

Bridging Institutional Fragmentation: Designing a Coordinated Support Infrastructure for Deep-Tech Scale-Up in Europe

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Abstract: Deep technology ventures are widely recognized as critical drivers of industrial transformation and sustainability transitions. Yet their progression from laboratory validation (TRL 4-5) to pilot and demonstration scale (TRL 6-7) remains structurally constrained within fragmented European innovation systems. While substantial public funding instruments and research infrastructures exist, deep-tech startups continue to face persistent coordination failures in accessing capital, pilot facilities, and industrial validation environments. Drawing on exploratory qualitative insight from an in-depth interview with an experienced startup mentor within an EIT HEI project, this study identifies recurring systemic bottlenecks in the TRL 4-7 transition. These include limited visibility and accessibility of mid-scale pilot infrastructures, fragmented and poorly sequenced funding architectures, and misalignment between blended finance instruments and long development cycles. Anchored in entrepreneurial ecosystem theory, regional innovation systems literature, and the “valley of death” framework, the paper combines this empirical diagnosis with a structured desk analysis of European support mechanisms, including the European Innovation Council (EIC), EIT Knowledge and Innovation Communities (KICs), Horizon Europe, Eurostars, InvestEU, and Research and Technology Organisation (RTO) networks. The analysis demonstrates that Europe’s deep-tech scale-up gap reflects not an absence of support, but insufficient institutional integration and orchestration across funding and infrastructure domains. In response, the study advances a design-oriented framework for coordinated support infrastructure within EIT HEI ecosystems. The proposed model conceptualizes EIT HEI as a systemic intermediary performing three functions: (1) venture-stage diagnostic alignment, (2) infrastructure and blended finance brokerage, and (3) cross-institutional ecosystem orchestration. By integrating dispersed opportunity structures into a coherent navigation architecture, the framework aims to reduce transaction costs and improve pathway continuity for research-intensive ventures. The paper contributes to ongoing debates on Europe’s deep-tech scale-up challenge by reframing fragmentation as a coordination problem and proposing institutional design principles for enhancing systemic alignment within innovation ecosystems.

Keywords: Deep-tech Scale-up, Valley of Death, Entrepreneurial Ecosystems, Institutional Fragmentation, Ecosystem Orchestration

1. Introduction

Deep technology ventures have become increasingly important in Europe’s efforts to renew industry, strengthen strategic competitiveness, and support sustainability transitions. Unlike many conventional startups, these ventures are built around scientific and engineering advances that must be translated into practical applications in fields such as advanced materials, energy, biotechnology, and digital systems. Their development is therefore not only a matter of entrepreneurial capability or investor interest, but also depends on the institutional environments through which scientific knowledge, technical validation, industrial partnerships, and commercialization pathways are connected (Autio et al., 2018; Grande et al., 2025).

A particularly difficult point in this journey appears between laboratory validation and pilot or demonstration scale, typically associated with Technology Readiness Levels 4-7. At this stage, ventures must move beyond proof of concept and demonstrate that their technologies can function in more realistic operating conditions. When access to validation settings, industrial engagement, and suitable finance remains disconnected, promising firms risk losing momentum before reaching commercial viability.

This problem is especially visible in Europe. On paper, the region has a substantial innovation support architecture, including public funding instruments, research infrastructures, university-based initiatives, industrial networks, and intermediary organizations. Yet despite this dense landscape of programmes and institutions, European deep-tech ventures continue to face difficulties in moving from laboratory validation to demonstration and scale-up (Grande et al., 2025). This creates a paradox: significant support mechanisms exist, but they do not consistently produce smooth scale-up pathways. The central problem may therefore lie not in the absence of support as such, but in how the available pieces fit together.

Although previous research has examined deep-tech finance, infrastructure access, entrepreneurial ecosystems, regional innovation systems, and intermediary organizations, less attention has been given to how these support domains can be coordinated into coherent pathways for ventures moving through TRL 4-7. This paper responds to that gap by examining the TRL 4-7 transition as a coordination challenge within European deep-tech

ecosystems. Drawing on an expert interview conducted within an EIT HEI-funded venture support project, together with a structured desk analysis of European support mechanisms, the study identifies recurring bottlenecks in funding sequencing, pilot infrastructure access, and support-system navigation. Based on this analysis, the paper develops a design-oriented framework that positions EIT HEI actors as systemic intermediaries performing three interconnected roles: venture-stage diagnostic alignment, infrastructure and blended-finance brokerage, and cross-institutional ecosystem orchestration. In doing so, the paper contributes to debates on deep-tech scale-up by reframing Europe's scale-up gap as an institutional coordination problem rather than a simple shortage of support instruments.

