Centres for European Policy Network
FREIBURG | BERLIN | PARIS | ROMA

cepInput

Nr. 5 | 2023 6 April 2023

Catalyzing the EU's Green Industrial Transformation

A Survey of the Cleantech Startups Environment in Germany, France, and Italy

Anselm Küsters, Anna Meister, Eleonora Poli, Victor Warhem, André Wolf

The US Inflation Reduction Act, which aims to boost sustainable companies in the domestic market, has pushed the EU to launch the Net-Zero Industry Act and the Green Deal Industrial Plan. However, Europe's ambitious strategy requires innovative cleantech startups to successfully introduce new technologies that increase energy efficiency or replace non-renewables. This cepInput points to this overlooked facet of the envisioned economic transition by analysing the current environment for cleantech startups in the cepNetwork countries from different perspectives. Here are its key insights:

- No harmonised definition of cleantech startup exists in the EU today, which prevents any simple European endeavours from supporting this type of company. Policymakers must harmonise national legal cleantech-related categories underlying their green innovation agendas.
- Cleantech startups in Italy, Germany, and France face difficulties accessing funding, especially in their development and growth phases. Hence, private venture capital ecosystems should be promoted through public investment banks' participation in roundtables acting as leverage for private funds.
- Bureaucratic reflexes in all countries prevent cleantech startups from quickly growing – for instance, establishing their first industrial production site – which reveals the urgent need for further simplification reforms to promote cleantech startup developments.

Table of Contents

List of Figures

1. Motivation

Innovation is an essential driver of economic growth in the European Union (EU). It allows economic systems not only to remain competitive but also helps overcome social and economic challenges.[1] Currently**, climate change, inflation, and the energy crisis, as well as increasing competition within a global market often dominated by digital giants from the US and China, are just some examples of these stress tests the European economy has to deal with**. Moreover, when it comes to innovation, Europe is often considered the "old continent", unable to reinvent itself. However, such an assumption is wrong. Not only has the EU a long history of generating innovative products, systems and models, but still today, it is optimally positioned to lead innovation waves. **In 2022, the majority of the top 30 most innovative economies continued to be from Europe**.[2] Yet, to define where the EU is innovative and where it is deficient, it is important to define what innovation means. Indeed, **innovation is a blurry term**. According to the OECD, it could deal with a good or a service that is new or significantly improved (**Product Innovation**), or with a new or significantly upgraded production or delivery method (**Process Innovation**). Innovation could also entail a new marketing or organizational method (**Marketing Innovation** or **Organizational Innovation**).[3]

In order to provide a more explicit analysis of innovation within the EU, this paper will concentrate less on the nature of innovation per se and more on specific subjects delivering innovation within sectors considered to possess high potential in terms of long-term and sustainable economic growth. Hence, the notion of innovation considered here is more fluid, encompassing all the four aspects mentioned by the OECD. This is in line with the definition of innovation by Moore, namely as a general capacity to create novel and valuable products or knowledge that positively impact economic development. [4]

Building on the premises of the EU Green Industrial Plan, innovation is at the base of the transformation process needed by the EU to support a fast transition to climate neutrality and create sustainable long-term welfare for societies. Indeed, as French President Emmanuel Macron outlined, in a historical moment when abundance is over,[5] to remain competitive and generate long-term growth, **European member countries must become smarter in optimizing scarce resources** and renew their way of producing and delivering goods and services. This is especially pressing given the European Green Deal, which aims to transform the EU into the first climate-neutral continent by 2050 and to reduce net greenhouse gas emissions by at least 55% by 2030. Against this backdrop, the European Commission has developed a **New Innovation Agenda to make the EU a leading player in innovation, especially in green energy and digital technologies**. The agenda considers five flagship areas where the EU aims to invest in the following years, such as the need to increase private capital investments, develop incubator initiatives or attract talents through specific visas, to name a few.

---

1 Agénor, P. R., & Neanidis, K. C. (2015). Innovation, public capital, and growth. *Journal of Macroeconomics*, *44*, 252-275; Galindo, M. Á., & Méndez, M. T. (2014). Entrepreneurship, economic growth, and innovation: Are feedback effects at work?. *Journal of business research*, *67*(5), 825-829; Bottazzi, L., & Peri, G. (2003). Innovation and spillovers in regions: Evidence from European patent data. *European economic review*, *47*(4), 687-710.

2 https://www.globalinnovationindex.org/Home.

3 Manual, Oslo. "The measurement of scientific and technological activities." Proposed Guidelines for Collecting an Interpreting Technological Innovation Data 30.162 (2005): 385-395.

4 Zheng, Y., Liu, J., & George, G. (2010). The dynamic impact of innovative capability and inter-firm network on firm valuation: A longitudinal study of biotechnology startups. *Journal of Business Venturing*, *25*(6), 593-609. Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard business review*, *71*(3), 75-86.

5 https://www.france24.com/en/video/20220824-macron-warns-sacrifices-ahead-after-end-of-abundance.

Moreover, the energy crisis generated by the Russian invasion of Ukraine and the US Inflation Reduction Act, which aims to inject 369 billion dollars into the US market to boost sustainable companies, have pushed the EU to launch **the Green Deal Industrial Plan**. Its prime goal is to develop globally competitive production capacities and supply chains for climate-neutral technologies in Europe.[6] As a first catalogue of measures, the European Commission has published a draft of a **Net Zero Industry Act**. At its core is the identification of so-called Net Zero Resilience Projects of strategic importance, which are supposed to be prioritized in approval procedures and access to public funding.[7] However, with such a focus on impressive frontrunner projects, it is unclear what role startups and their innovative solutions will play in a future framework of support.[8] There is a danger that by prioritizing large-scale solutions, the existing barriers to growth for startups in the cleantech field will remain disregarded, thus stifling innovation as a key to future competitiveness of Europe in Net Zero technologies. As one example, available data indicates difficulties for EU cleantech startups in receiving significant venture capital funding, especially in comparison to capital markets in the US (see Figure 1).

Against this backdrop, **this paper contributes to the debate on green transformation by focusing on the overlooked role of cleantech startups and their regulatory environment.** As the paper will outline, the prospect of their economic development in Europe is enormous. However, it could still be better, as the number of startups in the EU, especially in some member countries, is still below expectations.[9] In brief, the paper will analyse cleantech startups in the EU by considering the biggest Eurozone economies, namely Germany, France and Italy. Indeed, despite their different socio-economic indicators, with Italy exhibiting the highest rates of unemployment and national debt compared to the other two, the three countries represent the most economically developed Eurozone member countries in terms of GDP. Moreover, they embody three different models of capitalism that could make them paradigms for other EU countries.[10] Such differences are also evident in innovation.[11] According to the Global Innovation Index, in 2021, Germany and France were among the Top 25 most innovative economies in the world, being positioned respectively at 8th and 12th place, while Italy lagged, being at 28th place.

The paper will be structured as follows: The first part will provide a working definition of cleantech startups, here identified as companies combining innovation and attention to the environment (Section 2). It will then provide a quantitative analysis of the cleantech startups across the three countries by crosschecking several European databases to conduct a partial empirical mapping of the emerging cleantech scenes in Germany, France, and Italy (Section 3). Third, it will analyse the national landscapes

---

6 European Commission (2023). The Green Deal Industrial Plan: putting Europe's net-zero industry in the lead. https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510

7 European Commission (2023). Proposal for a Regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act), COM/2023/161 final.

8 In fact, the entire draft of the Net Zero Industry Act refers to startups explicitly only once, in the contect of providing priority access to regulatory sandboxes (Art. 26).

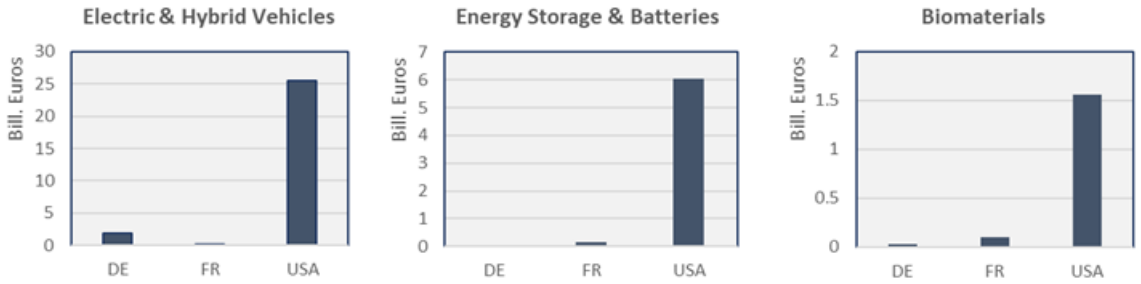
9 DB Research (2016), Start-ups and their financing in Europe: Out of the woods with Capital Markets Union, EU Monitor (September 29, 2016).

10 Schmidt, V. (2003). French capitalism transformed, yet still a third variety of capitalism. *Economy and society*, *32*(4), 526-554.Kornelakis, A. (2011). Dual convergence or hybridization? Institutional change in Italy and Greece from the varieties of capitalism perspective. *CEU Political Science Journal*, *6*(1), 47-82. Sternberg, R., Kiese, M., & Stockinger, D. (2010). Cluster policies in the US and Germany: varieties of capitalism perspective on two high-tech states. *Environment and Planning C: Government and Policy*, *28*(6), 1063-1082.

11 Adner, Ron, 2006. Match your innovation strategy to your innovation ecosystem. Harv. Bus. Rev. 84 (4), 98–107; Schmid, J., & Kwon, S. (2020). Collaboration in innovation: An empirical test of Varieties of Capitalism. *Technological Forecasting and Social Change*, *157*, 120099.

in the above countries by considering their regulatory frameworks and policies favouring the development of startups and cleantech startups, as well as views of entrepreneurs in some cases (Section 4), before concluding (Section 5).

Figure 1: Total Venture Capital Deal Volumes for Selected Clean Technologies 2019-2021



Source: KfW Research (2022)[12]; own representation.

