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CASE STUDY

# Southern European entrepreneurship engine: A model for deep tech commercialization and sustainable growth

[version 1; peer review: awaiting peer review]

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## Abstract

The European Innovation Scoreboard (EIS) evaluates the research and innovation performance of EU Member States, categorizing them into four innovation groups. Southern European countries, except for Cyprus, fall into the two lower performing categories: moderate and emerging innovators. To close this innovation gap Southern European countries need a targeted approach to increase the efficiency in translating R&D outputs into social and economic value.

The Southern European Entrepreneurship Engine (S3E), an EU-funded initiative, proposes an approach to bridge this gap by focusing on nurturing early-stage R&D projects with commercialization potential and accelerating deep tech start-ups. The project employs a three-tiered approach targeting different stages of development: (i) early-stage R&D projects seeking market alignment, (ii) growth-stage startups needing robust business plans and funding networks, and (iii) scaling startups and SMEs requiring corporate partnerships for market access.

This case study presents the S3E project, its methodology, impact, and lessons learned, aligning with sustainability goals and EU strategic objectives.

**Open Peer Review**

**Approval Status** *AWAITING PEER REVIEW*

Any reports and responses or comments on the article can be found at the end of the article.

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## Introduction

The European Innovation Scoreboard[1] offers a framework for comparing the research and innovation capacities of EU Member States, as well as other European and selected non-European nations. It serves as a tool for identifying the strengths and weaknesses within national innovation systems and highlighting areas that require improvement to boost performance. Based on their scores, countries are divided into four categories: **'Innovation Leaders**,' with scores exceeding 125% of the EU average; **'Strong Innovators**', scoring between 100% and 125%; **'Moderate Innovators'**, with scores ranging from 70% to 100%; and **'Emerging Innovators'**, falling below 70%.

A clear divide exists between Innovation Leaders and Strong Innovators on one side, and Moderate and Emerging Innovators on the other, particularly in the origin and funding of deep tech startups[2]. Some of Europe's most valuable deep tech companies - such as BioNTech (Johannes Gutenberg University Mainz, Germany), Climeworks (ETH Zurich, Switzerland), and Darktrace (Cambridge, UK) - have emerged from academic institutions in Innovation Leader countries. However, the European Innovation Scoreboard (EIS) suggests that this success is not mirrored in countries with developing innovation ecosystems, where there is a lag in research commercialization and venture capital (VC) investments.

Both the European Innovation Scoreboard 2024[1] and The European Deep Tech Report 2023[2] highlight weak investment in startups in Moderate and Emerging Innovator countries. Despite the existence of high-quality research, these countries struggle to convert scientific discoveries into marketable products. The lack of structured support and technology transfer processes prevents these countries from fully harnessing their innovation potential, particularly in deep tech, where complex technologies often require specialised support beyond just funding[3].

To address this innovation gap, Moderate and Emerging Innovator countries need to focus on several key areas: the societal spillover of research, access to funding, talent development, and stronger collaboration between academia, industry, and governments. This gap is especially evident in Southern European countries—such as Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Italy, Malta, Montenegro, North Macedonia, Portugal, Romania, Serbia, Slovenia, Spain, and Turkey—which are classified as Moderate or Emerging Innovators.

European countries also lag globally in the commercialization and industrialization of deep tech-related products[3]. In response, the European Commission launched the New European Innovation Agenda, a strategic initiative aimed to put Europe at the forefront of the new wave of deep tech innovation and start-ups. This framework is designed to make Europe a global leader in innovation by creating a conducive environment for startups, scale-ups, and innovative enterprises to thrive and expand more easily across the European Union[4]. Since deep tech startups are often rooted in academic research, accelerating these startups and SMEs plays a crucial role in promoting knowledge spillover and transforming socio-economic development in countries with less developed innovation ecosystems.

Over the past two decades, innovation has been predominantly driven by disruptive business models anchored in digital platforms and web or mobile-based apps, making innovation synonymous with the tech industry. However, the rise of deep tech marks a shift in focus among startups, venture capitalists, and policymakers, moving away from traditional digital startups[5]. Deep tech refers to technologies with profound societal and national impact[3], that are founded on scientific discoveries or meaningful engineering innovations[6] and, according to the European Institute of Technology and Innovation, have the potential to transform lives, accelerate the green and digital transition, and tackle pressing global challenges such as climate change, sustainable energy, and health. Achieving the Sustainable Development Goals (SDGs) is a strategic priority for governments, and deep tech innovations play a critical role in addressing these global challenges[7].

