 2 KET TCs among EU countries and Horizon2020 partner countries. These grants aim at fostering the use and development of KETs for achieving cleaner production processes[41].

The project reveals on its webpage various success stories that arise from the project with the aim of promoting the benefits of applying for the grants.

By the beginning of 2021, the KET4Cleanproduction platform has received 97 proposals for microgrant projects and 152 technology requests from 28 European countries. By 2021 the KET4Cleanproduction has funded 40 projects.

Box 4: 3DP Pan EU platform

3DP Pan EU platform	**Model:** Awareness-based model and joint-service model **Target:** Technology providers, technology start-ups (downstream SMEs)

The '3DP Pan EU' project (DG GROW, 2019-2021) aims at fostering awareness, knowledge and uptake of 3D Printing technologies in Europe by facilitating and promoting SMEs' access to high quality services related to testing, validating and certifying 3D Printing solutions. The project is developed by several regional economic agencies across Europe and other organisations. The main objectives of the project are twofold. First, the project aims at developing and delivering a functional and user-friendly online interface which will provide complete and comprehensive information on 3D Printing facility centres (and the services offered to SMEs in testing and validation) at the European level. Second, the collaboration between SMEs and facility centres through the online interface are then being pilot tested, following the launch of an open call for funding of 10 individual projects. Through this open call, 10 cross-regional 3D Printing industrial demonstration projects have been selected and are currently being supported. Final results of the supported projects are expected by October 2021.

Complementing this online-interface, the project will deliver a gap-analysis of the availability and provision of 3D Printing solutions across the EU Member States. The consortium has finalised the development of the online interface, with over 300 Facility Centres that have registered on the interface, with their services and equipment mapped and made available to SMEs, ensuring that SMEs can have access (cross regionally) to 'Best Value for Money Solutions'.

1. Facility centres registered on the web-based interface have benefitted / are benefitting from the following main opportunities:
    - Offering their services to a broader range of clients and entering in contact with SMEs (incl. outside of their region/country) looking for demonstration services.
    - Some of the registered Facility Centres are involved in the 10 industrial cases funded by the action (max. €40 000 of support per SME), providing demonstration services to supported SMEs.
2. Relying upon various 'entry points', SMEs are able to describe, online, their 3DP-related needs and to find the optimal demonstration service providers. In addition, 10 SMEs have received

[41] The call was open for applications until April 2020 and the selected projects are expected to last 6 months. The total funding for the call is of EUR 2.000.000. The maximum support per project is EUR 50.000. The grant partially covers the costs: 70% of the project costs are provided by the micro grant and 30% by the SMEs´ own resources.

funding for implementing cross-regional demonstration projects (the abovementioned €40 000 max. support per SME)

The sustainability aspect of the platform is also currently addressed: the consortium is investigating various ways of ensuring sustainability and expandability (more actors from the value chain, other technology fields) of the online matching tool.