2. General Definition of Cleantech Startups

According to Joseph Schumpeter, innovation is deeply connected with entrepreneurs' creative destruction. This refers to their ability to combine "creativity" and "novelty" to allow the economy to experience changes, attempt progress, and generate added value in the form of new goods and services.[13] As outlined by Skala, the core nature of startups, or a set of entrepreneurship projects dealing with the creative business, science, technology or the digital industry, are deeply interrelated with implementing innovation.[14] Originally, the term startups referred to any form of business in its early stage of development.[15] Yet, by the beginning of the 1970s, the term was then used only to refer to ambitious and innovative technological undertakings with a temporal framework. Indeed, as Blank highlights, a startup is a temporary organisation created to develop "a repeatable and scalable business model".[16] Normally, startups have three different characteristics differentiating them from small, medium or large companies. They aim to become a large company with a massive impact in a specific sector or create a new market. Startups constantly test new business models, and they usually have a financing structure that, at the advanced stage of development, incorporates resources from external sponsors intending to reduce the funders' share in the company's capital.[17] Among the several different startups, the paper addresses those that can aim to combine innovation and a contribution to a cleaner environment, here defined as cleantech startups. Cleantech startups pay in-depth attention to high technological and environmental standards to innovate how products, services or value processes encompassing different sectors are produced and sold.[18]

12 KfW Research (2022). Venture Capital: Marktchancen in Zukunftstechnologien. Nr. 392/2022.
13 Schumpeter, J. (1942). Capitalism, socialism and democracy. New York: Harper & Brothers.
14 Skala, A., Skala, & Barlow. (2019). *Digital Startups in transition economies*. Springer International Publishing.
15 Breschi, S. J., Lassébie, C., & Menon, C. (2018). A portrait of innovative startups across countries (OECD Science, Technology and Industry Working Papers). OECD; Csaszar, F., Nussbaum, M., & Sepulveda, M. (2006). Strategic and cognitive criteria for the selection of startups. Technovation, 26(2), 151–161.
16 Blank, S. (2013). Why the lean startup changes everything. Harvard Business Review, 91(5), 63–72.
17 Skala, A., Skala, & Barlow. (2019). *Digital Startups in transition economies*. Springer International Publishing.
18 Pernick, R., & Wilder, C. (2007). The clean tech revolution: the next big growth and investment opportunity, Collins.

Different from the greentech startups, which adopt technical solutions already in use and have limited environmental impact, cleantech startups use innovative solutions to decrease waste or restrict the use of non-renewable resources and positively impact the environment.[19] Regarding sustainable economic growth, job creation and financial returns, clean tech startups certainly have high potential, which should urge national governments to create favorable conditions for their development.[20] On the one hand, the reconciliation of economic and environmental performance embodied by cleantech is central to promoting long-term sustainable economic growth. On the other, different from traditional business, cleantech's mission is explicitly related to creating positive externalities that benefit the entire national and international communities. Hence, understanding which characteristics favour the developments of cleantechs could help national governments design better policies to stimulate their growth.[21]

Against this backdrop, the following sections will map cleantech startups across Germany, France, and Italy to then develop an analysis of the national regulatory landscapes to identify national best practices or effective initiatives that could be replicated at the EU level.

3. Empirically mapping the cleantech sector in Germany, France, and Italy

To empirically map the emerging cleantech startup scenes in Germany, France, and Italy, we search several online databases and industry reports and merge the information into a novel dataset that can be explored quantitatively and with the help of Natural Language Processing (NLP) methods. This is known as a "text as data" approach in the current research literature.[22] To construct our dataset, we start with an analysis of the EU Startups database, the most comprehensive database freely available online.[23] The startup database promises the list of "the most promising startups in Europe" and includes several thousand startups. However, it is essential to note that startups must register themselves and pay after the first 1000 days of being listed online, which means that the sample is likely distorted and incomplete. However, even if the database suffers from self-selection bias, we expect to get a good impression of crucial national players (as the most successful startups are likely able to afford to list themselves in this database) and a good overview of the cleantech startup scene in Germany, France, and Italy (due to the overall high number of listed startups).

Searching the business descriptions of all listed startups, as given by the EU Startups database, for the term "clean tech" leads to 74 results at the time of writing (November 2022). There are 43 startups in this area in Germany, 19 in France and 12 in Italy. For this sample of 74 startups, we manually extract information about their company name, country of residence, city of residence, funding information (if available), and year of establishment. In addition, we manually search their websites for further information about their business model and extract all textual information from their respective

[19] Cumming, D., Henriques, I., & Sadorsky, P. (2016). 'Cleantech' venture capital around the world. International Review of Financial Analysis, 44(March), 86–97. Georgeson, L., Caprotti, F., & Bailey, I. (2014). It's all a question of business': investment identities, networks and decisionmaking in the cleantech economy. Geografiska Annaler: Series B, Human Geography, 96(3), 217–229.

[20] Pernick, R., & Wilder, C. (2007). The clean tech revolution: the next big growth and investment opportunity, Collins.

[21] Giudici, G., Guerini, M., & Rossi-Lamastra, C. (2019). The creation of cleantech startups at the local level: the role of knowledge availability and environmental awareness. *Small Business Economics*, *52*(4), 815-830; Xian'guo Li. (2011). *Green Energy: Basic Concepts and Fundamentals*. Springer.

[22] For a concise and up-to-date overview, see: Justin Grimmer Margaret E. Roberts Brandon M. Stewart. Text as Data: A New Framework for Machine Learning and the Social Sciences. Princeton: Princeton University Press, 2022.

[23] https://www.eu-startups.com/directory/.

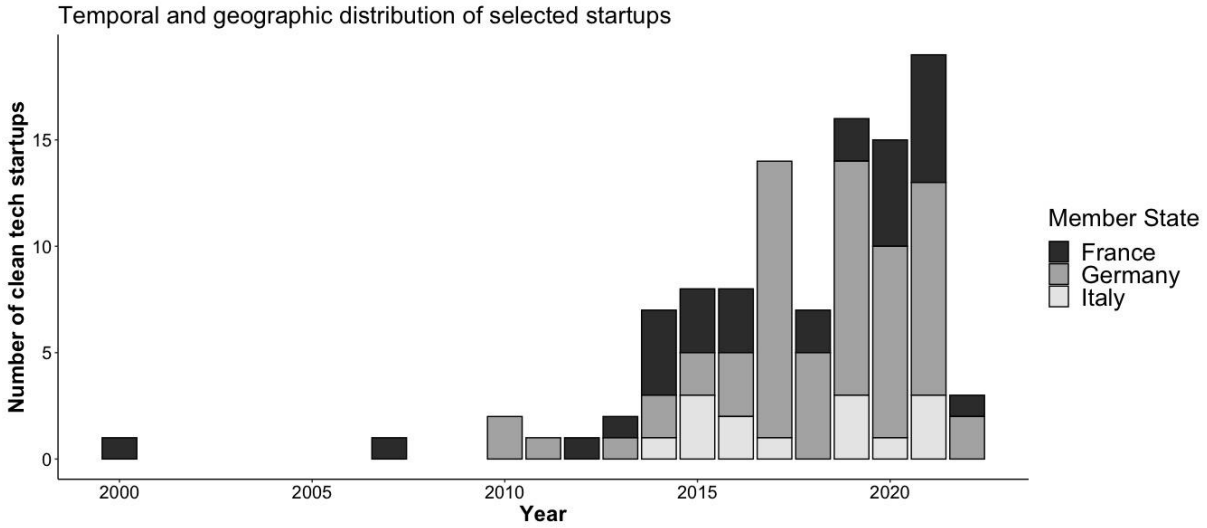
"About us" sections. In order to broaden the amount of text data for later NLP analytics, we merge the business descriptions from the EU Startups database with the additional texts scraped from the respective startups' websites, thereby creating one overall text variable in our dataset.

We consult other datasets and websites to increase the number of observations as much as possible. This includes "Europe's top 30 cleantech startups" as ranked by the "Climate-KIC" network,[24] the "Top Clean Energy Startups in Europe in 2022" list given by the online startup community "wellfound",[25] the "Top Clean tech Startups in Europe" list provided by "StartupCity" magazine[26] and the "Global Cleantech 100" assembled by the Cleantech Group.[27] For each of these three sources, we search startups stemming from one of the three selected EU member states and check whether they have been already listed in our dataset – whenever this is not the case, we add them to the list and search for the same metadata as given for entries in the EU Startups database. This leads to the inclusion of 25 additional startups into our sample (8 from "Europe's top 30 cleantech startups," 16 from "Top Clean Energy Startups in Europe in 2022," and 1 from "Top Clean tech Startups in Europe"). Other potential sources such as "Crunchbase,"[28] the Orbis Database on startups,[29] "Tracxn"[30] or "vestbee"[31] were not consulted since they either required credit card information or did not respond to our requests in time. However, we expect that sifting through the four databases mentioned above already gives a comprehensive overview of the European cleantech startup scene.

The complete dataset thus combines the information from several startup databases. It features 105 companies in Germany, France, and Italy, including information on the source, name, country, business description, city, tags, funding, year, website texts, and further notes. To get a sense of the size of the underlying text data, we calculated the number of tokens included in the metadata: Taken together, the business descriptions contain 9,437 words, also known in NLP terminology as "tokens" (average: 90 tokens per startup), and the website texts consist of 23,138 tokens (average: 220 tokens per startup). Figure 2 gives an overview of our sample with respect to both geography and time period. As can be seen from this visualisation, the dataset covers mainly the years from 2014 to 2022 (albeit featuring some older startups from previous years) and includes predominantly German startups. In total, there are 61 German startups, 30 French, and 14 Italian in our sample.

[24] https://www.climate-kic.org/news/top-30-cleantech-startups/.
[25] https://angel.co/startups/l/europe/clean-energy
[26] https://cleantech-europe.startupcity.com/vendors/top-cleantech-startups-in-europe-and-uk.html.
[27] https://www.cleantech.com/the-global-cleantech-100/.
[28] https://www.crunchbase.com/.
[29] https://www.bvdinfo.com/en-gb/our-products/data/international/orbis.
[30] https://tracxn.com/.
[31] https://www.vestbee.com/.

Figure 2: Temporal and Geographic Distribution of Selected Startups



Source: own calculations.