Despite the significant potential for deep tech innovation, Moderate and Emerging Innovator countries in Southern Europe face barriers in accessing the necessary resources, expertise, and investment to successfully commercialise their research. These challenges underscore the need for structured programs that can foster innovation ecosystems, support deep tech startups, and accelerate their growth.

Recognizing this need, the Southern European Entrepreneurship Engine (S3E) was established. This initiative aims to bridge the innovation gap in Southern Europe by creating a supportive ecosystem that enables research teams, startups, and SMEs to thrive. Below, we introduce the three main tracks of the S3E program and explore how it addresses the region's specific challenges in deep tech innovation.

## The Southern European entrepreneurship engine program

Fostering deep-tech innovation in Southern European countries constitutes a powerful driver for the region's economy and to support the European Commission in its goal of positioning Europe at the forefront of the new wave of deep-tech innovation. To that end, the Southern European Entrepreneurship Engine Program (S3E) was created in 2022 as a program designed to enhance the connectedness and efficiency of the emerging innovation ecosystems in Southern European countries. S3E focuses on accelerating deep-tech projects and startups that, by providing solutions for a more sustainable economy and society, can boost economic growth in these countries and contribute to the timely achievement of the United Nations Sustainable Development Goals (SDGs). To achieve this, S3E was designed with three tracks that support value creation in different stages of the deployment of deep-tech projects, namely: (i) **Start** –a hands-on training program for research teams that want to explore the commercialization potential of their research results; (ii) **Charge** – a mentoring program

for growth-stage startups, designed to help them develop an investment-ready business plan; and (ii) **Reverse** – a (broker mediated) program that matches deep-tech challenges presented by corporates with startups and SMEs that can provide solutions to those challenges. Together, these tracks create a cohesive ecosystem for accelerating deep-tech innovation in Southern Europe. The following sections explore each track in further detail.

## Track 1: S3E start

The complex innovation processes necessary for transitioning research results to commercialisation of the technologies that they enable need to overcome a wide range of barriers that include, e.g., the lack of alignment between the skills required for knowledge valorization and the incentives of the research career[8], the lack of alignment between research publication and intellectual property protection[9,10], the limited competencies to connect technical knowledge to a commercial opportunity[11] and the communication gap between researchers and business people[12].

S3E Start is the keystone of the S3E program as it targets research teams, from Southern European countries, with early stage deep-tech projects (up to a Technology Readiness Level of 5[13]).

S3E Start is an 18-week hands-on training program that includes online tutorials, webinars, and mentoring sessions. Each participating research team (consisting of 2 to 5 members) proposes a technology or scientific discovery and, over the course of the program, follows a structured process (known as "the algorithm"[14]) that was designed specifically to embed sets of skills and behaviors that allow technology commercialization novices to operate as competent technology entrepreneurs or as technology-product champions[15]. This training model, originally named Technology Entrepreneurship and Commercialization (TEC) "algorithm" was initially developed at North Carolina State University from 1995 to 1999[16] as a two-semester course for MBA students. The process has been refined and adapted, since 2004, by the HiSeedTech[17] team, as a technology commercialization program for researchers aiming to support participants in overcoming the barriers referred earlier in this section[18].

The online tutorials account for less than half of the total workload of the program, with the remaining time dedicated to group meetings facilitated by the mentors. Each week, participants are required to complete specific deliverables, which will guide them through the program's three phases: ideation, development, and commercialization, ultimately leading them to the outcome of the program - a business project for a product grounded on the technology proposed by the research team.

The initial goal of any successful technology commercialization endeavour begins with the identification of an unmet or ill-met market need that will benefit from a technological solution[19]. Therefore, the first five weeks of S3E Start are dedicated to the Ideation phase. During this time, the research teams develop and prioritise product concepts based on the market needs that their technology can address. The model used to refine these product concepts is called 'T-P-M' (Technology–Product–Market)[20]. Since technologies often have multiple applications, the challenge here is to devise product ideas that utilise their unique capabilities. This model explores how the technology can evolve into one or more products and links them to relevant market needs. First, technological capabilities are defined, and then these are transformed into specific product attributes. Product attributes are then matched with customer needs to find valuable market applications[21].