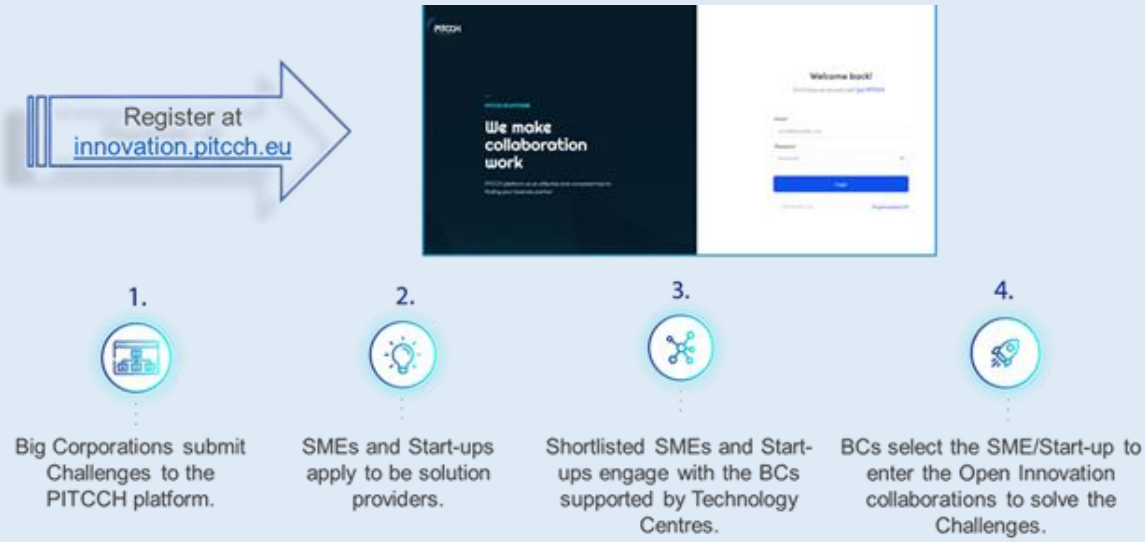
Box 5: PITCCH

PITCCH	**Model:** Coaching-based model and joint-service model **Target:** Technology start-ups (and large companies)

PITCCH (2020-2023) stands for 'Pan-European Open Innovation Network for Corporate Challenges in Advanced Technologies' and is a Coordination and Support Action (CSA) project funded under Horizon 2020.

The aim of the project is to promote Open Innovation by establishing a pan-European network where technology centres act as intermediaries to facilitate structured collaborations between Big Corporations, as technology seekers, and SMEs/start-ups as technology providers. By promoting Open Innovation and co-creation of inventions, PITCCH has the objective of increasing the competitiveness of European industry as a whole and of accelerating the uptake of Advanced Technologies.

To match-make Big Corporations' requests and SMEs' offers, PITCCH has launched in December 2020 an Open Innovation Platform (https://innovation.pitcch.eu/login) where large companies can publish Corporate Challenges (CCs) and SMEs submit solution proposals. The project has already selected and launched 7 Corporate Challenges (CCs) which have already identified solution providers with whom to start the Open Innovation collaboration. Additional 10 CCs, based on the needs of large companies, are expected to be selected and published under two cut-off dates around September 2021 and February 2022.



Source: PITTCH project

PITCCH helps large companies in the different steps of the process from the definition of the requests to the promotion of the challenges and to the scouting of qualified SMEs. PITCCH further provides brokerage services to help with the negotiation and moderation between the companies. The PITCCH project offers financial support and consultancy services to the selected SMEs to implement the collaborative projects. These services include process facilitation, training on pitching and IP,

negotiation and moderation for agreements, technology advice and positioning. Different financial support schemes will be tested throughout the three different cut-offs.

Technology Centres outside the PITCCH consortium are invited to join the network with the possibility of registering in the PITCCH platform as from June 2021. They will be involved under the second and third cut-off in the collaborations between Big Corporations and SMEs.

The project focuses on Advanced Technologies and specific sectors of the economy. Solutions from SMEs/start-ups shall be based on one or more of Advanced Technologies (i.e. advanced manufacturing, advanced materials, nanotechnology, micro and nano-electronics, photonics, industrial biotechnology and digital technologies). Corporate Challenges shall be relevant to one or more of the following sectors: climate, energy and mobility; digital, industry and space; health; food, bioeconomy; natural resources, agriculture and environment; culture, creativity and inclusive; and civil security for society.

Section 6

6. Recommendations for action to improve SME's access to advanced technology centres

The following section presents recommendations for each model e.g. joint-service model, awareness-based model and the coaching-based model. The recommendations are summarised in Table 3.

Table 3: SME needs and recommended mechanisms to support SME access to technology centres