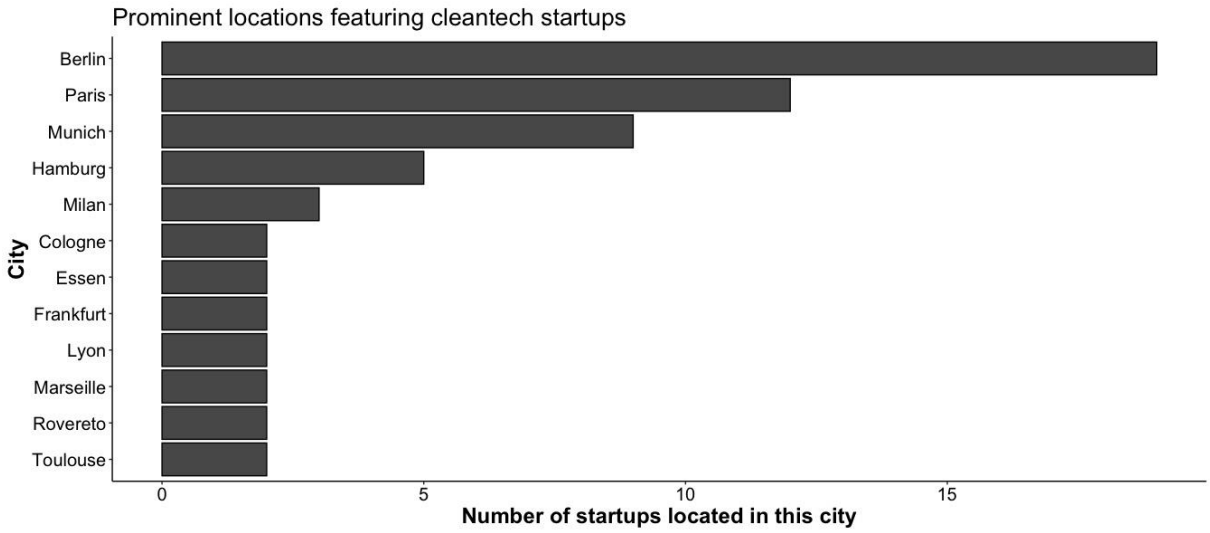
As we also recorded the city in which the startup was established, we can use the dataset to investigate whether some locations are preferred by cleantech startups in Germany, France, and Italy (Figure 3). This is of interest, as in neoclassical economic theory, having a single area with numerous successful companies will lead to agglomeration and spillover effects from the abundance of investors, mentors, and talent that can be leveraged. Albeit technology has made it possible to work from anywhere in the world, some research suggests that there are still benefits from working together in person. Results show that university spillovers are positively correlated with the creation of innovative startups. Furthermore, human capital significantly influences the location decisions of startups, being a source of competitiveness for firms close to universities.[32] Startups can offer large firms access to new technologies, so there is increasing awareness that corporate-startup collaboration matters, too.[33] Nevertheless, other researchers suggest that there is currently a trend towards a lean phase in technology-based global startup research and practice, where location becomes less relevant as talent is globally spread.[34] We investigate the relevance of location here quantitatively and, further below, qualitatively in our interviews. According to the quantitative perspective, Berlin, Paris, Munich, Hamburg, and Milan dominate our sample (Figure 3). Interestingly, these are not necessarily national capitals or cities with particularly well-known tech universities, such as MIT in Silicon Valley.

[32] Calcagnini, G., Favaretto, I., Giombini, G. et al. The role of universities in the location of innovative startups. J Technol Transf 41, 670–693 (2016). https://doi.org/10.1007/s10961-015-9396-9.

[33] Annika Steiber, Technology Management: Corporate-Startup Co-Location and How to Measure the Effects, Journal of Technology Management & Innovation vol.15 no.2 Santiago ago. 2020.

[34] Tanev, Stoyan. (2017). Is There a Lean Future for Global Startups?. Technology Innovation Management Review. 7. 6-15. 10.22215/timreview/1072.

Figure 3: Prominent Locations Featuring Cleantech Startups



Source: own calculations.

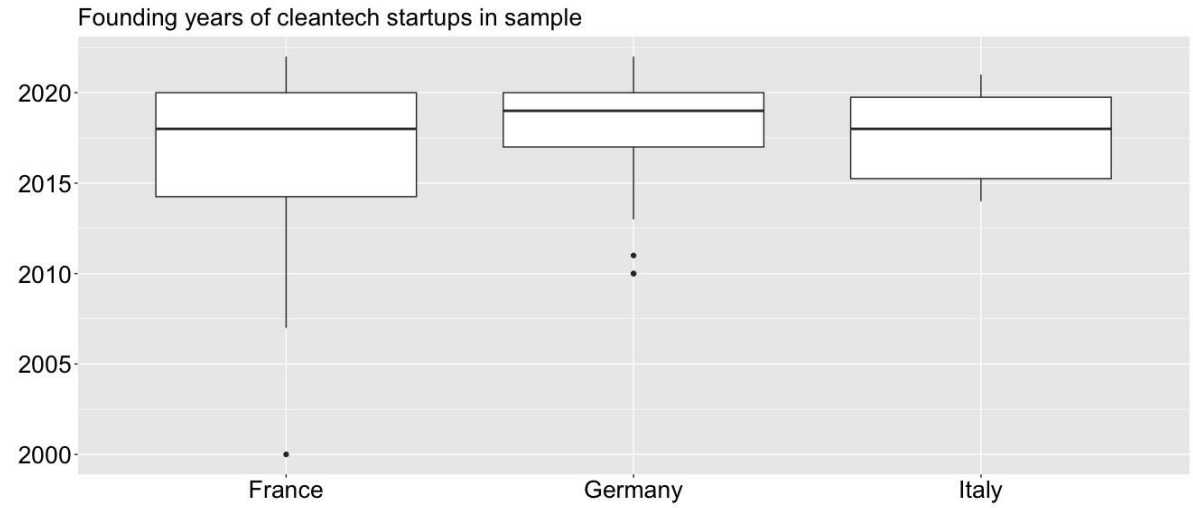
Next, we want to know when these startups were founded and whether we can learn about their average corporate life. As currently envisioned and drafted, EU funding and general support schemes for cleantech startups must consider somewhere in the valuation that most young companies do not survive empirically.[35] According to a US study, information-industry firms have a seven-year survival rate of 24.8%.[36] In this context, we want to learn from our dataset whether there are national differences concerning year of establishment and, thus, likely age. Knowing the average age of startups is an important proxy for the respective startup scene, financing and regulation: Researchers investigating samples of European startups have found that larger startups and startups with less founding leverage are more likely to survive for more extended periods.[37] The same is true of startups that opt to maintain a unique bank-lending relationship and those with a bank among its shareholders. To gain an overview of the year structure of startups in our sample, we use a boxplot diagram (Figure 4). Boxplots are a well-known method for graphically demonstrating numerical data's locality, spread and skewness groups, here year of foundation. According to this figure, on average, Germany has the "youngest" startups. In contrast, our dataset's Italian and especially French startups seem relatively older.

[35] Damodaran, Aswath, Valuing Young, Startup and Growth Companies: Estimation Issues and Valuation Challenges (June 12, 2009). http://dx.doi.org/10.2139/ssrn.1418687.

[36] Knaup, Amy E. and Merissa C. Piazza. "Business Employment Dynamics Data: Survival and Longevity, II." Monthly Labor Review 130 (2007): 3-10.

[37] Farinha, Maria Luísa Alcoforado, and João Santos. The survival of startups: Do their funding choices and bank relationships at birth matter?. SSRN, 2006.

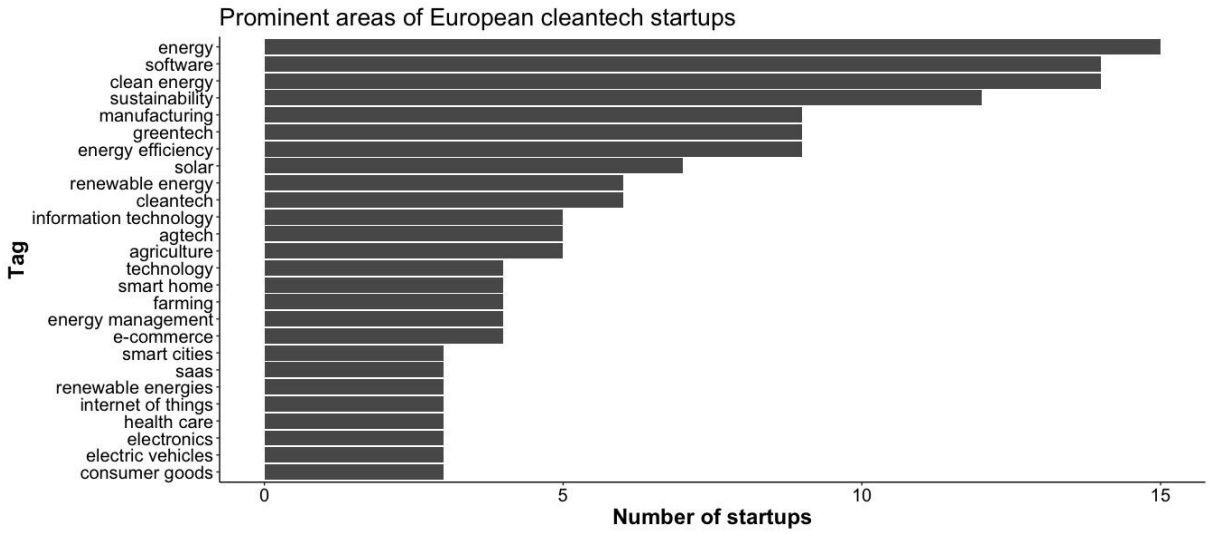
Figure 4: Founding Years of Cleantech Startups



Source: own calculations.

After surveying descriptive statistics about the country of origin and time period, location, and year of establishment, we want to gain a deeper understanding of the economic fields in which our chosen cleantech startups are engaged. To do so, we concentrate on the "tags" that characterize each startup in the sample. For most startups, these tags were extracted from the EU Startups database. We manually allocated designations for the remaining firms on our list, aiming to use the same categories as established on the EU Startups website. We could not simply count the different tags, as many startups are assigned several tags simultaneously, which are stored within the same "text" variable. Therefore, we conducted an NLP operation, namely a string separation, that allowed us to count each tag individually and remove all white space before and after the tags. The resulting frequency counts are shown below in Figure 5. This visualization illustrates that most cleantech startups in our sample focus on alternative energy sources, such as solar, or hope to increase the energy efficiency of existing sources. Moreover, there are references to making agriculture/farming cleaner, adopting smart home/smart city technologies, and revolutionizing health care. The technology focus of the startups, legitimizing their self-declaration as "cleantechs" and in line with our definition from the previous section, becomes evident from frequently given tags such as software, information technology, the internet of things and electronic vehicles.

