AGÊNCIA NACIONAL DE INOVAÇÃO

2021 CoLABs Annual Report

Evolution and integration of CoLABs in Portugal and Europe

Agência Nacional de Inovação, 2021

THE COLLABORATIVE LABORATORIES NETWORK: *BUILDING THE FUTURE*

Manuel Heitor
Minister for Science, Technology and Higher Education

There are currently 35 Collaborative Laboratories in operation, as described in this report, which correspond to initiatives in various areas of knowledge and on a regional or national level, contributing to the densification of the national territory in terms of knowledge-based activities. They currently mobilize around 300 entities, including more than 120 companies, for the development of their research and innovation agendas.

The process launched since 2017 for the creation and promotion of "Collaborative Laboratories - CoLAB" through the Interface Program has had as its main objective the creation, directly and indirectly, of qualified employment in Portugal in close association with the social and economic valorization of knowledge and the encouragement of diversification and institutional innovation. I note, in particular, that this process has been guided and implemented in conjunction with:

1. The **strengthening of exports** and the enhancement of the technological balance of payments, which has had an increasingly positive balance in recent years;
2. The **reinforcement of Human Resources in R&D activities**, with the number of researchers increasing in 2020 to 10.2 per thousand active (it was 7.4 in 2015 and 9.6 in 2019), growing 5% compared to 2019 (2369 more FTE) and 36% since 2015 (more 13.863 FTE). It includes 21.389 researchers in companies in 2020, showing an increase of 81% since 2015 and now representing around 41% of the total number of researchers in Portugal;
3. The **reinforcement of the total expenditure in R&D**, which in 2020 reached a historical maximum in Portugal of 1.6% of GDP, growing 7% compared to 2019 (211 million euros) and 43% since 2015 (when it represented around 1, 2% of GDP), surpassing three billion euros for the first time. These data reveal an increase for the fifth consecutive year in total expenditure in R&D, with an

accumulated growth of 969 million euros compared to 2015 (when it was 2.234 million euros). The increase is particularly expressive in companies, growing 15% compared to 2019 and 75% since 2015. It now reaches 0.89% of GDP, with an overall business expenditure in R&D of 1.811 million euros in 2020, which represents 57% of total expenditure in R&D (it was 46% in 2015 and about 44% in 2009);

4. The **reinforcement of the Portuguese participation in the European Framework Program for Research and Innovation**, which reached a historic maximum in 2020, with around 217 M€ raised by national entities, corresponding to a rate of return of 1.79%, and reaching values never reached before.

The Collaborative Laboratories network has been implemented through the competitive selection, after evaluation by international experts, of research and innovation agendas oriented towards the creation of economic and social value. It includes the internationalization of the national scientific and technological capacity in relevant intervention area(s) and the carrying out of R&D activities that enhance the reinforcement of synergies with scientific and higher education institutions, namely within the scope of specialized, professional or advanced training programs in close collaboration with social, economic and cultural partners.

The main challenge that Collaborative Laboratories must respond to is the effective **densification of the national territory in terms of knowledge-based activities**, through a growing institutionalization of forms of collaboration between science, technology and higher education institutions and the economic and social fabric, namely companies, the hospital and health system, cultural institutions and social organizations.

Collaborative Laboratories must, therefore, consolidate and promote the capacity and potential that the scientific, academic and business communities have to face the opportunity to relate knowledge with well-being and social and economic development in Portugal (as expressed in the Portuguese legal regime for R&D institutions and activities, or "Science Law", Decree Law 60/2019 of 16 May 2019). It is an opportunity for scientific and academic institutions, in

close collaboration with economic, social and cultural actors, to contribute to the construction, in Portugal, of projects of international relevance, with an effective impact on society, stimulating the creation of qualified employment in Portugal.

Also under the terms of the Portuguese "Science Law", it is intended that Collaborative Laboratories reinforce the current structure of technological interface centers and other intermediary institutions in Portugal, **diversifying and complementing** the existing structure and the performance of the R&D units and Associate Laboratories, with the objective of stimulating the active participation of the scientific and academic system in the understanding and **resolution of complex and large-scale problems**, generally not susceptible of being solved within a single disciplinary, scientific, technological or institutional strand. They imply the coordination of different scales and a business, social and cultural intervention with a view to implementing effective solutions with a socio-economic impact. Thus, Collaborative Laboratories have a complementary and supplementary role to that of R&D units, including Associate Laboratories, as well as technological interface centers or State Laboratories and, naturally, companies.