2. Literature Review

2.1 Deep-tech Scale-up and the Valley of Death

Deep-tech entrepreneurship differs from conventional startup development because it is closely tied to scientific discovery, engineering complexity, and long commercialization pathways (Grande et al., 2025). Deep-tech ventures often require specialized facilities, technical validation, regulatory knowledge, industrial partners, and substantial capital before they can demonstrate commercial viability (Grande et al., 2025; Muscio, Simonelli and Vu, 2023). Their development therefore depends not only on entrepreneurial capability, but also on the institutional conditions through which scientific knowledge is translated into industrial application (Autio et al., 2018; Asheim, Isaksen and Trippel, 2019).

The transition from laboratory validation to pilot and demonstration scale is commonly described through the "valley of death" framework (Auerswald and Branscomb, 2003; Markham, 2002). This concept refers to the gap between technical feasibility and commercial viability, where technologies have moved beyond proof of concept but are not yet mature enough to attract sustained private investment or large-scale market commitment (Auerswald and Branscomb, 2003; Markham, 2002). In deep-tech contexts, however, the valley of death should not be understood only as a funding gap, because financial constraints interact with infrastructure access, industrial validation, customer engagement, and development timing (Muscio, Simonelli and Vu, 2023; Grande et al., 2025). Ventures at TRL 4-7 often need several forms of support at the same time: access to pilot facilities, opportunities for testing and validation, industrial partners, regulatory guidance, customer feedback, and patient capital (European Commission, 2026b; Grande et al., 2025). When these elements are not connected, the transition from validation to demonstration becomes slower, more uncertain, and more costly (Auerswald and Branscomb, 2003; Muscio, Simonelli and Vu, 2023). Recent work on European deep-tech and sustainability-oriented innovation similarly shows that scale-up barriers are multidimensional and involve the interaction of finance, infrastructure, validation, and industrial engagement (Muscio, Simonelli and Vu, 2023; Grande et al., 2025).

2.2 Ecosystem Fragmentation and Coordination Failure

Entrepreneurial ecosystem theory provides a useful lens for understanding why the existence of many support instruments does not necessarily produce effective scale-up outcomes (Isenberg, 2010; Autio et al., 2018). The ecosystem perspective argues that entrepreneurship depends not only on individual firms, founders, or resources, but also on the quality of interaction among entrepreneurs, investors, universities, support organizations, public agencies, infrastructures, and markets (Isenberg, 2010; Autio et al., 2018). From this perspective, the availability of resources is only one condition for venture development, while the visibility, accessibility, and sequencing of those resources are equally important for firms moving through development stages (Autio et al., 2018; Reischauer, Güttel and Schüssler, 2021).

Regional innovation systems literature makes a similar argument from a territorial and institutional perspective (Cooke, 2016; Asheim, Isaksen and Trippel, 2019). It emphasizes that innovation performance depends on how knowledge institutions, firms, infrastructures, policy actors, and intermediary organizations are connected across regions and governance levels (Cooke, 2016; Asheim, Isaksen and Trippel, 2019). This is especially relevant for Europe, where deep-tech ventures often operate within multi-level support environments involving universities, RTOs, regional development agencies, European funding programmes, and sectoral innovation networks (EIT, 2024; Grande et al., 2025; European Commission, 2026a). Such environments may contain considerable resources, but they can still remain difficult to navigate when instruments operate through different eligibility rules, timelines, access points, and institutional priorities (European Commission, 2026a; European Commission, 2026b; Eureka Network, 2026a). Europe's deep-tech scale-up challenge can therefore be

interpreted less as a problem of absolute scarcity and more as a problem of weak systemic alignment (Autio et al., 2018; Cooke, 2016; Grande et al., 2025).