Businesses need to focus on one application, as a deep-tech venture cannot pursue all T-P-M linkages simultaneously[19]. From the Ideation phase, the program transitions into the Development phase, during which, over six weeks, teams refine, improve, validate, and select from the product concepts devised in the Ideation phase. This is done using a guided approach that requires teams to engage with the market, challenging and sustaining each of the T-P-M linkages proposed in the previous phase. While Ideation requires limited interaction with external experts, Development pushes participants to interact with and build relationships with external parties, including scientists, managers at potential competitor firms, suppliers, and especially customers[18].

During the initial stages of this phase, research teams will focus on identifying any "fatal flaws"—whether related to the product or the market—that may sustain eliminating one or more T-P-M linkages. Using insights gathered from the market, teams will develop a value proposition for their products in a structured format. This process will require them to: (i) clearly define the product, (ii) connect customer needs to the economic benefits of using the product, and (iii) distinguish their product from competitors by highlighting its unique features. Furthermore, teams will develop a business model for the selected product, articulating how the future startup plans to create, deliver, and capture value. Throughout this phase, participants will use various management tools—such as 5 Forces Analysis, SWOT Analysis, Industry Mapping, and "Voice of the Customer"—to deepen their understanding of market dynamics. These tools, integrated into the methodology, will support teams in refining their product concepts and choices[17].

The next four weeks is the phase where teams put the pieces of the puzzle together by building a strategy to bring the product to market. This phase begins with the definitions of the pricing point and the sales plan answering strategic questions such as market traction and market entry point(s). Additionally, drawing on the business model previously designed, teams will define their development roadmap that will allow them to build the financial projections and carry out a risk analysis. At this stage teams will have all the elements needed to produce a business case and a pitch that are the final outcomes for the Program.

The S3E Start process is highly iterative. When a team learns something that calls a prior decision into question, they are required to "iterate back" to the relevant part of the

algorithm and repeat the process. In fact, the typical team experience involves repeated iteration as new discoveries are made[14]. The mentors play a crucial role in this iterative process by encouraging teams to revisit decisions and select the best options. Throughout the program, eight 90-minute mentor meetings are held. These mentors were chosen through a call for expressions of interest and were selected based on their expertise and professional experience in supporting deep tech projects.

Throughout the duration of the program, teams are required to present their work three times. The first presentation takes place during the program's kick-off, where teams pitch their technologies to their peers participating in the program. The second is the mid-term presentation, during which teams pitch their value propositions to a panel of experts. These experts provide feedback on the work completed thus far and offer suggestions for improving the deliverables. The final presentation is at the S3E Start Open Day, where teams deliver a 7-minute presentation followed by a 3-minute Q&A session. The audience for this session includes researchers, executives, investors, and relevant stakeholders.

The Open Day is a highly choreographed event and represents a substantial investment of time and resources during the final three weeks of the program for participants, faculty, and members of the HiSeedTech executive team. This effort also benefits the program by generating press coverage and showcasing business opportunities to investors.

The uniqueness of this pedagogical approach lies in its ability to address the challenges that cause technology and innovation to stall in the 'Valley of Death'—the gap deep tech projects face during their early development stages to commercialization[19],

a critical issue in technology commercialization. Since researchers are working on their own deep-tech projects, they remain fully engaged throughout the program, exploring pathways to bring ideas to market, which can include starting a new company, co-developing with a corporate or licensing[22].

## Track 2: S3E charge

The S3E Charge accelerator program forms a unique accelerator, designed for growth start-ups from the South of Europe, specialising in deep-tech solutions contributing to one or more of the 17 UN Sustainable Development Goals SDGs and the European Green Deal[23], as sustainable business models can offer organisations a competitive advantage by adapting traditional business models to support sustainable development, while still maintaining profitability and productivity[24]. Targeting companies in the growth development phase in deep tech, as focal accelerators are more prone to expedite the speed to raising different levels of funding[25], S3E Charge provides participating start-ups with essential tools and mentoring support to advance their business plans, prepare for investor engagement, and connect with influential industry networks. Aligned with the SDGs and providing an introduction to ESG practices, the program's focus is to foster innovation that contributes to global sustainability and prepares start-ups to access investing, including liaising them with impact investors.