In this context, the development and promotion of Collaborative Laboratories has been stimulated within the scope of **mobilizing research and innovation agendas** and programs of international relevance and national impact, duly coordinated between universities, polytechnics, R&D units and associated laboratories, State laboratories, and the social, cultural and economic fabric, involving, in particular, companies, intermediary and knowledge transfer institutions, including technological and engineering centers. Their ultimate goal is to stimulate an effective «Commitment to Knowledge and Science», encouraging qualified employment and the creation of economic and social value, as defined in the terms of the national Interface Programme.

The agendas should result from a joint and **collaborative effort** between researchers and experts from the public and private sectors, in close participatory collaboration **with citizens and social organizations**, adopting a matrix that crosses specialization priorities with technologies and scientific knowledge of a transversal

nature and defining a reference for the allocation of public and private funding for science and innovation. They are intended to mobilize the productive, social and cultural sectors, in order to facilitate and strengthen the qualification of the population at the territorial level, stimulating qualified employment, attracting foreign direct investment for activities with greater added value and **converging** to the European average in terms public and private investment effort in R&D.

The role to be played by the Collaborative Laboratories is especially important to stimulate **new forms of interaction** and a **non-linear relationship** between research, innovation and social and economic development activities, stimulating the co-design and co-accountability of participating institutions for knowledge transfer and diffusion processes and improving the value of products and services provided by companies, as well as facilitating the social relevance of academic research activity and its appropriation by society.

The establishment and reinforcement of Collaborative Laboratories thus represents a **new phase of evolution** and development of the Portuguese research and innovation system to reinforce the institutionalization of collaboration between different institutions, together with the inter-institutional co-responsibility of knowledge-based strategies, as well as the reinforcement of collaboration between scientific and higher education institutions with intermediate and knowledge transfer institutions promoted in recent years. It is intended to encourage cooperation between R&D units, higher education institutions and the productive, social or cultural sector, ensuring new forms of collaboration and **risk sharing** between the public and private sectors that enhance the creation of value and qualified employment.

Collaborative laboratory status is granted by the Portuguese Science and Technology Foundation, FCT, for a period of five years, renewable, after an evaluation process by an international panel of experts, coordinated by Professor José Luis Encarnação (Fraunhofer Society and Darmstadt University, Germany). The National Innovation Agency, ANI, coordinates the monitoring process that has been implemented of the activity of collaborative laboratories, naturally in

close collaboration with the Regional Coordination Commissions and based on best international practices and a broad group of international experts, also coordinated by Professor José Luis Encarnação.

Thus, I would like to thank the FCT, ANI and the Regional Coordination Commissions, but also the panel of experts, for the continuous and systematic mobilization in monitoring and enhancing the network of collaborative laboratories and their affirmation at national and international level. But I would also like to thank all the people and entities engaged in collaborative laboratories and their engagement and dedication to the development of research and innovation agendas. We are, collectively, **creating a better future** and **building trust for the next generations**.

A RATIONALE FOR COLLABORATIVE LABORATORIES

Helena Pereira
President, Fundação para a Ciência e a Tecnologia

Collaborative Laboratories – CoLABs – are one of the building stones that structure the Portuguese system of science and technology. They were designed to diversify the system and to fill a gap in the interaction between the creation of knowledge by research, the development of innovation and the application of the obtained results in societal useful environments, thereby promoting economic and social development in a broad territorial framework.

The national science system lacked this organizational tool. There are very many research units in Portugal, with a considerable diversity in dimensions, strategies and organizational status, including State Laboratories, that cover the different scientific areas. They have been the pillars for research and innovation, allowing for the steady growth of scientific outputs in terms of publications, patents and other science indicators. The research units have also provided a hosting environment for the development of doctorates, leveraging the increasing convergence of this indicator to EU levels.

CoLABs have by creation requirement an autonomous and legal status, either a non for profit association or a private company, and a mix of partners involving research units, knowledge transfer entities and private companies. It is the Fundação para a Ciência e a Tecnologia (FCT) who awards the title of a Collaborative Association, after an external and international evaluation of the application. One central piece in the application is a 5-year business plan, since it is expected that after the initial period of launching and seed funding, the CoLAB will rely on a triangle of state funding, competitive funding, and services and products delivered to the market. It is expected that CoLABs will create qualified employment and effectively valorise knowledge. The seed funding was provided by European structural and investment funds and by national budget from FCT.