2.3 Innovation Intermediaries and Ecosystem Orchestration

The role of innovation intermediaries is important in fragmented ecosystems because intermediaries can reduce search costs, connect firms to relevant resources, translate between institutional logics, and support collaboration across organizational boundaries (Reischauer, Güttel and Schüssler, 2021; Bäumle, 2025). In ecosystem settings, intermediation goes beyond providing isolated advisory services and may involve orchestrating relationships among actors, aligning resources with venture needs, and creating continuity between different stages of development (Reischauer, Güttel and Schüssler, 2021; Leceta and Könnölä, 2021). This orchestration role is especially relevant where innovation ecosystems contain multiple specialized actors but lack a single navigable route through funding, infrastructure, validation, and market-access domains (Leceta and Könnölä, 2021; Vujovic and Baloutsos, 2025). It is also relevant for EIT HEI ecosystems, where universities, startups, incubators, RTOs, public agencies, investors, and European-level programmes may all be present but not necessarily integrated into a clear pathway for ventures (EIT, 2024; Leceta and Könnölä, 2021; Vujovic and Baloutsos, 2025).

3. Methodology and Data

3.1 Research Design

This study utilizes an exploratory qualitative design and draws on two sources of evidence: an expert interview with a startup mentor engaged in an EIT HEI-funded project, and a structured desk study of European support mechanisms. The interview provides practice-level insight into the challenges and support needs. The desk study maps how support is formally organized across funding, infrastructure, and intermediation domains. Where the two sources converge, interpretive confidence is stronger; where they diverge, the divergence is treated as analytically informative.

3.2 Interview Data

An in-depth semi-structured interview with an experienced startup mentor in an EIT HEI project was conducted in January 2026. The interviewee was selected based on their direct and sustained engagement with deep-tech ventures at TRL 4-7, and a number of supported startups (15) over a five-to-six-month period. This cross-case exposure partially compensates for the inferential constraints of a single-interview design, as observations reflect patterns across multiple ventures rather than a single firm's experience (Neergaard and Leitch, 2015; Ahmad and Wilkins, 2025). The supported ventures were registered companies at TRL 4-5, operating in materials and industrial innovation with B2B orientations and developing research-based technologies for industrial application.

3.3 Desk Study

The desk study examined European support mechanisms relevant to TRL 4-7, focusing on the EIC, EIT KICs, Horizon Europe, Eurostars, InvestEU, and RTO networks. The documents included programme descriptions, work programmes, implementation guidelines, and strategic documents. Analysis was guided by four questions: what type of support is offered; which development stage it targets; whether it addresses single or combined support functions; and how explicitly it connects to adjacent instruments or stages (Hall and Steiner, 2020; Kayesa and Shung-King, 2021).

3.4 Data Analysis

The interview transcript was coded around venture characteristics, support needs, access conditions, and coordination gaps. Desk-study documents were coded by instrument type, target stage, support function, and degree of institutional linkage. Both datasets were then compared to identify alignments and mismatches between formal support structures and practitioner-observed experience.

4. Results

4.1 Deep-tech Venture Needs and Bottlenecks

According to the interview, support requirements demonstrate consistency in terms of the mutual relationship between the needs. While the most frequently mentioned problem was a lack of adequate funding, it rarely occurred in isolation. Deep-tech ventures needed help not only with determining the right funding instruments but also with sequencing funding sources to align with technical milestones. Another critical issue, closely tied to financing, was accessing pilot customers. The term 'pilot customer' referred to early-stage industrial clients who could simultaneously serve as testers and facilitators of market-related learning. This was further supported by validation, including guidance on proving that laboratory solutions work well in conditions closer to reality. In addition, scale-up preparation emerged as an interrelated need, as ventures had to understand which partnerships or facilities were required before building their production capacities. However, the interview showed that each of these concerns required a specific engagement on the part of a support provider. As the interviewee noted, "repeated interaction gives time to dig deeper and actually find the real problems," which cannot be done in one-time meetings.

According to the interviewee, four bottlenecks were recurrent in the cases when support had been provided. The first problem was poor visibility and access to pilot and demonstration infrastructure, which were critically important for ventures at the point of transition to scaling. Second, there was fragmentation and poor sequencing of funding pathways, which required not only a choice of instruments appropriate to a given stage of venture development but also an understanding of the process by which they gradually combine. Third, there were few options for continuity of support across all domains, which meant that issues such as funding, validation, industrial contacts, and infrastructure needs should have been addressed simultaneously, but not as independent matters, which current support frameworks were designed for. Finally, there was a lack of visibility and unclear entry points for seeking support, which meant that discovering available resources was accidental, and many firms were unaware of their existence. In the interviewee's words, "there is no real pipeline inside the European Union funding that would make it really clear for anyone that these things are happening and available."