Model	Needs to be addressed	Recommendations	Targeted SME
Joint-service model	Development of new solutions and products	Setting up collaboration networks targeting clear value chains	Technology-supplier SMEs/ Technology start-ups
	Lowering coordination costs by ensuring that projects step up the ladder of innovation in a seamless way	Putting in place mechanisms for the seamless provision of services across different TCs	
	Maximising the contribution of best-place experts	Applying clear and simple IPR procedures	
		Involvement of regional policy makers to facilitate funding opportunities	
Awareness-based model	Matchmaking	Setting-up matchmaking platforms with business-oriented focus	Technology-supplier SMEs/ Technology start-ups/Downstream SMEs
	Increasing awareness of available offer	Creation of online catalogues with business-oriented focus	
	Communicating about best practices	Promoting collaboration and alignment across existing initiatives	
		Investing in awareness and communication campaigns on best practices and success stories	
Coaching-based model	Support in the identification of innovation needs and investment priorities	Developing common methodologies to be applied by different actors supporting downstream SMEs and training the coaches in applying such methodologies consistently	Downstream SMEs/ Technology start-ups
	Provide tailored information on the business returns and advantages of investing in innovation	Training the companies in a way that they can detect their innovation needs and act accordingly	
	Lack of skilled personnel to foster innovation within companies	Demonstrating the outcome of the support provided to SMEs	
	Coaching support for the commercialisation and latest stages of the development of new products and services.		

Source: IDEA Consult

6.1 Joint-service model

The joint-service model focuses on SMEs that have a previous understanding of their technological needs. The objective is to foster access to the best placed experts for the provision of (joint[42]) services to companies. This model is essentially covering networks of technology centres that can hence increase their offering to companies by complementing it with that of other technology centres in the network. In so doing, these networks also facilitate the access to services required when these are located in another country.

[42] Some initiatives, most notably in the EU level, put the emphasis on the access of SMEs to work in common projects with technology centres located in different countries.

The suggested mechanisms related to model are the following:

- Setting up collaboration networks of technology centres targeting clear value chains

There are currently different ways to address the collaboration between technology centres (and the broader ecosystem). These can be based on a local/geographical approach, such as the Digital Innovation Hubs, or they can have a technological focus (such as those networks focusing on specific technologies). Developing networks of technology centres following a value chain-oriented approach is a complementary approach to these existing ways of collaboration by being solution-oriented. This type of approach fosters the collaboration of technology centres and other actors across technologies and geographical borders while being able to provide a more targeted response to industry needs. In this sense, the 3DP Pilot of the Vanguard Initiative[43] is an interesting example. The objective of this pilot is to accelerate market uptake of 3D printing applications by fostering cross-regional demonstration, i.e. showing a clear added value compared to what already exists at regional level, and by targeting industry-led activities to ensure the market relevance of the projects developed.

- Putting in place mechanisms for the seamless provision of services across different TCs

In the development of an R&D project, a company often needs the support from more than one technology centre throughout the project. This usually entails higher coordination costs and SMEs are not always prepared to lead the coordination of the project from one step of the process to the next one. In this sense, there are already interesting initiatives offering a single-entry point for companies and a seamless provision of services throughout the lifespan of the project. This is notably the case of the industrial biotechnology innovation and synthetic biology accelerator (IBISBA). This initiative, funded by two H2020 projects, operates in the field of bioprocessing and offers a single-entry point for clients to harmonised practices and delivery of R&D&I services for end-to-end bioprocess development[44]. The focus is on the simplification of the access to multidisciplinary services from bioprocess conceptualisation to pilot phase.

- Applying clear and simple IPR procedures

One of the challenges SMEs face when dealing with the development and commercialisation of their own products are IP procedures. This relates to the IPR negotiations towards the technology centre supporting the company in the process but also towards other (usually larger) companies that might be the end-users of the product or application. It is therefore important to set clear, simple and transparent IPR procedures. The European Commission has set up the IPR helpdesk initiative[45] that gathers resources, tools and training relating to IP topics. This initiative also offers a helpline where users can submit their questions and have access to regional experts that can help them. Interestingly, the IPR helpdesk features the Horizon IP Scan which is a free-of-charge service provided by the European Commission for European start-ups and other SMEs to efficiently manage and valorise the IP of EU-funded collaborative R&I projects.

The H2020 PITCCH project[46] offers interesting approaches in this regard. The initiative offers an open innovation network facilitating, among others, the IPR process for the negotiations between large companies and SMEs. IPR issues deserve a lot of attention within this project: tools and materials are provided by the project[47] to accompany the companies along the open innovation project. Training on IPR are also provided to companies that might require it.