The S3E Charge Accelerator has been developed for deep-tech (as opposed to Business Model Innovation), growth start-ups aiming to scale quickly on a global stage. Acknowledging that accelerators have become a comprehensive cornerstone within many entrepreneurial ecosystems[26], this program has been designed for companies with Technology Readiness Levels (TRL) up to 6–7, and specifically addresses startups that either have no prior funding or are at the pre-seed stage. The goal is to guide participants toward creating investment-ready business plans that could attract both dilutable and non-dilutable funding opportunities and giving them the opportunity to hone their pitch decks and present them in Open Days and in other events. Following a cohort-based model that standardises some services and has structured educational and mentorship services, plus the advantage of peer-learning[25], through a combination of webinars, mentorship and networking, spanning either 14 weeks or 4 weeks for the fast-track version, S3E Charge provides participants with hands-on support to refine their business strategies, clarify their value propositions, and prepare for investor engagement.

The program targets growth start-ups in the science and technology sectors, including fields like agricultural sciences, engineering, medical sciences, and natural sciences, as long as the innovation aligned with one or more of the UN SDGs and the EU Green Deal (most of the start-ups that have been accelerated also are aligned to the five EU Missions[27]). Eligible start-ups are required to submit a detailed application, including a concise description of their business, a video pitch, and a comprehensive business case covering their technology concept, competitive advantage, market needs, intellectual property strategy, and funding requirements. S3E leverages the F6S platform[28] to manage the application process, ensuring inclusivity, transparency, and broad accessibility in application and selection.

Through a combination of webinars, mentorship and networking that can last either 14 weeks (three months being the average accelerator duration) or 4 weeks for the Fast-Track program, the S3E Charge program has a structure based on creating an investment-ready business plan and pitch deck for startups and on accessing funding opportunities. Webinars and mentoring sessions are interconnected as regards themes and topics and usually are consecutive so that teams have the chance to get introduced to a topic and then discuss this with their mentor, thus integrating the knowledge gained into their business plan.

The cornerstone of the S3E Charge program's success is the series of webinars designed to equip startup teams with essential knowledge for navigating the challenges of business growth as learning is a crucial process that influences the success of its startup graduates in an accelerator[29]. Over the

fourteen-week or the fast-track program, S3E Charge provides webinars, covering a spectrum of critical topics essential to start-up development. These webinars are part of a pre-design curriculum and address fundamental areas such as funding, sustainability, intellectual property protection, marketing, and pitch preparation, providing participants with well-rounded, in-depth training to support their journey toward an investment-ready business. Each webinar is delivered by field experts, including ecosystem partners, S3E Charge mentors, and leaders in their sector. This inclusive approach also welcomes consortium members and stakeholders from related projects, fostering an environment of shared learning and collaboration. If there is a specific need to be covered, the program is also flexible enough to include more webinars and experts on specific topics.

Additionally, community meetings are set up so that people-to-people connections are established, given that "innovation happens in the context of relationships"[30], start-ups can get to know each other, express concerns and/or feedback and pitch to each other. These meetings foster a community, increase in social network[31,32] and are also an opportunity for fostering connections, exchange ideas and promote collaboration amongst the participating teams.

Central to the S3E Charge program is also its mentorship pillar, tailored to address the unique challenges facing deep-tech start-ups. The one-to-one mentorship program has been built upon international best practices and has been structured to help participants develop a robust, investor-ready business plan and a pitch deck, whilst working on their soft skills[29]. Each science-based start-up is paired with an experienced mentor that is not part of the accelerator staff specialising in technology commercialization, business development, and intellectual property protection, ensuring high-quality guidance[28,33]. Each mentor undergoes an onboarding process where the S3E Charge Mentors' Handbook, crafted for the program and based on literature[34], is given and presented as it forms the basis of the mentoring, ensuring quality of the program and timing the deliverables. In most cases, it is preferable to match a start-up with a mentor from a different country, thus ensuring exposure to diverse mindsets and cultures and access to the mentors' social networks[28]. The program so far has had leading mentors from the EU, the US, Oman and Malaysia.