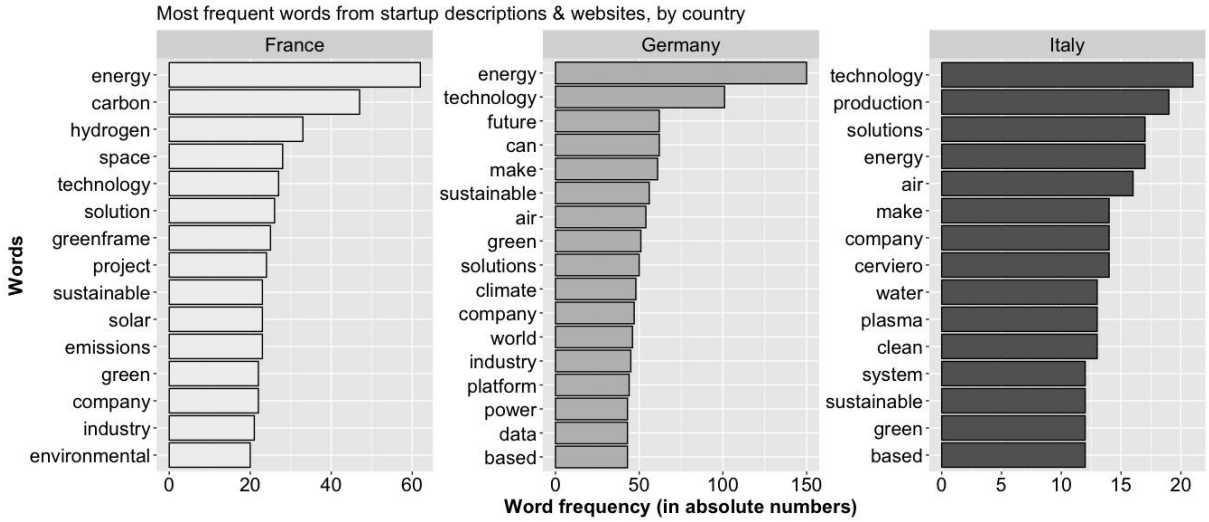
Figure 5: Typical Activities Pursued by European Cleantech Startups



Source: own calculations.

To get a more detailed overview of the activities pursued by the startups in our sample, we searched for the most frequent terms included in the dataset's text variable, which is, as mentioned earlier, created by combining the startups' business descriptions with the self-descriptions from their respective websites. Here, it is helpful to differentiate according to country of origin to identify national differences and/or similarities. The results are shown in Figure 6. Most startups frequently talk about "energy" and "technology", in line with their definition of cleantech. There are also some distinctive traits: French startups often speak about "carbon", "hydrogen", and "space"; German startups prefer the words "data" and "platforms", pointing to the business models of many of these firms; and Italian startups talk about "water" and "plasma". It needs to be noted that the Italian sample is relatively small and thus less significant in its explanatory power.

Figure 6: Most Frequent Words Used by Cleantech Startups

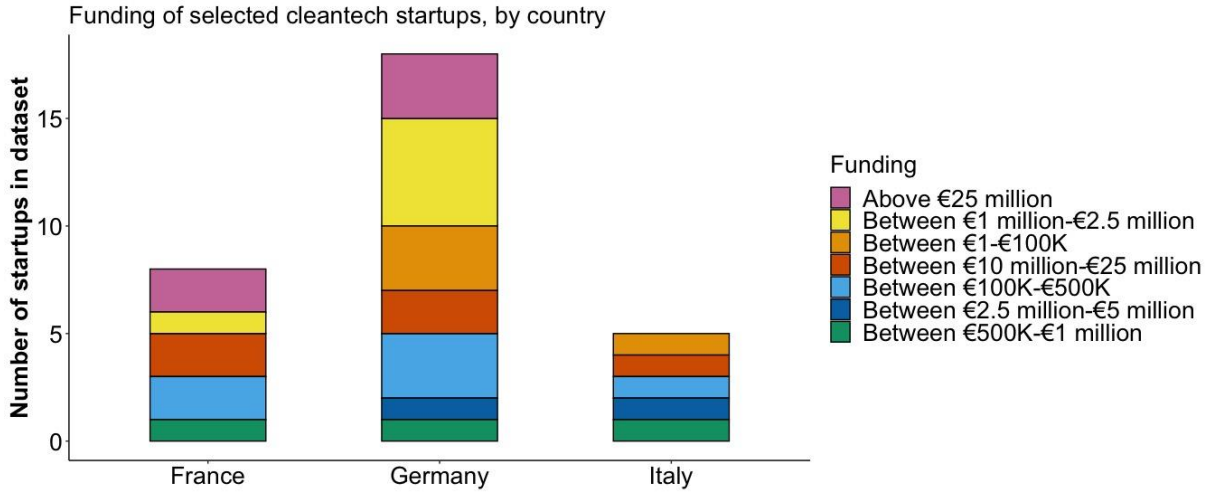


Source: own calculations.

Finally, to structure the subsequent qualitative analysis and guide our selection of insightful interview partners, we can utilize the fact that our dataset includes (public) information on funding. It is to be

expected that the most relevant startups for our research question have acquired some form of financing in the past years, so we rank all listed startups by the amount of money that they have raised (Figure 7). As can be seen from this list, Italian startups suffer from a lack of funding as opposed to their German and French competitors, who have secured larger funding rounds. Unfortunately, we cannot provide precise information on average funding levels of considered startups by country to stress that this discrepancy at the top is not just due to the limited number of Italian firms in the sample.

Figure 7: Funding of Startups, by Country



Source: own calculations.

After surveying the most important startups for each selected member state in terms of money raised, we have a first impression of important topics as well as policy and regulatory issues that might be relevant for the qualitative analysis. In this way, our dataset loosely guides our subsequent discussion and provides a high-level survey. We also aim to find interview partners that have already raised significant rounds of funding to ensure that our legal and economic analysis is relevant to the key players in this emerging field. However, it was only possible in some instances to conduct interviews with startups selected in this way, as they typically do not possess dedicated PR offices that can respond to academic inquiries in time. Where appropriate, we thus also rely on descriptions of other relevant startups as well as reports, newspaper articles and academic literature. Before we start analysing the business plans of typical firms in this sector and the regulatory hurdles they encounter, however, we need to survey the support schemes for cleantech in each country considered by this study.

4. Public Support Schemes for Cleantech Startups and Hurdles to be Overcome

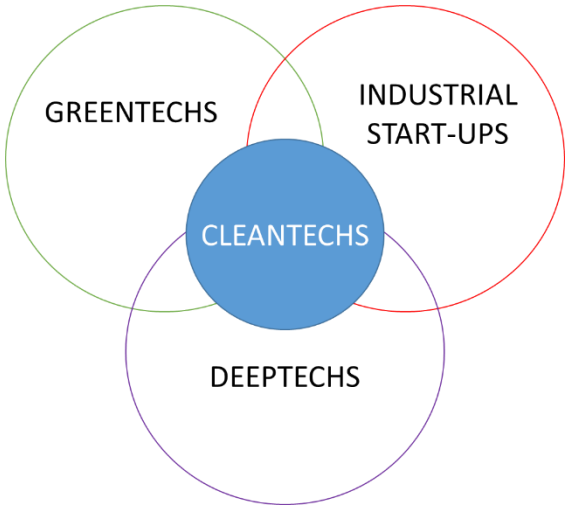
4.1 France

Since 2018, investments by financial funds in cleantech have been skyrocketing in France, increasing from about 400 M € total investments[38] in 2017 to 1,6 to 2,3 bn € investments in 2021, depending on the counting method[39]. Cleantech investments in 2022 will probably exceed that level despite the general slowdown observed since the beginning of the war in Ukraine, with, for instance, startups like Electra or Zeplug having respectively raised 160 bn € and 240 bn € for electric charging points.[40]

Even if this dramatic increase in public and private fundraising efforts is a sign that a real cleantech ecosystem can be sustained in France, it remains far less than what Germany, a comparable country in terms of cleantech developments, achieved over the last few years, especially in 2021, when it counted more than three bn € raised by financial funds for cleantechs.[41]

Yet, if some official metrics exist to measure funds raised for cleantech startups in France, none exists to define the public support dedicated to this specific pool of startups. Still, three other categories are used for public support, encompassing the entire scope of cleantechs: greentechs, deeptechs and industrial startups. Their definition and scope are first needed before introducing public support schemes in France in their favour and, hence, in favour of cleantechs, and finally, detailing paths for improvement.

Figure 8: Cleantechs' Scope in 2023 Following Official French Startup Category Definitions



Source: own conception based on Bpifrance reports.

[38] Bpifrance, Panorama des Greentechs en France, 05.04.2022, slide 13.

[39] Bpifrance, Panorama des Greentechs en France, 05.04.2022, slide 13 ; & France Invest, Baromètre des Levées de Fonds Transition Écologique – 1er semestre 2022, p.3 ; & Cleantech for France, Décarbonation, Réindustrialisation et Souveraineté Verte en France, 2022, p.14. Furthermore, when considering the total amounts raised by cleantechs, i.e., including money raised outside financial funds, the amount reaches 3,4 bn € in France in 2021 in 155 different operations. GreenUnivers, 3,4 Md € levés par les cleantechs en 2021, 13.04.2022.

[40] France Invest, Baromètre des Levées de Fonds Transition Écologique – 1er semestre 2022, p. 3 ; & Les Echos, Levées de fonds : malgré la crise, la French Tech a battu son record, 17.01.2023. According to France Invest, the amounts invested by financial funds already reached 1,9 bn € only for the first semester of 2022.

[41] Cleantech for France, Décarbonation, Réindustrialisation et Souveraineté Verte en France, 2022, p.14.