- Involvement of regional policy makers to facilitate funding opportunities, e.g. through the provision of funding support (vouchers) to lower the risk for SMEs

At regional level, several initiatives exist that provide financial support schemes based on vouchers. Also various InnoSup-1 projects[48] have applied a combination of instruments to support SMEs, including vouchers. The popularity of such mechanisms is based on two main features: its simplicity in terms of administrative burden and the fact that it addresses one of the main barriers for SMEs to embark on R&D projects: access to finance. The Regional Innovation Monitor of the European Commission has compiled examples of regions where this type of mechanism has been implemented (at least until 2020),

[43] High Performance Production through 3D-Printing. More information available at : https://www.s3vanguardinitiative.eu/cooperations/high-performance-production-through-3d-printing
[44] https://www.ibisba.eu/About
[45] https://intellectual-property-helpdesk.ec.europa.eu/index_en
[46] https://pitcch.eu/
[47] Materials are available at the project website : https://pitcch.eu/
[48] https://ec.europa.eu/easme/en/news/innosup-1-providing-innovation-support-smes-develop-cross-sectoral-value-chains

such as Thuringia[49] and Baden-Württemberg[50] (Germany) or the Region of Madrid[51] (Spain). In general, these schemes are popular among SMEs, yet for many of these initiatives, there are little insights on their actual impact on SMEs.

Vouchers are also applied in various EU-funded projects. The KET4 Clean Production project presented in Section 5.1.1, for instance, offers vouchers of €50000 for the access to services based on cross-border cooperation between SMEs and at least two technology centres working on Key-Enabling Technologies located in EU countries and Horizon 2020 partner countries. The initiative ICT Innovation for Manufacturing SMEs (I4MS)[52] promoted by the European Commission to expand the digital innovation of manufacturing SMEs in Europe is another interesting example. I4MS supports the access of SMEs and mid-cap to technological and financial support to experiment with different technologies and services. There are several open calls to which SMEs can apply for depending on the scope of their project and objectives. In general, these open calls (and the financial support provided) are considered to be interesting for SMEs because 1) it lowers the financial risk; 2) they do not entail a high administrative burden; and 3) the decision on the allocation of grants/vouchers can be done quickly[53].

6.2 Awareness-based model

The awareness-based model targets primarily SMEs that are looking for certain technological solutions. The main difference with the former model is that it focuses on making the available offer more visible. In this sense, it is interesting to highlight the European Commission´s initiative 'Common mapping of innovation supporting actors' that aims at developing a central website with a mapping tool, based on existing EU-financed websites, which can be used by end-users to look for innovation facilities and supporting actors.[54] This model is found in those initiatives that are focusing on the development of communities, marketplaces, catalogues, etc.

The recommendations related to this model are the following:

- Setting up matchmaking platforms with a business-oriented focus

SMEs often do not look for a specific technological solution, but rather for a solution that can help them to address the needs of their customers. In this sense, SMEs would need to be able to know quickly and easily whether (a network of) technology centres could provide an answer to its request. This can be done 1) by presenting and communicating a clear service offer from the perspective of the companies´ needs, and 2) by being able to reply quickly to all SME requests.

Examples of such matchmaking platforms can be found at the level of individual technology centres and at regional or EU level. In the former, we can cite the case of Translucent Innovation[55], a platform for request based Open Innovation developed and owned by RISE – Research Institute of Sweden[56]. This platform (also accessible via an app) channels a stream of requests from industry that can be answered by scientists at RISE and companies in the network of Swedish Incubators & Science Parks. RISE centres and the companies in the network can answer each request. Special focus is also set in the proper management of IPR and confidentiality throughout the process.

- Creation of online catalogues with business-oriented focus

Online catalogues are powerful tools to make visible the available offer. However, the setup of these platforms might depend on the types of SMEs that are targeted. Technology savvy companies might find more useful a catalogue structured by expertise, infrastructure and equipment as these companies have a good knowledge of the exact services they need.