Mentorship sessions are held biweekly, with each meeting lasting 1.5 hours. Through structured sessions (seven in the long program or four for the fast-track one), start-ups receive personalized advice, learn to validate their business assumptions, and are provided with industry insights that informed their strategies. Mentors play a crucial role in guiding participants through the iterative process of refining their business plans, ensuring that all critical areas—such as market analysis, sales, financial planning, and IP protection—are thoroughly developed and investment-ready.

The S3E Charge program creates unique networking opportunities, connecting participants with industry leaders, investors, and potential clients. A highlight of the program has been the S3E Open Day for the long version, where start-ups presented their pitches, followed by a 10-minute Q&A session with investors. These events allow participants to showcase their business models, gain exposure, and establish valuable connections. After the S3E Charge program graduation, a structured follow-up mechanism enables one-on-one meetings between start-ups and interested investors, further facilitating potential partnerships and funding discussions.

Completing S3E Charge allows start-ups to develop detailed and well-researched. business plans, enhancing their readiness for the market. The key outcomes include:

- A validated business plan with in-depth sections on product concept, market analysis, IP strategy, sales and marketing, and financial planning.
- Improved skills in aligning their products or services with market demands and effectively communicating their value propositions to investors.
- Increased readiness to pitch and adapt their business model to various audiences.
- Enhanced knowledge of IP protection, ensuring their innovations remained secure.
- Access to ongoing funding opportunities via the S3E project's network and resources.
- A Participating Certificate of the S3E Charge program to be featured in their material, as accelerator affiliation is important as a "visible cue" for start-ups that have not yet any commercial or social validation[28].
- Be part of a community of practice[28].

Participants also gain a deeper understanding of how to strategically position their innovations within high-impact ecosystems, connecting with both "Innovation Leaders" and "Strong Innovators" networks.

The S3E Charge program provides invaluable support to the participating start-ups, enabling them to refine their technology concepts and strengthen their strategic foundations. By linking their products with tangible market needs and receiving rigorous mentorship, participants emerge with robust business plans and an increased capacity to attract funding and partnerships. One of the unique aspects of the S3E Charge program is its iterative approach, allowing start-ups to continually refine their business strategies based on market feedback and mentor insights. This iterative process helps participants become agile, with the flexibility to revise their assumptions and adjust their plans as they gather new data and insights. Mentors play a vital role in guiding participants through these revisions, ensuring they developed the best possible strategies for commercialization.

The S3E Charge program empowers growth start-ups with the mentorship, resources, and connections needed to advance their deep-tech solutions in the market. The program fosters the development of start-ups that not only contribute to technological

innovation but also support a sustainable future in light of climate-related and sustainability policies and expectations at the EU and global levels. With an investment-ready business plan and access to a robust network of industry leaders, the participants of S3E Charge are well-equipped to make a meaningful impact in their respective fields and drive sustainable development forward.

### Track 3: S3E reverse

S3E Reverse is the most downstream of the program key pillars and as such has been designed for helping startups and SMEs to gain market traction through a pan-European brokerage program. The idea is to help the startups connect with established corporate and public organisations, with specific challenges and problems, which they can – after a successful match - work together to solve.

Identifying challenges from the corporate world is not a novel concept in the field of research and innovation, as it forms the foundation of Open Innovation approaches. However, most of the EU projects were inviting startups to both identify and solve a problem of a sector, often with very limited participation of the key stakeholders of this sector. It was only in Horizon Europe that EIC introduced explicit challenges in the program.

To bridge this gap, we have invited corporations and public sector entities from various fields, referred to within the project as 'Challenge Organisations', to disclose the challenges they encounter. The objective is to address these challenges through deep tech solutions, while aligning them with the Sustainable Development Goals (SDGs).

Each of the Challenge Organisations were asked to submit challenges through a fully transparent open call mechanism. After the submission, appointed experts reviewed the challenges and converged to selecting those with the highest degree of potential, feasibility, impact and innovation.

It is at this point that an open call for SMEs and start-ups was launched to attract the interest of 'Solvers' to submit their ideas, products, and solutions that address those specific challenges. Again, and instead of going for some type of automated matchmaking we preferred to keep the principle of the 'human in the loop' to the entire process by having the S3E appointed deep-tech brokers in selecting the start-ups or SMEs with the most effective solutions to match them with the challenge organisations.