4.2 European Support Architecture for Deep-Tech Ventures at TRL 4-7

The desk study analyzes Europe's formal support framework covering the mid-TRL commercialization trajectory. According to Horizon Europe's General Annexes, the TRL 4-7 stage encompasses "technology validated in a lab", "environmentally tested and validated", "technical validation/demonstration" through "system prototype demonstration in an operational environment" - the stage where instruments start mentioning validation, piloting, deployment and scaling, and when coordination needs for ventures are at their peak (European Commission, 2026b).

Across all considered sources, the framework proves quite wide-ranging but is still distributed across four functional domains. The domain of funding is covered by Horizon Europe Research and Innovation Actions and Innovation Actions aimed at collaborative R&D, testing, and demonstration with specified TRL targets (European Commission, 2026b; European Commission, 2026c). EIC Transition funds technology maturation based on previous EU-funded achievements, supporting maturation from TRL 3-4 to TRL 5-6 stage, supplemented with business-readiness elements, yet only for those TRL 3-4 results achieved under specified upstream EU-funded project types (European Innovation Council, n.d.-a). EIC Accelerator provides funding for maturation at TRL 6-8 through grants combined with equity/quasi-equity investments and Business Acceleration Services (European Innovation Council, n.d.-b). Eurostars represents a unique case in that it funds collaborative R&D oriented toward the market, led by innovative SMEs, within a competitively ranked project portfolio with national-level joint funding. It is relevant for ventures looking to work with international partners and collaborate in piloting during the TRL 4-6 phase, even though pathway continuity would still depend on national criteria and scheduling differences among consortium members (Eureka Network, 2026a; Eureka Network, 2025a; Eureka Network, 2025b).

In the domain of advisory and intermediation services, the EIT KIC framework delivers partner network-based assistance focused on finance access, customer networks, and market development, segmented by stages of business development but not by formal TRL (EIT, 2024; EIT, n.d.). EIC Business Acceleration Services and Coaching supplement the mix with stage-specific coaching, business-to-business and corporate buyer matching and special partner access via the Ecosystem Partnership Programme (European Innovation Council, n.d.-c;

European Innovation Council, n.d.-d; European Innovation Council, n.d.-e). The financing domain is represented by InvestEU with guarantee-backed instruments and advisory support via the Advisory Hub, targeting demonstration, deployment, and scaling (European Commission, n.d.-a; European Commission, n.d.-b). Finally, in the infrastructure domain, the RTO networks link applied research competence with pilot facilities and industrial collaboration, presenting themselves as intermediaries between knowledge creation and its application (EARTO, n.d.).

Formal connections exist among the various instruments in the described framework. Thus, EIC Transition is explicitly tied to previous EU funding. EIC Accelerator features Fast Track and Plug-In routes for projects previously funded under Horizon or nationally, as well as Seal of Excellence schemes for proposals that remain unfunded despite being strong candidates (European Innovation Council, n.d.-b). There is also a particular Fast Track route from Eurostars-3 to the EIC Accelerator program, indicating that Eurostars is conceived as one of the steps in a broader sequencing strategy leading to the scaling stage (Eureka Network, 2025c). Moreover, according to the EIC Work Programme 2026, STEP Seal proposals can be referred to InvestEU implementing partners as candidates for venture debt funding (European Commission, 2026a).

Thus, the framework is quite extensive and formally interconnected in several ways. However, this does not necessarily mean it is navigable in practice - its impact on venture pathway continuity will be discussed below.

4.3 Coordination Gaps Between Venture Needs and Support Structures

By integrating the interview findings and the desk study, it becomes evident that a misalignment issue lies at the core of the problem with support provision in deep tech. Specifically, there is an important gap between the integrated nature of venture needs and the segmented structure of support tools. Three misalignments stand out in this regard.