In general terms, at EU level the most common approach to these catalogues is the former: i.e. focusing on technology scope rather than business needs. An example of this approach can be the '3DP Pan EU' project (DG GROW, 2019-2021) which aims at fostering awareness, knowledge and uptake of 3D Printing technologies in Europe. This has been achieved by developing and delivering a functional and user-friendly online interface[57] which provides complete and comprehensive information on 3D Printing facility centres (and the services offered to SMEs in testing and validation) at the European level. The

[49] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/innovation-vouchers-12
[50] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/innovation-vouchers-small-and-medium-sized-enterprises
[51] https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/support-measure/innovation-voucher
[52] https://i4ms.eu
[53] https://i4ms.eu/open-calls/
[54] https://joinup.ec.europa.eu/collection/cmisa/about
[55] https://translucentinnovation.org/
[56] The network is operated in collaboration between RISE, SISP – Swedish Incubators and Science Parks, and Business Sweden – The Swedish Trade & Invest Council.
[57] https://3dppan.eu/sme-matching-tools

collaboration between SMEs and facility centres through the online interface is now being pilot tested through an open call for funding of 10 individual projects. Through this open call, cross-regional 3D Printing industrial demonstration projects will be supported. Examples of catalogues that are more user-friendly for non-tech savvy companies can be the mapping of ATI technology centres or the Digital Innovation Hubs catalogue. In both catalogues, the user can find the technology centre (or digital innovation hub associated to a technology centre) by filtering on the most important criteria for this type of companies: geographical proximity and sectoral scope.

- Promoting collaboration and alignment across existing initiatives

Those SMEs willing to embark on R&D projects might face difficulties finding their way through the multiple initiatives operating at regional, national and EU level. As mentioned above, there are currently several networks of technology centres operating at different levels (European, national, regional) and with a different technology/application focus. Facilitating and structuring the access and information about these initiatives could facilitate SMEs access to them. In this sense, there is a need to facilitate the access to this information for SMEs (and intermediary organisations that support them). This role of local 'satellites' in the individual countries which can bridge language and national gaps and serve as a gateway to the broader European offer can be crucial in this regard.

Efforts would be recommended in the following areas: 1) to facilitate the access to information (on the ongoing initiatives and their focus); 2) to identify synergies and complementarities.. These areas would be strengthened in practical terms by the development of a large-scale information exchange campaign among ongoing individual initiatives.

- Investing in awareness and communication campaigns on best practices and success stories

SMEs, especially downstream SMEs, have often very limited R&D in-house knowledge to be up to date with technology solutions that can strengthen their businesses competitiveness and resilience. Awareness and communication campaigns on the possibilities of technologies for specific sectors and areas of application would be needed to lower this barrier. During the workshop[58] organised in preparation for these recommendations, participants highlighted the need to set up comprehensive communication campaigns in this sense. The previous Watify campaign[59], an awareness-raising campaign aiming at stimulating the modernisation of European industry, was mentioned as a good example to follow.

6.3 Coaching-based model

The coaching-based model focuses on two of the types of SMEs that most frequently indicate the need of coaching support.

- First, downstream SMEs require this type of support to 1) identify the challenges that could be addressed through technology development or uptake and 2) determine the priorities in terms of development or investments. This model makes reference to the provision of coaching support for SMEs to start the innovation process by helping them identify and prioritise their needs and pointing them to the most appropriate 'joint-service' or 'awareness-based' network.
- Second, technology start-ups present very different challenges to those of downstream companies. Start-ups tend to require coaching support in areas that will help them commercialise and develop their own products and services (see Table 3 above).

The mechanisms that are suggested in relation to this model are:

- Developing common methodologies to be applied by different actors supporting downstream SMEs and training the coaches in applying such methodologies consistently.

It is important to support companies in the development of their own innovation strategy and provide them with tools that can facilitate this process. The development of this type of methodologies can help technology centres and other intermediary actors to provide a more tailored support to companies, addressing their challenges in a more comprehensive manner. By helping the companies assess their concrete needs, it becomes easier to find the best placed experts to support each company. At the same

[58] "Moving from technology-based networks to value chain-based networks: how to improve the effectiveness of cross-border networks of ATI technology centres?": this workshop took place on 24 September 2020 and was organised within the abovementioned Advanced Technologies for Industry (ATI) project.
[59] The campaign focuses on the technological transformation of traditional SMEs, promotion of regional digitisation and uptake of Advanced Technologies – notably Key Enabling Technologies. https://ec.europa.eu/growth/tools-databases/dem/watify/

time, these methodologies can have a strong positive effect on the ecosystem as they might reinforce the interaction between actors operating within the same innovation ecosystem (technology centres, cluster organisations, innovation agencies, service providers, etc.).