Greentech startups are defined by the French public investment bank Bpifrance[42] as companies developing a product, a service or a technology whose objectives are both to improve environmental efficiency for companies and/or consumers. They must also address at least one of the six goals of the European green taxonomy, i.e., climate change mitigation, adaptation, sustainable use of sea resources, circular economy, pollution avoidance and reduction, and biodiversity preservation.[43]

Deeptech startups are defined by Bpifrance as companies showing a strong potential added-value for their respective market(s), developing groundbreaking innovation(s) in their domain(s) – characterized by many patents and an ongoing work partnership with private and/or public research –, and facing high technological entry-costs on their market(s), which usually make them very capital-intensive.[44]

On top of green deeptech companies – which happen to be greentechs and deeptechs at the same time according to Bpifrance's definitions –, deeptechs can also innovate in strategic sectors like health, the digital sector, the quantic sector, etc. Hence, given the narrow definition of greentechs in France (see above), deeptechs, which are not counted as greentechs but still act in favour of the ecological transition, can also be cleantechs (see Figure 8).

Finally, a third category also characterizes most cleantechs: industrial startups. This category has been promoted by a recent strategy of the French government for "industrial startups and deeptechs".[45] Industrial startups are characterized by their industrial project, i.e., their development of an industrial demonstrator or a pilot factory, which is quite unusual in developed countries.

Hence, there is also a chance for cleantechs to be outside the scope of deeptechs – because they are not a market with high-entry costs, for instance – and greentechs – because they are out of the EU Green Taxonomy's scope – while still being industrial startups which have an impact on the ecological transition, given the cleantech definition of our study (see Figure 8).

Regarding private R&D public support, France was the second most generous OECD country after Russia between 2006 and 2017, with 0.4% of its annual GDP spent. [46] This represented about ten bn € every year, i.e. 28% of private R&D spending.[47] Most of this support was conveyed through fiscal incentives, especially the "Crédit d'Impôt Recherche" – an untargeted tax credit for R&D activities mainly benefitting large companies – which amounted to 6,4 bn € in 2019.[48] The rest is spread in countless subsidies, loans, equity, etc. This high number of programs is due to the successive waves of unrelated innovation policies supported by the government, territorial communities or public agencies during the last decades. All of these different actors pursued their own goals (incentivizing R&D, promoting industrial competitiveness, etc.), followed different functioning methods (institutional agenda, public-

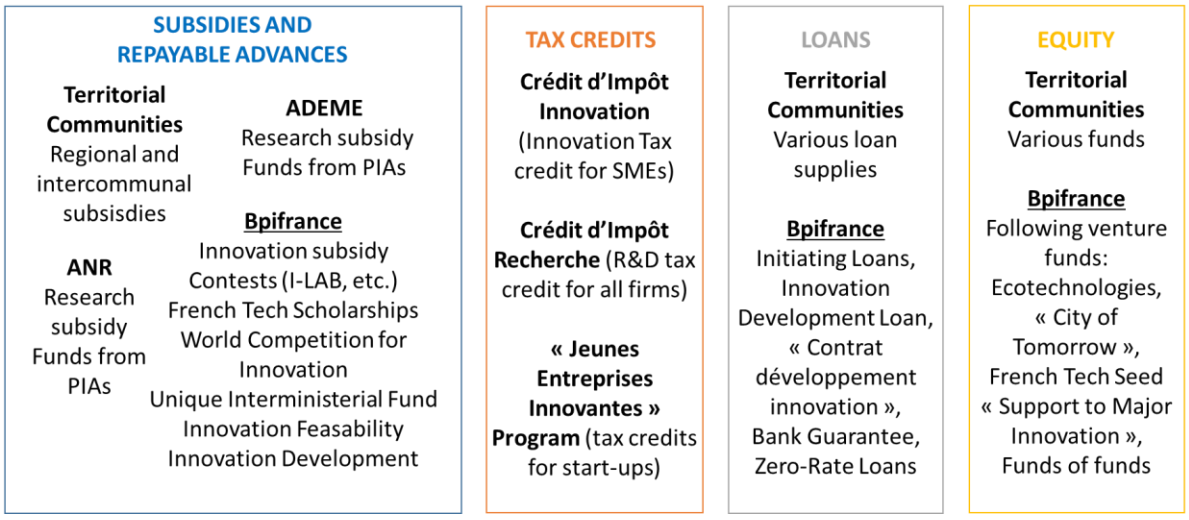
[42] Bpifrance is the French public investment bank, which count a vast number of missions defined below in the chapter. Bpifrance, notre mission.
[43] Bpifrance, Panorama des Greentechs en France, 05.04.2022, slide 6.
[44] Ibid., slide 15 & Les Deeptechs, Qu'est que la deeptech ?.
[45] Ministère de l'Économie, des Finances, et de la Souveraineté Industrielle et Numérique, Le Gouvernement dévoile sa stratégie « Startups industrielles et deep tech », 20.01.2022.
[46] Cour des Comptes, Les aides publiques à l'innovation des entreprises, 04.2021, p. 30-31.
[47] Ibid., p. 30-31.
[48] Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.

private partnerships, thematic targeting, etc.), and finally targeted all sorts of actors from innovation ecosystems (public research, private research, ecosystem builders, etc.).[49]

Since the election of Emmanuel Macron in 2017, the support for private innovation has intensified. Implementing this new political agenda coincides with the take-off of cleantech private investments described above. Furthermore, between 2020 and 2022, the "France 2030" plans have brought at least 80 additional bn € to promote industrial, deeptech and/or greentech innovation.[50] According to the French Senate, between 2022 and 2027, the support to innovation should reach 20 bn € every year on average[51], i.e., almost one-third of the average annual R&D expenditures before 2017.

There are 149 different public measures available to support innovation in France and to support company creations, there are almost 500 different ones, counting national, territorial and European ones.[52] Nevertheless, some public measures for innovation are more usually adopted by startups than others (see Figure 9).

Figure 9: Main Public Support Measures to Innovation in France

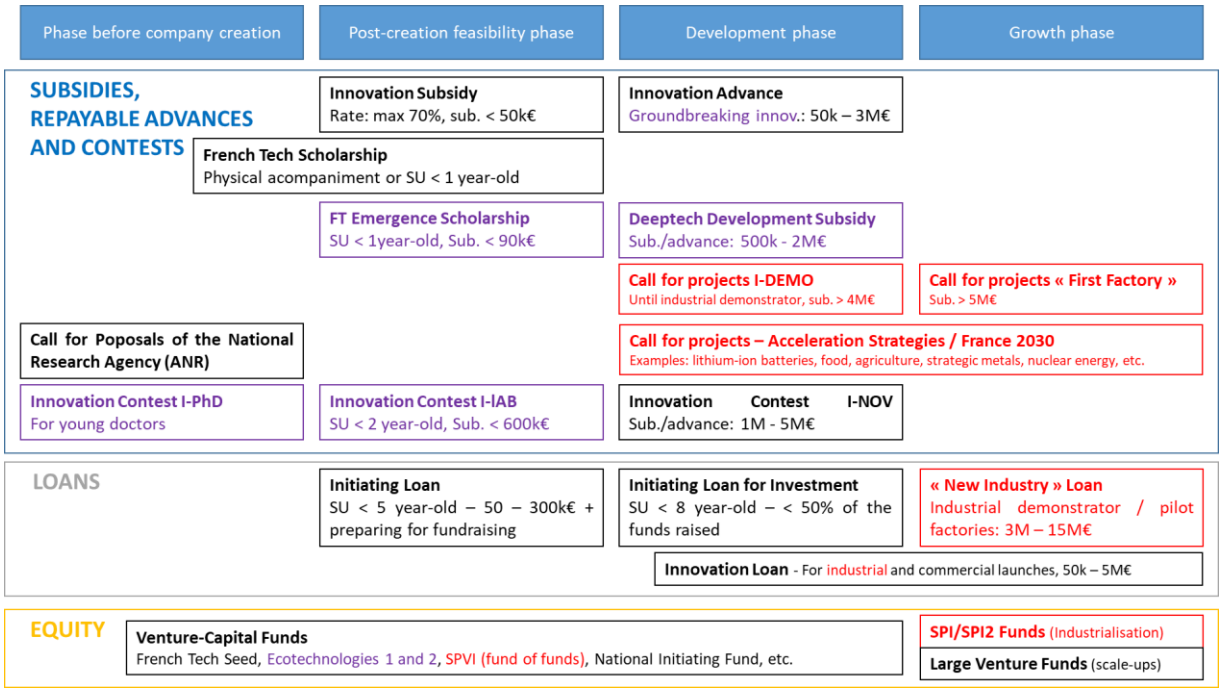


Source: Inspection Générale des Finance.[53] ADEME: Environment and Energy Control Agency (2,3 bn € spent between 2010 and 2020). ANR: National Research Agency (2,3 bn € spent between 2006 and 2019). Territorial Communities: regions, departments, inter-municipalities, etc. Subsidies and repayable advanced amounted to 3,1 bn € in 2019, while tax credits to about 7 bn €.

When analysing all these measures, excluding tax credits, one institution plays a significant role in innovation public support and, hence, for cleantech public support: Bpifrance. With 45 territorial sites, this French "public investment bank" provides many subsidies, advances, loans and accompaniment programs. Some of its programs are tailored for deeptechs or industrial startups, while greentechs benefit from common programs, as shown in Figure 10. Hence, cleantechs can benefit from various support measures in what is usually called the "innovation support continuum" of Bpifrance.

[49] Cleantech for France, Décarbonation, Réindustralisation, et Souveraineté Verte en France, 2022, p. 7.
[50] Cleantech for France, Décarbonation, Réindustralisation, et Souveraineté Verte en France, 2022, p. 30-31.
[51] Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
[52] Bpifrance, Base nationale des aides publiques aux entreprises.
[53] Inspection Générale des Finance, Leviers de développement des startups industrielles en phase d'industrialisation, 09.2021, p. 12.

Figure 10: Bpifrance's Innovation Support Continuum Applied to Cleantechs



Source: Bpifrance.[54] The violet color indicates the programs exclusively reserved to deeptechs, while the red color indicates those for industrial startups. All programs introduced here can possibly apply to greentechs.