As organisations and companies face enormous pressure and challenges in complying with the UN SDG and creating a more sustainable business, the role of deep tech brokers is crucial in enabling open innovation.

Like in any market, the innovation system only runs when all the intermediaries who make interacting and partnering possible are in place[35].

The idea in S3E Reverse was that the appointed deep-tech brokers should be the ones who shall translate these challenges into specific problems, bringing the requirements of the challenge organisations close to the offerings of the start-ups, so that the latter may be able to work on them with as precise specifications as possible.

During the program, the deep tech brokers were able to facilitate both the challenge organisations and the solver teams through a stepwise refinement process of breaking down a problem (in our case a Challenge) into a series of steps that, eventually, lead to solutions.

The approach we promoted concentrates all essential characteristics of a co-creation process, where all involved parties benefit from the customised innovation support program designed specifically for them and the coaching and technology brokerage services they will receive.

The idea of brokerage appears in the bibliography as an enabler to facilitate interactions between science and policy[36] as well as to trigger third-party influence[37]. However, it is also its role to foster urban and regional growth and development processes that is now given increased importance, and which appears as more relevant to the rationale and the activities of the S3E project and the Reverse intervention in particular.

It is to this aspect that brokerage in S3E Reverse is regarded as a formal process and is specifically designed to support the participating teams of Innovators bridging the gap between a submitted Challenge and the Solutions that aspire to meet them. In the project we adopted the NESTA Innovation Brokerage Model[38] as a flexible guideline, allowing our deep tech brokers to adapt it and customise it to suit the unique needs and circumstances of each challenge organisation involved. We also mapped the actions to be taken in the form of the four phases of Innovation Brokerage as defined by NESTA and adapted for the needs of S3E Reverse:

- Prepare phase, where the S3E Deep Tech Broker helps Challenge Orgs understand what they are looking for;
- Search phase, where the S3E Deep Tech Broker helps Challenge Orgs find what they are looking for;
- Align phase, where the S3E Deep Tech Broker helps Challenge Orgs establish trust and align their motives, culture and working practices. This allows them to collaborate effectively with the Solvers with the goal of doing the match; and last but not least
- Support phase, where the S3E deep tech broker supports the Challenger Orgs to make the relationship with the Solvers a success in the long run.

Deep tech brokerage as approached in S3E Reverse has three main goals:

- Facilitate collaboration between challenge organisations and potential solutions providers that may lead to solving specific industrial challenges (submitted in our project).

- Help the challenge organisation better understand the innovation process, mature, and clearly define their challenges into specific problems.

- Help cutting-edge and high-performance deep tech companies, startups and SME bring their innovations into the domain of the problems outlined above.

In this setting, the S3E Deep Tech Brokers are expected to combine (or better integrate) market pull and technology push to find the most suitable match to a given challenge. And while they may already be part of a regional or national innovation ecosystem within their country, they are expected to reach out to other networks and projects to ensure a pan-European reach.

## Impact, lessons learned and future challenges

Measuring the real impact of a program targeting deep tech projects and startups can only be fully assessed over the long term, given the extended time-to-market for most of these initiatives. However, some immediate network effects and preliminary outcomes can already be observed. Table 1 presents some of the most relevant output Key Performance Indicators (KPIs) of the S3E project

The provisional KPIs are in line with the forecasted figures for the project and there are two aspects that do not show up in the figures that are particularly relevant. The first one is that research teams and startups from all the Southern European countries targeted by the S3E project participated in, at least, one of the three tracks and, the second one, relates to gender balance, as a significant number of the teams and startups were led by women or, at least, had women in the team.

Table 2 shows some quotes from participants in each of the three tracks of the S3E program, that summarise the overall impression transmitted by the teams regarding the program.

The program's success is also evident in the high visibility of its website[39] and social networks[40], thanks to a well-coordinated and structured program and an effective communication and dissemination team. The connections established during the program have laid the foundation for future collaborations. Participants have formed valuable relationships with experts, mentors, and investors, opening doors to further opportunities, including follow-up investment discussions and potential partnerships.

Both HiSeedTech[17], that leads the S3E Start Track, and the Institute for Sustainable Development – EPLO[41], that leads the S3E Charge Track, have been actively sharing funding opportunities with the projects and startup teams from the very beginning of the program on a regular basis, thus ensuring building a community and getting updated on the success stories of the program.