An example of such methodology targeting downstream SMEs is the one developed by the ADMA initiative[60]. This project focuses on facilitating the access of manufacturing SMEs to technological, organisational, financial as well as business model expertise. This support features a methodology that addresses the digitalisation of companies from a holistic perspective[61]. This methodology is the basis for the short and long scans that the ADMA initiative has developed for companies to be able to have a more in-depth view of their needs and to assess their investment priorities in their efforts to become a Factory of the Future. On the basis of the outcome of these scans, a 'transformation plan' is drafted with the help of an advisor and relying upon a transformation plan template and guidelines, made available by the initiative. Finally, a selected number of SMEs will receive support from coaches in order to draft an 'implementation plan'. This methodology and tools are designed so that it will be applicable in the future by organisations outside the ADMA consortium. In this sense, the project stemming from the INNOSUP-08-2020 call (Pan-European advanced manufacturing assistance and training for SMEs) will contribute to the further roll out of this methodology at EU level.

An interesting example of coaching support provided to technology start-ups is the one offered by the European Innovation Council (EIC) launched in March 2021. The EIC is a novelty of Horizon Europe and is presented as the most ambitious innovation initiative that Europe has taken, with a budget of €10 billion for the period 2021-2027. The EIC is based on a pilot programme carried out under Horizon 2020 and combines research on emerging technologies with an accelerator programme and a dedicated equity fund (the European Innovation Council Fund) to scale up innovative start-ups and SMEs. The EIC business coaching programmes are available for various target groups and are said to be tailor made for each of them[62] (the name of the programme in parentheses):

- To improve the value proposition, business plan and investor pitch (Accelerator).
- To discover innovation opportunities and to provide insight in the entrepreneurship potential (Pathfinder)
- To analyse the industry and to create a value proposition (Transition).
- To improve the business plan, the strategy implementation and a faster market entry (Accelerator).

- Training the companies in a way that they can detect their innovation needs and act accordingly

SMEs across Europe indicate to have problems in hiring people with the required expertise and skills[63]. These companies might be reluctant to introduce changes in their companies´ ways of working if they do not have the required expertise to lead this process in-house or find difficulties to hire the required profiles. Actions aiming to reinforce the upskilling and reskilling of SMEs´ employees and workers would contribute to the willingness of SMEs to introduce technology developments in their companies (and hence to access networks of technology centres to help them develop them). Addressing these skill needs can hence have a positive impact on the degree of awareness of new technologies and their potential for the companies, hence fostering the demand side of technologies and innovation.

There are a number of initiatives at EU level targeting these types of trainings but the information on the available training offer is fragmented. The EU SME Strategy for a sustainable and digital Europe announced on the 10th of March 2020 included the setup of digital crash courses for SME employees to become proficient in areas such as AI, Cybersecurity or Blockchain[64]. The EU´s industrial strategy latest update also pays a lot of attention to skills, highlighting the role of initiatives like the European Skills Agenda[65], the Pact for Skills, the Blueprint for Sectoral Cooperation on Skills, the Digital Skills and Jobs

[60] https://www.adma.ec/
[61] The ADMA methodology has seven transformations: Advanced Manufacturing Technologies, Digital Factory, ECO Factory, End-to-End Customer Focussed Engineering, Human Centred Organisation, Smart Manufacturing and Value Chain Oriented Open Factory.
[62] There is an additional coaching programme targeting women, the Women Leadership Program (WLP), to address potential glass ceiling issues.
[63] See, for instance, recent work on skills for SMEs:
Capgemini Invent, European DIGITAL SME Alliance, Technopolis Group (2019). Skills for SMEs: Supporting specialised skills development: Big Data, Internet of Things and Cybersecurity for SMEs. https://op.europa.eu/en/publication-detail/-/publication/bb5c6c09-6285-11ea-b735-01aa75ed71a1/language-en
PwC (2019). Skills for Smart Industrial Specialisation and Digital Transformation. https://op.europa.eu/en/publication-detail/-/publication/21a549e7-05c8-11ea-8c1f-01aa75ed71a1/language-en/format-PDF/source-search
[64] https://ec.europa.eu/digital-single-market/en/news/sme-strategy-launched-european-commission
[65] COM(2020)274, European Skills Agenda for sustainable competitiveness, social fairness and resilience

Coalition and the European Alliance for Apprenticeships. The first European skills partnerships in key industrial ecosystems have also been announced recently, as well as a vision for achieving the European Education Area and a new Digital Education Action Plan (2021-2027).