Hence, overall, the French system to support private innovation in cleantech startups is very developed, if not too developed. The ambition of public authorities to develop as much as possible innovation for ecological transition, reindustrialisation, and strategic economic comparative advantages, has created a vast complex of programs, which nowadays remain challenging to navigate for startups and cleantechs in particular. What lacks is a multi-annual innovation programming law, which would give once and for all consistency to an increasingly visible industrial policy, with an efficient governance and distribution system as objectives.[55] Still, in this context, the French government targets 100 new industrial sites every year from 2025 on, ten industrial unicorns out of 100 by 2030,[56] and the French Senate wishes that the French industry's share of GDP increases from 10 to 20% until 2030.[57]

Besides, regulation should evolve to allow industrial cleantech startups to create their industrial sites independently from administrative lengths, which are considerably higher in France than, for instance, in Switzerland.[58] A governmental body should simplify as many administrative processes as possible to help cleantechs thrive.[59] The "Credit d'Impôt Recherche", whose funds mostly serve to maintain competitiveness of what's left from legacy industries in France without showing positive multipliers for

54 Bpifrance, Panorama des Greentechs en France, 05.04.2022.
55 Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
56 Ministère de l'Économie, des Finances, et de la Souveraineté Industrielle et Numérique, Le Gouvernement dévoile sa stratégie « Startups industrielles et deep tech », 20.01.2022.
57 Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
58 Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
59 Inspection Générale des Finances, Leviers de développement des startups industrielles en phase d'industrialisation, 09.2021, p. 3.

innovation, should be reshaped to benefit more small innovating actors like cleantechs while the "Credit d'Impôt Innovation" targeting SMEs should increase its rate.[60]

While public-private partnerships are usually well appreciated in France, industrial cleantech startups[61] find it hard to cooperate with larger industrial groups or significant financial funds. First, both culturally disregard them, especially when they are not established in Paris. The Parisian region remains the one with the highest tickets for cleantech investments. A restrained pool makes those of about 40 investors, including 15 sizeable private equity funds, which make most of the fundraising effort.[62] Second, private financial funds leave "holes" for industrial cleantech startups willing, first, to test their innovation (Serie A fundraising) or to scale up (Serie C fundraising).[63] For instance, the former CEO of "CleanCup" – which produced ecological coffee cups for companies – Eleonore Blondeau, explained it was nearly impossible to raise funds from this pool of large private equity funds without 1 million euros of sales already expected for the firm and without being in Paris.[64]

Also, private investors in France are more used to digital startups, or simply deeptech startups, as they have represented the bulk of innovation for the last ten years in France.[65] Most ask for more information on cleantech startups before establishing new fundraising "routines" in their favour. Once this has happened, a new wave of specialized private venture and growth capital funds focusing on cleantechs should be developed everywhere in France to allow the innovations outside the Parisian area to scale up as well. To encourage large private companies to invest in cleantechs through their Corporate Venture Capital funds (CVC funds), ESG criteria could also legally include financing startups acting in favour of the ecological transition.[66]

However, even if private capital should invest more in cleantechs, many projects are financed today. For instance, regarding greentechs, 400 have been financed in 2021, vs 200 in Germany and even less in the UK.[67] In France, the entire scope of cleantech types is covered by investments, with the risk of "sprinkling" investments instead of concentrating on real opportunities. It results from this situation that fundraising tickets are much lower, which reduces the chances of financed startups to live up to the international competition in their markets.[68] More private venture and growth funds should bet more on fewer cleantech projects. For instance, it could discard cleantechs, which want to innovate in sectors where legacy industries are already strongly innovating. More precisely, the advantage could be pushed even more on Agtechs (Ynsect, InnovaFeed), where France has the opportunity to lead global markets. Finally, investment timings should be considered in any case, as many French cleantechs have failed in the past for this reason, as mentioned by Ludovic Deblois, former CEO of Sun Partner Technologies specialized in solar energy.[69]

---

60 Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
61 Le Défi des Startups Cleantech Industrielle en France, 19.01.2021.
62 Bpifrance, Panorama des Greentechs en France, 05.04.2022.
63 Le Défi des Startups Cleantech Industrielle en France, 19.01.2021.
64 Ibid.
65 Ibid.
66 Sénat, Transformer l'essai de l'innovation : un impératif pour réindustrialiser la France.
67 Bpifrance, Panorama des Greentechs en France, 05.04.2022.
68 Direction Générale des Entreprises, Globalisation has forced French industry to play by its strengths, 2017.
69 Le Défi des Startups Cleantech Industrielle en France, 19.01.2021.

In conclusion, the French authorities are doing as much as possible, especially since 2017 and even more since 2020, to reindustrialize, foster the ecological transition, and stimulate innovation. This directly channels their financial effort to cleantech startups. Nevertheless, administrative confusion and lengths and the "CAC 40" culture – which still favours Parisian projects – are slowing down the progress without even concentrating the effort on the most promising projects. Even though the French public support already corresponds to this range, the French government pleaded in favour of a 200 bn € European plan, which would give 35 more bn € to subsidize cleantechs in France further.[70] Maybe they will need it to avoid a crash of the nascent French cleantech ecosystem, which still seems to hardly find a path to profitability, maybe due to a lack of demand. As many say, France is a specialist in producing innovation and not benefitting from it. Let us hope this massive public funding effort will not only intensify the escape of cleantech talents abroad.

4.2 Germany

Innovations in the field of green technologies represent a fundamental strength of the German economy within the circle of future technologies. A study by the Fraunhofer ISI Institute shows that Germany has demonstrated a high level of patenting and specialization in recent years, particularly in biomaterials, alternative solar cells, and recycling technologies.[71] However, this high level of innovation activity is not reflected in the markets for startup capital. For example, the number of venture capital deals in 2019-2021 in Germany in the energy storage and biomaterials segments was not only far below the figures for the US but was also lower than in France and the UK in each case.[72] In terms of investment amounts, Germany lags even more significantly in a country comparison. Despite its high level of innovation, for example, only €29 million in venture capital was invested in the biomaterials segment in 2019-2021, compared with €99 million in France and €1.56 billion in the United States. For startups in the field of energy storage and batteries, a particularly critical technological bottleneck in the future transformation of the energy system, the discrepancy is even more severe: only €10 million went to German startups, while €147 million went to French companies. Concerning economic strength, France and the US also provided significantly more venture capital for green technologies than Germany. Compared to the US and the UK, this is primarily the consequence of a still considerably lower market liquidity of venture capital overall. However, compared to France, the 2019-2021 period also showed relatively lower importance of biomaterials and energy storage in the investment portfolio. The focus of venture capital in Germany was more on areas such as robotics and automotive engineering.[73] The current financing shortage is thus not only the result of a lack of market liquidity but also an inadequate focus, given the ambitious decarbonization plans at the political level.

In order to promote the development of cleantech startups in Germany, a wide range of government funding instruments are available. These can be divided into four types: grants, government loans, government guarantees and provision of equity. Grants are non-repayable subsidies. The focus here is on contributions to cover operating costs, both in connection with the procurement of working capital and personnel costs. One example is the GRW (Joint Task for the Improvement of Regional Economic Structures) investment program.[74] Its general aim is to support firms located in low-income regions in

[70] Les Echos, le projet détonant de la France en réponse à l'IRA américain, 17.01.2023.
[71] Schmoch, U., Beckert, B., Reiß, T., Neuhäusler, P., & Rothengatter, O. (2020). Identifizierung und Bewertung von Zukunftstechnologien für Deutschland. Karlsruhe: Fraunhofer ISI.
[72] KfW Research (2022). Venture Capital: Marktchancen in Zukunftstechnologien. Nr. 392/2022.
[73] See KfW Research (2022).
[74] https://www.gtai.de/en/invest/investment-guide/incentive-programs/cash-incentives-for-investments

Germany. Among these are regions hit particularly hard by the downturn of coal- and oil-based industries during structural change. In such an environment, cleantech startups can represent a particularly promising live-cell therapy for the regional economy, helping not only to maintain existing production capacities but repurposing them towards a sustainable regional growth model. The Federal Employment Agency also offers grants to finance training programs for employees, as well as wage subsidies in the case of hiring long-term unemployed and persons from other disadvantaged groups.[75] In the case of cleantech startups, the specific skill requirements imposed by the novelty of the technologies developed can render training subsidies a particularly useful instrument. Moreover, The *EXIST* program provides targeted support for startups by students and university staff through a 12-month startup grant.[76] Providing innovative technology-based solutions belongs to the key eligibility requirements for this grant, putting cleantechs in a good competitive position. Given the critical role universities (especially technical universities) play as incubators of technology-oriented startups in Germany, this is highly relevant. Finally, the Federal Office of Economics and Export Control (BAFA) provides through its program "INVEST" tax-free grants to private persons, especially business angels, who are willing to invest capital in startups. This program is currently under reconstruction.[77]

However, the focus of government support to startups in Germany is clearly on loans and guarantees. Government loans to companies are issued nationally by the public investment bank *KfW (Reconstruction Credit Institute)*.[78] Entrepreneurial loans at subsidized interest rates are provided for up to €25 million. Each German federal state also has its own development bank. Government guarantees enable companies with insufficient collateral to access loans from commercial banks. Moreover, various channels are available for the public provision of equity capital for startups. From the perspective of cleantech companies, the *High-Tech Gründerfonds (HTGF)* is particularly relevant.[79] This is a venture capital fund in the form of a public-private partnership created specifically for high-tech startups. The maximum investment across all potential rounds amounts to €4 million per startup. Potentially eligible startups must belong to the fields of Digital Tech, Industrial Tech, Life Sciences, Chemicals or adjacent areas. Cleantechs are not explicitly mentioned but given their overlap with many of the areas referred to, many of them are likely addressed as well.

In November 2020, the German government launched a new program to support startups in Germany, focusing on technology companies.[80] The new Participation Fund for Future Technologies ("Future Fund") aims to strengthen financing options in the capital-intensive growth phase of startups, particularly with a quantitative and qualitative expansion of the federal government's funding architecture. €10 billion in new funding is available for the investments and costs of the *Future Fund* for an investment period until the end of 2030. In addition, the ERP Special Fund is participating financially in several instruments of the Future Fund. Together with other private and public partners, the *Future Fund,* with its various modules, is expected to mobilize additional funds totalling €30 billion for startups in Germany by the end of 2030.