First, integrating venture needs and segmenting support instruments. As demonstrated in the interview, deep tech companies need funding to validate ideas, run pilots, and build networks that enable pilots. This is an interconnected, iterative process based on guidance, network building, and the evaluation of outcomes. On the other side of the spectrum, desk research revealed that the functions mentioned are distributed among separate instruments covering each element of the development process. It means that startups have to integrate support on their own rather than follow some coordinated pathway.

Second, the availability of necessary infrastructure and practical accessibility. Desk research confirmed the existence of various infrastructure-related support tools in the ecosystem under discussion. Nevertheless, these opportunities can be accessed via completely different pathways (consortia membership, award of company status, partner network, or bilateral arrangement), thus making ventures face the problem of fragmented opportunities despite the objective existence of relevant capacities. Mentoring and advisory services follow the same pattern - although they are technically available, they are not always coordinated throughout the entire venture development process.

Finally, formal linkages between support tools versus the practical navigability of the support ecosystem. The desk research showed that there are several ways for handoffs from one program to another. Thus, it proves that the ecosystem of support in deep tech is not completely isolated, at least at the programme level. However, experience from interviews shows that these links do not work properly for companies, as access is mostly accidental, and many support tools remain unknown to the ventures that need them. Thus, there is a clear gap between the institutionally constructed interconnectedness of programmes and their navigation in practice.

The conclusions about the nature of the problem revealed in this case study can be summarized in Table 1.

Table 1: TRL-specific venture needs, support options, and support limitations in the European deep-tech support architecture

TRL	Main Needs	Support Options	Main Limitations
4	Lab validation, early business case development, next-step planning, seed funding	Horizon Europe grants; EIC Transition (where eligible from prior EU-funded results); EIT KIC pre-seed support; RTO infrastructure and technical collaboration	Fragmented entry points; restricted eligibility in several schemes including EIC Transition; low venture awareness of available support; weak pathway continuity

TRL	Main Needs	Support Options	Main Limitations
5	Validation in relevant environment, pilot facility access, first industry contacts, sustained diagnostic mentoring	Horizon Europe RIAs/IAs; EIC Transition (where eligible from prior EU-funded results); Eurostars (subject to national co-funding alignment); EIC BAS (for EIC-funded companies); EIT KIC networks; RTO infrastructure and technical collaboration	Pilot access is uneven and instrument-dependent; support functions spread across separate programmes; Eurostars pathway continuity subject to national eligibility and funding timetable variation across consortium partners
6	Technology demonstration, scale-up planning, blended finance, investor and customer readiness	EIC Accelerator; Eurostars (subject to national co-funding alignment); Horizon Europe IAs; EIC BAS; EIT KIC acceleration support; InvestEU; RTO infrastructure and technical collaboration	Coordination demands peak: demonstration, validation, mentoring, and finance require combining multiple instruments simultaneously; Eurostars does not include built-in scale-up finance; no single instrument covers the full TRL 6 support need
7	Operational prototype demonstration, deployment planning, scaling finance, procurement and customer access	EIC Accelerator; EIC Accelerator STEP Seal / InvestEU referral; InvestEU; EIC BAS; EIT KIC scale-up support; RTO infrastructure and technical collaboration	Dedicated scale-up finance more accessible than at earlier stages; navigation remains complex and multi-instrument; no single coordinated entry point into the combined finance and deployment support landscape

4.4 Toward a Coordinated Support Model in EIT HEI Ecosystems

The implications of the results point towards a distinct model design: improving support for deep-tech scaling at TRL 4-7 does not require more instruments but rather better mechanisms for alignment, accessibility, and continuity amongst those that already exist. In this section, an integrative model will be proposed in which EIT HEI actors function as systemic intermediaries, performing three intertwined roles. The model is not meant as an alternative to existing instruments in Europe, but rather as a reframing of the role of EIT HEI nodes to build a coherent navigation architecture for research-intensive ventures.

4.4.1 Venture-stage Diagnostic Alignment

During the TRL 4-7 stage, companies' challenges are iterative and overlapping. Technical validation, industrial testing, customer validation, regulatory validation, and financial needs occur together and evolve dynamically as venture development progresses. Successful support required iterative engagement to understand the actual constraints underlying perceived needs. The first step of the support programme for deep tech companies, therefore, is the systematic diagnosis of venture readiness at each development stage and the identification of the particular bottlenecks, in terms of a combination of factors. The objective would be to develop a progression pathway for each venture based on a realistic assessment of its technological and market potential. This would provide a much more tailored form of support for research-intensive ventures than general startup support and would create a basis for the subsequent two intermediary roles: structured and purposeful brokerage and orchestration.