For both the S3E Start and S3E Charge Tracks the main lesson learned are: (i) more time is needed to consolidate the

**Table 1. Provisional KPIs of the S3E project per track.**

| KPI | Track | Value | Notes |
|---|---|---|---|
| Research teams presenting @ Open Days | 1 | 27 | |
| Experts participating | 1 | 56 | (1) |
| Trainees | 1 | 23 | (2) |
| Average Net Promoter Score (Research Teams) | 1 | 53% | |
| Startups participating | 2 | 51 | |
| Corporates presenting challenges | 3 | 26 | |
| Startups replying to challenges | 3 | 98 | |
| Corporate startup-matches | 3 | 71 | |
| Investors participating in Open Days | 1,2 | 85 | |
| Projects & startups connected to funding opportunities | 1,2 | 39 | |

Notes:

(1) Experts are both the evaluators that selected the participating projects, as well as the mentors for the S3E Start Track.

(2) Trainees are Technology Transfer Officers that attended the Start Track, as members of one of the research teams, to acquire skills in technology commercialization and learn the "algorithm", so that later they can develop a similar program in their own institution.

**Table 2. Quotes from participants in each of the S3E program tracks.**

| | | |
|---|---|---|
| The **S3E Start** program has a comprehensive curriculum that provided us with the necessary information on deep-tech commercialization. With the TEC sessions, webinars and mentor meetings, we had the chance to learn from experts. The S3E Start team has been very supportive and answered all the questions we had. We strongly recommend this program. | The **S3E Charge** program was crucial for our development and current success. It helped us refine our business plan and strategy, and we learned to become more business-oriented and less technical when pitching or talking to investors. | For Alumil, taking part in the **S3E Reverse** program has been a very useful experience. The structured approach to encouraging creation, along with the stimulating sessions, has helped us move forward. The Brokerage we received was excellent; it addressed our specific problems and helped us better clarify our needs. Having conversations with a lot of skilled professionals has broadened our view and improved how we deal with problems unique to our business. |
| **Elif Begüm Elçioğlu, personal communication, July 30, 2023, CEO & Co-Founder, NANOPLEXIA Technology.** | **Michalis Kyriacou, personal communication, May 17, 2024, Co-founder & CEO, Intellectra.** | **Athanasia Bartzou, personal communication, October 16, 2023, Project Manager, Alumil** |

outputs of the program and (ii) regular sharing of funding opportunities and success stories helps build a community and keeps participants engaged and informed and (iii) follow-up initiatives at national or EU levels could ensure continuity and sustained impact.

S3E Reverse was experimental, particularly within the Southern European context. While initial results are promising, long-term planning and support are essential to measure final outcomes and ensure sustained collaboration and progress. Developing a method to assess the costs and benefits of ongoing relationships between Challenge Organizations and Solvers is crucial. Regular reviews, adapting to changing capabilities and structures, and supporting relationship management are essential for successful long-term collaboration

To ensure the long-term success and sustainability of the S3E Reverse Track, several future challenges need to be addressed:

- Establish a Cost-Benefit Evaluation Process: Develop a method to assess the costs and benefits of ongoing relationships between Challenge Organizations and Solvers. This will help determine if the collaboration is producing desired results and identify areas for adjustment.

- Periodically Review Collaborations: Introduce a regular review process to evaluate the performance of collaborations. This will help identify underperforming collaborations and enable timely decisions on whether to continue, adjust, or terminate the partnership.

- Adapt to Changing Capabilities and Structures: Recognize that the capabilities, structures, and personnel of both Challenge Organizations and Solvers may change over time. Continuously monitor these changes and facilitate adjustments to the collaboration as necessary to ensure ongoing alignment.

- Support Relationship Management: Assist both parties in maintaining strong communication and coordination throughout the collaboration. Address any issues or conflicts that arise and help resolve them promptly.

The dynamics of the intervention can only be fully studied and assessed after the completion of the program, following methodologies such as those presented in Massa *et al.* (2022)[42].

## Ethics and consent

Ethical approval and consent were not required (the quotes used in the paper were publicly disclosed by their authors in written or recorded form).

## Data availability statement

No data are associated with this article.

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