---

75 https://www.gtai.de/en/invest/investment-guide/incentive-programs/grants-for-hiring-personnel-65422
76 https://www.exist.de/EXIST/Navigation/EN/Home/home.html
77 https://www.bafa.de/DE/Wirtschaft/Beratung_Finanzierung/Invest/invest_node.html
78 https://www.kfw.de/inlandsfoerderung/Privatpersonen/Existenzgr%C3%BCndung/index-2.html
79 https://www.htgf.de/en/
80 https://www.bmwk.de/Redaktion/EN/Artikel/Economy/future-fund.html

The *Future Fund* is divided into various modules and sub-funds. The cleantech sector was also explicitly considered via a *DeepTech & Climate Fonds (DTCF*).[81] Its declared aim is to produce the hidden champions of tomorrow. The fund will support growth companies that have the potential to become global market leaders. Up to €30 billion will be made available to a startup over its lifetime for this purpose. Hence, financial support is not limited to the initial stage of market entry but takes the form of a permanent pillar of the company's financing structure. A particular focus is on climate deep-tech technologies. These are defined as companies that aim to achieve climate protection targets through efficient use of resources and pave the way to a climate-neutral, resource-conserving future. Hence, there is a significant overlap with our definition of cleantechs, putting many cleantech startups in the focal point of this initiative.

In 2022, the German government presented a new *startup strategy*.[82] It is intended to improve the framework conditions for startups in Germany at various levels. In addition to the provision of subsidies, this includes facilitating administrative processes for company registration through digitization and better coordination of startup conditions at universities between the federal states. Startups should also be given easier access to public contracts. To increase the attractiveness of startups as employers, employee share ownership models are to be promoted. In addition, the relevant players in the startup ecosystems are to be more closely interlinked. Within the catalogue of measures, two points are especially vital from the perspective of cleantech startups. The first one is a better promotion of university-founded startups. To this end, the EXIST program shall be complemented by a support competition for long-term university projects that aim to create sustainable startup ecosystems linking firms with regional value chains. Moreover, the transfer of intellectual property rights to private investors shall be facilitated. The second point is improved access for startups to projects marketizing innovative products under special regulatory treatment (so-called "laboratories of reality"). Given the complex set of taxes and charges cleantech products, especially in energy conversion, can be confronted with, those projects are an essential opportunity to test the sensitivity of market success towards changes in the regulatory environment.

Overall, Germany's regulatory environment has had positive and negative effects on the development of cleantech startups. On the upside, the persistent governmental support of renewable energy deployment in Germany over the past 20 years has contributed to strengthening investment incentives in the cleantech field, as pointed out by Migendt et al. (2017).[83] Guaranteed feed-in tariffs have provided a stable revenue base for electricity from renewables, which in turn has incentivized demand for related technologies. Numerous public funding programs, some with a long-term focus, have also supported the startup landscape in Germany. On the other hand, the variety of programs at the national and regional levels with their different requirements leads to high information costs for potential founders. In the case of publicly funded venture capital investments, the existing size restrictions also burden the profitability of innovation funding. In general, German policy has not yet succeeded in establishing a genuine venture capital culture in Germany, not even in the private sector. As in other areas, investment amounts in cleantech are still far below the activities in the USA and UK. This also

[81] https://dtcf.de/en/

[82] BMWK (2022), Die Startup-Strategie der Bundesregierung, https://www.bmwk.de/Redaktion/DE/Publikationen/Existenzgruendung/startup-strategie-der-bundesregierung.pdf?__blob=publicationFile&v=14.

[83] Migendt, M., Polzin, F., Schock, F., Täube, F. A., & von Flotow, P. (2017). Beyond venture capital: an exploratory study of the finance-innovation-policy nexus in cleantech. Industrial and corporate change, 26(6), 973-996.

has to do with tax policy. For example, the inability to transfer a loss carry-forward in the case of transfers of ownership of companies weighs heavily on the prospects for long-term returns. Finally, excessive bureaucracy has long been a well-known obstacle for German startups. Obtaining legal legitimacy still requires for startups a large number of procedural steps.

These limitations are also reflected in the perceptions of the startups themselves. In the most recent version of the Startup Monitor, a regular large-scale survey among German startups, almost 90% of all respondents considered an acceleration and simplification of administrative procedures to be one of their most important expectations to politics. More than three quarters of the respondents viewed an easier access for startups to public procurement as important. About 60% of respondents identified an extension of public venture capital investment as an important lever.[84]

4.3 Italy

According to the quantitative analysis, the number of cleantech startups in Italy is limited compared to Germany and France. As outlined by Giudici et all., cleantech in Italy represents only 14% of innovative Italian startups.[85] To understand the reason behind such a low number compared to both other EU countries and to the national percentage of innovative startups, this section will evaluate the Italian regulatory and policy landscape, focusing on the red-lines that might have undermined the development of such niche startup business line. In Italy, innovative startups are regulated by the Startup Act (Law no. 221/2012), which aims at stimulating the development of new entrepreneurial ideas with a highly innovative nature. The Startup Act provides a series of fiscal benefits and cuts of administrative red tape rules. For instance, the latter are exempted from paying annual fees, they can access to tax incentives and be facilitated in case of bankruptcy procedures.[86] The Act addresses only technologically innovative startups, which have been operational for less than four years, have their head offices in Italy and a turnover of less than EUR 5 million. In other words, startups need to be new business and they cannot have been formed by a merger, company division or as a result of a transfer of company or company branch.[87]

There are several criteria that Startups that want to have access to benefits provided by the Act must satisfy. In particular, they need to comply with at least two of the following requirements: 1) expenses devoted to Research and Innovation (R&D) must be at least 15% of either the annual costs or turnover, 2) they need to hire highly qualified workers, with at least one third of employees being PhDs or researchers, 3) they need to have a registered patent or be the owner of a registered software. Newborn companies respecting these requirements have to register in a special section of the Italian Business Register dedicated to innovative startups. Certainly, the Startup Act seems to reflect the set of provisions needed to boost private initiatives, as highlighted by the European Commission's New Innovation Agenda.

However, according to Giuseppe Spanto, CEO of CleanAir, when it comes to cleantech startups, the Italian regulatory framework and policy making the need to be further improved. According to him, the Italian regulatory framework is very helpful in supporting the building up of startups in their early

84 PWC / Startup Verband / netSTART (2022). Deutscher Startup Monitor 2022.

85 Giudici, G., Guerini, M., & Rossi-Lamastra, C. (2019). The creation of cleantech startups at the local level: the role of knowledge availability and environmental awareness. *Small Business Economics*, *52*(4), 815-830.

86 Biancalani, F., Czarnitzki, D., & Riccaboni, M. (2022). The Italian start up act: A microeconometric program evaluation. *Small Business Economics*, *58*(3), 1699-1720.

87 Italia Startup Visa la politica del Governo italiano per attrarre imprenditori innovativi stranieri

development. For instance, as a startup, CleanAir, a company providing devices to purify the air, enjoyed the cut of several administrative red tapes and financial benefits. Yet, the Italian regulatory framework lacks strong initiatives to help startups develop into small and medium companies. However, for a representative of Termo, a cleantech startup that deals with household energy savings, the general regulatory framework is adequate and the right idea, even in the cleantech field, can push for more private investments. In the case of Termo, for instance, the startup received funding in 2017 from Eprice and in 2020 from the Mediaset group and by the Italian Investments Fund.[88]

As highlighted by the European Commission New Innovation Agenda, when it comes to the development of startups, incubators and accelerators should be central. Those are regulated by the Italian Decree law 179/2012, (art. 25, paragraph 5), which regulates a set of fiscal benefits for certified incubators that favour the development and acceleration of new innovative high-tech companies. In particular, a certified incubator needs to have adequate facilities and space to allow startups to install equipment for trial, test, verification or research, has to be administered or directed by persons of recognized expertise in enterprise and innovation and has at its disposal technical and advisory management on a permanent basis. According to the law, which does not distinguish between incubators and accelerators, incubators need to have regular collaborative relationships with universities, research centres, public institutions and financial partners carrying out activities and projects related to startups.[89] As reported by the Social Innovation Monitor's report, in 2021 Italy had 229 startup incubators and accelerators, with a growth rate of 7 percent over the previous year.[90]To date, the most recent cleantech startup acceleration project is certainly ZERO, a platform implemented by the Cassa Depositi e Prestiti, a prominent Italian public investment bank, which addressed software and hardware startups developing solutions with a view to environmental sustainability to obtain an investment of up to 80.000 euro.

Yet, according to CleanAir's representative, the role of incubators and accelerators in Italy is not sufficient for the full development of a cleantech startup and even when it is useful, it is only in the first stage of their development. When it comes to transforming the startup into a small-medium enterprise, companies struggle because banks in Italy do not trust small businesses, and it is very hard to find capital since business angels are very few. Cleantech startups need long-term investments in order to provide solid economic return, as they are based on technologies that need to be constantly implemented or rebooted. Instead, the Italian investments' environment is based mostly on short-term speculation, which does not pay off, if the aim is to develop solid clean tech innovation. On the contrary, Termo had access to funding from acceleration projects. In particular, the company enjoyed a consistent investment in 2020 from the Italian Investment Fund financed by Cassa Depositi e Prestiti. Yet, Termo also confirmed the general tendency whereby it is difficult for cleantechs to make investors aware of their added value, beyond economic return. In this respect, to improve member countries' policy making tools, national institutions should become aware of this issue and evaluate whether it is convenient to pay a major role, becoming, for instance, a sort of guarantor for banks and financial institutions if they invest in those cleantechs.

88 https://www.termostore.it/chi-siamo/.

89 L'incubatore certificato Guida sintetica per utenti esperti sugli adempimenti societari, https://startup.registroimprese.it/isin/static/startup/document/Guida_Incubatore_Certificato.pdf.

90 Report completo sulle startup a significativo impatto sociale e ambientale (2022) , https://www.socialinnovation.shop/prodotto/report-completo-sulle-startup-a-significativo-impatto-sociale-e-ambientale-2022/.