4.4.2 Infrastructure and Blended Finance Brokerage

The desk study demonstrated that instruments for venture support were available in Europe but scattered across multiple institutions with different access mechanisms, eligibility criteria, and goals. In terms of intermediary functions, brokerage would mean actively matching needs diagnosed by the intermediary institution with infrastructure, collaborations, and funding opportunities provided by other institutions. According to the model proposed, EIT HEI actors would provide venture connections to RTOs, KIC partners, industrial clients, and other instruments, including the Eurostars and InvestEU programmes. In addition to brokerage, the model requires intermediary involvement in planning grant funding, blended finance, and follow-up investments during venture development.

4.4.3 Cross-institutional Ecosystem Orchestration

The above discussion of diagnostic alignment and brokerage highlights the deep tech companies' needs and how they can be matched to available infrastructure and financing instruments. However, what makes these intermediary roles necessary at all is the condition of low ecosystem-level integration, under which ventures cannot easily access support instruments. EIT HEI ecosystems are proposed to function as meso-level

orchestration intermediaries, connecting universities, incubators, RTOs, public institutions, investors, funding bodies, and infrastructure providers.

In conclusion, the three roles of intermediary institutions discussed together represent a coherent support model, the main strength of which is creating structural access to the resources of existing support programs rather than providing support itself. Only diagnostic alignment would ensure that brokerage is not random; only brokerage that intermediaries provide would make orchestration produce tangible benefits for ventures. The model's major institutional innovation is thus the positioning of EIT HEI not as a support program node but as a systemic intermediary.

5. Discussion and Conclusion

In relation to the paper's aim of examining the TRL 4-7 transition as a coordination challenge, this study suggests that the European scale-up problem for deep-tech companies is better understood as a coordination problem than as a simple under-supply of assistance. This finding supports entrepreneurial ecosystem and regional innovation systems research, which argues that innovation outcomes depend not only on the availability of actors and resources, but also on the quality of connections among them (Autio et al., 2018; Cooke, 2016; Asheim, Isaksen and Trippl, 2019). The key weakness is not only that support is fragmented, but that ventures are often left to combine funding, pilot access, validation, mentoring, and industrial contacts by themselves. This makes the valley-of-death problem more than a financing gap; it also becomes a problem of sequencing and institutional navigation.

The contribution of this paper is therefore to treat fragmentation in European deep-tech support as an institutional design issue. The proposed framework positions HEI-connected actors as systemic intermediaries that can support diagnostic alignment, infrastructure and blended-finance brokerage, and cross-institutional ecosystem orchestration. This argument is consistent with previous research on innovation intermediaries and ecosystem orchestration (Reischauer, Güttel and Schüssler, 2021; Leceta and Könnölä, 2021; Bäuml, 2025). This would not replace existing instruments, but could make them more usable by reducing search costs and improving continuity across support domains. At the same time, the framework should not be read as a simple institutional fix. If poorly designed, an additional intermediary role could add another layer to an already crowded support landscape.

Overall, the study remains exploratory and should be interpreted with caution. Its empirical base is narrow, relying on one expert interview and one EIT-related support case, although the interviewee's experience covered several ventures. The desk study also captures formal support mechanisms more clearly than informal access practices or regional differences. Future research should therefore test the proposed framework through multiple case studies and interviews with founders, investors, RTOs, and policy actors. Despite these limitations, the paper shows that improving deep-tech scale-up in Europe may require not only more support, but better coordination of the support that already exists.

Ethics Declaration

The interview participant participated voluntarily and was informed of the study's purpose and the intended academic use of the material. No sensitive personal data was collected. The interview transcript was used in anonymized form, and identifying details not relevant to the analysis were omitted. The study did not involve vulnerable participants, medical data, or interventions requiring formal ethical approval under institutional or national research ethics procedures.

AI Declaration

English is not the author's first language; Grammarly was employed to ensure grammatical accuracy and improve stylistic consistency.

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