Training courses for SMEs on Advanced Technologies have been provided so far at EU level under different programmes and with varying technological, geographical and SME target focus[66]. This leads to a rather fragmented landscape where SMEs might have difficulties finding the available offer that might better suit their needs.

The development of common frameworks and their uptake by national and regional policy makers (e.g. with regards to the mobilisation of funding instruments) and by service and training providers can help to structure and make visible the available offer (and gaps). SMEs will be in a better position to more easily 1) find the training courses and 2) choose the one that is more aligned with their needs. In this sense, it is worth noting the upcoming INNOSUP-08 call where the ADMA methodology will be scaled up together with the roll out of a training programme in advanced manufacturing.

- Demonstrating the outcome of the support provided to SMEs

One of the barriers companies face when considering embarking on R&D projects or adopting new technologies is the uncertainty on the business returns and the impact on their business. This uncertainty might be reduced if the impact of the support on companies is measured. Concrete examples of how certain technology or support have strengthened companies´ operations can inspire and motivate other companies, especially SMEs to take similar steps. At EU level, the KET4CleanProduction project constitutes a good example of this approach: the project has gathered various examples of best practices where technology centres join forces to address SMEs technological challenges in the field of clean production[67] The Belgian Made Different initiative which focuses on the provision of coaching support for manufacturing companies constitutes a good example of this. The initiative targets the manufacturing industry and proposes a framework based on seven transformations to develop factories of the future. The companies that access the initiative go through a process in which their needs and priorities are assessed, and a project is developed with partners of the initiative. Once the company achieves a high degree of maturity, it can apply for the Factories of the Future awards[68]. These awards showcase successful examples of digitalisation, smart specialisation and innovation in manufacturing companies. One of the most important objectives of these awards is to show other companies the possibilities of both technological and human-centred transformative innovations and inspire them to follow the same path.

[66] Initiatives fostering trainings for SMEs in these areas have been funded, for instance, by:
Interreg projects: e.g. the SKILLS+ project (https://www.interregeurope.eu/policylearning/good-practices/item/1680/trainings-for-sme-for-development-of-innovations-and-digital-technologies/)
ERAMUS+ projects: e.g., the project DIGIT-T (https://www.interregeurope.eu/policylearning/good-practices/item/1680/trainings-for-sme-for-development-of-innovations-and-digital-technologies/)

[67] More information of these best practices and success stories can be found here : https://www.ket4sme.eu/success-stories

[68] https://www.digitalwallonia.be/fr/publications/laureats-industrie-du-futur

About the 'Advanced Technologies for Industry' project

The EU's industrial policy strategy promotes the creation of a competitive European industry. In order to properly support the implementation of policies and initiatives, a systematic monitoring of technological trends and reliable, up-to-date data on Advanced Technologies is needed. To this end, the Advanced Technologies for Industry (ATI) project has been set up. It provides policymakers, industry representatives and academia with

- Statistical data on the production and use of Advanced Technologies including enabling conditions such as skills, investment or entrepreneurship;
- Analytical reports such as on technological trends, sectoral insights and products;
- Analyses of policy measures and policy tools related to the uptake of Advanced Technologies;
- Analysis of technological trends in competing economies such as in the US, China or Japan;
- Access to technology centres and innovation hubs across EU countries.

You may find more information about the 16 technologies here: https://ati.ec.europa.eu.

The project is undertaken on behalf of the European Commission, Directorate General for Internal Market, Industry, Entrepreneurship and SMEs and the European Innovation Council and Small and Medium-sized Enterprises Executive Agency (EISMEA) by IDC, Technopolis Group, Capgemini, Fraunhofer, IDEA Consult and NESTA.

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