A similar trend is also registered in the so-called "**Innovation valleys",** marked as an important flagship by the European Commission New Innovation Agenda. Italy is still far from reaching a full development of those initiatives. There are examples of regional "valley" such as the "Dolomiti Innovation Valley" in the north-east of Italy. However, innovation valleys are mostly based on regional initiatives, which make all investment scenes in Italy quite piecemeal. According to him, since the central government has designated many initiatives for the development of clean tech startups at the regional level, policy initiatives are often reachable only locally, creating differences among regions. Beyond the facilitation in terms of tax reduction and cut in red tape, to promote the development of a new entrepreneurial culture, create an ecosystem more inclined to innovation, foster greater social mobility and attract to Italy talents and capital from abroad, Italy has enforced a **Startup Visa policy,** to provide for Visa to those foreign citizens that decide to establish innovative startup' companies in Italy. Yet, this is not considered an advantage by many of those Clean Tech startups. Indeed, since they are technologically advanced companies, they often do not need their workers to physically move to Italy. On the contrary, they allow their employees to work from their countries, when possible, also for ethical reasons, to boost local development, or minimize re-allocation costs.

In conclusion, when it comes to cleantech startups in Italy, the reason behind such a small number compared to other countries seems related to lack of funding, which lowers the chances of such startups to survive, as it is difficult to access private capital when it comes to growing the business line. For CleanAir in particular, the Italian regulatory framework appears to be quite stringent when it comes to promote investments on real innovation. Indeed, national policies are based on criteria of economic returns, which in the case of cleantech startups cannot be fully applied. It takes years for a startup to have some solid economic returns, but in the case of cleantech startups, because they do not promote only innovation but also sustainable products, the criterion of pure economic gain is not sufficient. There is a need for a full analysis of the general benefits that the development of such companies can have for the society in terms of both economic return and climate change mitigation. This argument is confirmed by the data collected by the Observatory for Climate Finance of the Milan Polytechnic School of Management. Italian venture capital seems to not believe in green startups and so more specifically in cleantech startups. From 2015 to 2020, just 13 cleantech startups obtained funding for a total of 36.8 million euro out of 2,458 million euro that went to finance other innovative startups.[91] Indeed, venture capital seems to prefer focusing on digitization and web services, or on biotech and nanotech, where it identifies and chooses the most promising ventures and helps them to develop, rather than on companies committed to measuring, managing and mitigating the impacts of climate change. In this respect, as the interviewees confirmed, there is a profound misunderstanding on how to evaluate cleantech startups since the very beginning. Applying a pure concept of economic return is not paying back, since those startups require years to develop their technologies. Because of the nature of cleantech startups there is a need for long-term investments and state led initiatives should adopt a more comprehensive framework when evaluating those specific companies, taking into consideration, beyond the economic ratio, also the social and environmental benefits they create.

[91] https://www.osservatoriefi.it/efi/webinar-eventi/; https://www.corrierecomunicazioni.it/green-economy/green-economy-il-venture-capital-non-crede-nelle-startup-italiane-solo-13-finanziate-in-5-anni/.

5. Conclusion

Innovation in clean technologies is one of the keys to the ambitious long-term goal of turning the EU into a competitive Net Zero economy. The New innovation Agenda, the Net-Zero Industry Act and the Green Deal Industrial Plan are the most recent steps made by the EU to promote green and innovative business in general and cleantechs in particular. However, what is still missing is a sufficient focus on startups. While the EU innovation scene is growing, when it comes to cleantech startups, the development is still disappointing. For investigating the reasons for this disappointing performance, the first thing that is needed is a common definition of 'cleantech'. However, while the nature of cleantech startups should have been quite self-evident, when addressing national markets and how cleantech startups are supported, such a definition has proved challenging. In France, for instance, cleantech companies encompass different models such as greentech or deeptech. Thus, for the current cleantech agendas to work on a European level, policymakers and regulators must agree on concrete concepts and definitions regarding cleantech that can be readily operationalised in different member state settings.

For this very reason, the paper attempts to undertake its own empirical analysis to map the emerging cleantech startup scenes in Germany, France, and Italy, respectively, to rely on quantitative data. To do that, it started with an unprecedented empirical survey. Based on several different online databases, industry reports, and Natural Language Processing (NLP) methods, we created a novel dataset covering 105 startups that self-identified as cleantech and were mainly established between 2014 and 2022. Analysing the sampled startups with NLP methods underlines the breadth of the field and the difficulty of finding a common denominator and joint definition. In particular, most cleantech startups in our sample focus on alternative energy sources, such as solar, or hope to increase the energy efficiency of existing sources. Moreover, there are references to making agriculture/farming cleaner, adopting smart home/smart city technologies, and revolutionizing health care. The technology focus of the startups, legitimizing their self-declaration as "cleantech" and in line with our definition given at the beginning of this paper, becomes evident from frequently given "tags" such as software, information technology, internet of things, and electronic vehicles, which we identified with NLP.

This dataset was used to select appropriate interview parties for the country-specific case studies and to complement the qualitative insights with some quantitative, more aggregate results. While not entirely representative in a statistical sense, our quantitative analysis of this dataset highlights substantial geographical and financial concentrations in the emerging European cleantech landscape, raising questions about whether the intended subsidies as part of the EU Green Deal will contribute to a level playing field or further distort it: Among the 61 German startups, 30 French, and 14 Italian in our sample, most locate within Berlin, Paris, Munich, Hamburg, and Milan. Although the dataset does not allow calculating "survival rates" so far, it seems Germany has the "youngest" startups, on average. In contrast, our dataset's Italian and especially French startups seem relatively older. This hierarchy is partly reversed on the financial side: Using publicly available information on funding received, our dataset suggests that Italian startups lack funding compared to their German and French competitors, who have secured larger funding rounds. Regarding the qualitative analysis, **in the case of Italy**, this feature was confirmed. In particular**,** cleantech startups are experiencing **difficulties in accessing funding**, not just in the first developing phase as startups, but mostly when they need resources **to develop into small or medium businesses**. Apparently, **accelerators are ineffective in providing such resources** as banks require high guarantees. This seems to be an issue affecting cleantech startups in particular,

since they need more time than other more traditional businesses to develop and commercialize their highly innovative products.

In the case of Germany, instead, persistent governmental support has contributed to strengthening investment incentives in the cleantech field. However, significant obstacles are still **low market liquidity in the venture capital segment** in general and an **insufficient focus on innovation activities on clean solutions**. Moreover, **excessive bureaucracy** is identified by startups as a significant barrier to growth. Only very recently, Germany has developed a specific strategy targeting clean innovation, even though the country has committed itself to a green transition for quite some time.

In the case of France, instead, although the French authorities attempt to reindustrialize and foster France's ecological transition and business innovation, **administrative confusions and lengths**, as well as the **overlapping of different funding lines**, together with the **"CAC 40" culture** – which still favours Parisian projects due to their high visibility for private investors – are undermining the full development of cleantech startups. The concentration of cleantech startups in specific geographic areas and cities is also common in Germany and Italy, as demonstrated by the quantitative analysis. Yet, while in the case of the above countries, this is primarily due to the presence of more public or private funding as well as innovation or technological hubs or human capital, in the case of France, this seems also related to a cultural issue, whereby the capital city is also preferred compared to the rest of the country.

Figure 11: Most Salient Factors Slowing Down the Development of Cleantech Startups in Italy, Germany and France According to Cep's Analysis

Italy	Germany	France
Issues		
Lack of high-level funding opportunities, especially from the private sectors	Low market liquidity in the cleantech venture capital segment	Administrative confusions and lengths slowing down the development of cleantech projects
Difficulties to access funding to develop into SMEs	Insufficient focus on innovative cleantech projects	Multiplicity and overlap of public support programs for cleantechs
Lack of accelerators to accompany cleantech startup projects	Excessive bureaucracy	"CAC 40" culture favouring Parisian visible projects over the ones in regions
Recommendations		
Improve the efficiency and timing though which funding for startups are distributed, with a specific attention to cleantechs.	Streamline the current framework of support to startups and increase its focus on net zero technologies	Improve clarity of public support in favour of cleantechs by adopting a cleantech industrial policy

Reduce administrative burdens and introduce new paradigms when evaluating innovative startups such as the cleantech ones, beyond economic returns.	Reduce administrative lengths for the establishment of new cleantech production sites	Reduce administrative lengths for the establishment of new cleantech production sites
Overcome the fragmentation produced by the proliferation of regional initiatives on startups and clean tech startups by developing a solid national framework.	Review tax policies with respect to the needs of startups	Concentrate public support on fewer cleantech startups everywhere on the territory, in order to increase their likelihood to become leaders on their market
Provide public guarantees and fiscal incentives to boost the appetite of private investors in the sector of cleantech	Provide additional fiscal incentives for venture capitalists to invest in cleantech startups	Include cleantech financing in ESG criteria to encourage large companies to use their corporate venture capital funds to invest in cleantechs

Source: own conception.

As a wrap-up, Figure 11 highlights the most important obstacles to the flourishing of cleantech startups identified in our country studies. Moreover, it provides some country-specific policy recommendations. In general, while the specific issues differ between countries, common patterns are evident.

In conclusion, public and private cooperation in sustaining the development of cleantech startups is fundamental, considering that the presence of venture capitalism and accelerators could be better spread in all three countries. While public institutions can play the role of guarantors, massive private resources – in the form of accelerator or venture capital – are indispensable to inject liquidity in cleantechs and to allow them to acquire the necessary resources for generating new forms of economic and social prosperity.

Authors:

Dr. Anselm Küsters
Head of Digitalisation and New Technologies
kuesters@cep.eu

Anna Meister
Student Assistent to the cep

Dr. Eleonora Poli
Head of Economic Analysis and Business Engagement Centro Politiche Europee | ROMA
poli@cep.eu

Victor Warhem
Policy Analyst Centre de Politique Européenne | PARIS
warhem@cep.eu

Dr. André Wolf
Head of Technological Innovation, Infrastructure and Industrial Development
wolf@cep.eu

Centrum für Europäische Politik FREIBURG | BERLIN
Kaiser-Joseph-Straße 266 | D-79098 Freiburg
Schiffbauerdamm 40 Räume 4205/06 | D-10117 Berlin
Tel. + 49 761 38693-0

The **Centrum für Europäische Politik** FREIBURG | BERLIN, the **Centre de Politique Européenne** PARIS, and the **Centro Politiche Europee** ROMA form the **Centres for European Policy Network** FREIBURG | BERLIN | PARIS | ROMA.

Free of vested interests and party-politically neutral, the Centres for European Policy Network provides analysis and evaluation of European Union policy, aimed at supporting European integration and upholding the principles of a free-market economic system.