Being a new concept in the Portuguese science landscape, it is necessary that CoLABs have a follow- up and tutoring given by an external commission. This monitoring was outsourced by FCT to ANI

who is responsible for this accompanying counselling with an annual reporting and a show case for the CoLabs activities.

We are now at the moment of the 2nd annual CoLAB meeting. This is certainly an important occasion for CoLABs, funding agencies and society at large. Several questions are at the forefront of each CoLAB, namely:

- an effective governance structure is in place?
- qualified staff has been employed?
- applied research and innovation are underway?
- links to stakeholders and markets are being established?
- plans for autonomous funding are in place?

FCT is committed to successful CoLABs that fulfil their specific and targeted role in the national science system as sustainable entities.

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EXECUTIVE SUMMARY

Implemented since 2017, the support for the creation of Collaborative Laboratories (CoLABs) represents a new phase of evolution of the Portuguese national scientific and innovation capacity regarding the ambition of positioning Portugal as an innovative country that produces knowledge, but also invests in the economic and the social value of the knowledge produced.

Composed by 35 recently created institutions that already contributed to the direct creation of 562 highly qualified jobs, the national network of CoLABs have territorial expression in all regions of the continent (NUTSII) and corresponds to initiatives in various areas of knowledge, impacting in the densification of the territories in terms of knowledge-based activities in regional and/or national strategic areas.

This report provides an overview of the creation and evolution of CoLABs in the past year and is structured in three main sections.

Section one presents the network of 35 CoLABs in the context of the National Innovation System, highlighting the process of evaluation and monitoring.

The second section is dedicated to the presentation of the thematic specialization of CoLABs divided in eight main areas – 'Agri-Food', 'Biodiversity and Forest', 'Climate, Space and Ocean', 'Digital and Communication Systems', 'Energy and Sustainability', 'Health', 'Materials, Circular Economy and Urban Sustainability', and, 'Social Services and Tourism'. In addition, this section presents the current situation, the lessons learned and some recommendations for the future from the international experts who mentor the CoLABs.

Finally, the third section highlights the integration of CoLABs in regional innovation and specialization dynamics, approaching its impact in the creation of jobs and talent attraction and their contribution to R&D investment.

Considering the importance of monitoring the processes of growth and consolidation of the CoLABs, this report illustrates the evolution of the network, analysing the performance of CoLABs and their integration in the Portuguese Ecosystem.

THE NETWORK OF COLABS

The Collaborative Laboratories (CoLABs) represent a new phase of evolution of the Portuguese national scientific and innovation capacity regarding the ambition of positioning Portugal as an innovative country that produces knowledge, but also invests in the economic and the social value of the knowledge produced.

Established as a new form of partnership with industry and society oriented to deliver market-driven innovations and to generate highly skilled employment, a CoLAB is a private, non-profit association or a private company, that integrates higher education institutions through its institutes and research units, state and associate laboratories, intermediate and interface institutions, companies, business associations, public institutions and other relevant partners, such as social or cultural institutions. Aiming at stimulating the active participation of the scientific, business, and social and cultural communities in the analysis of large-scale, complex and multidisciplinary problems, the CoLABs complement and reinforce the current framework of 312 scientific research units, 40 associate laboratories and 8 state laboratories in Portugal, and the network of interface centres.

Thus, the Collaborative Laboratories should be understood as an element of a dense and diversified network of R&D institutions, oriented towards the creation of social and economic value through the definition and implementation of research and innovation agendas, of international relevance and national impact, involving the scientific and entrepreneurial system in understanding and solving complex problems, implementing effective solutions with socio-economic impact and contributing to the generation of high-quality employment in Portugal.

The support for the creation of Collaborative Laboratories has been implemented since 2017 based on two distinct phases. The first corresponds to the process of identification and recognition of Collaborative Laboratories, through an international evaluation process (since 2017) based on a permanently open public tender for the identification and evaluation of proposals, as systematically presented in Table 1. This process is conducted by the Foundation for Science and Technology, I.P. (FCT, I.P.) and the applications received are discussed and evaluated by an international panel of experts, who can recommend the recognition and attribution of the title of Collaborative Laboratory – CoLAB valid for 5 years.

Table 1. Approved CoLABs; March 2021

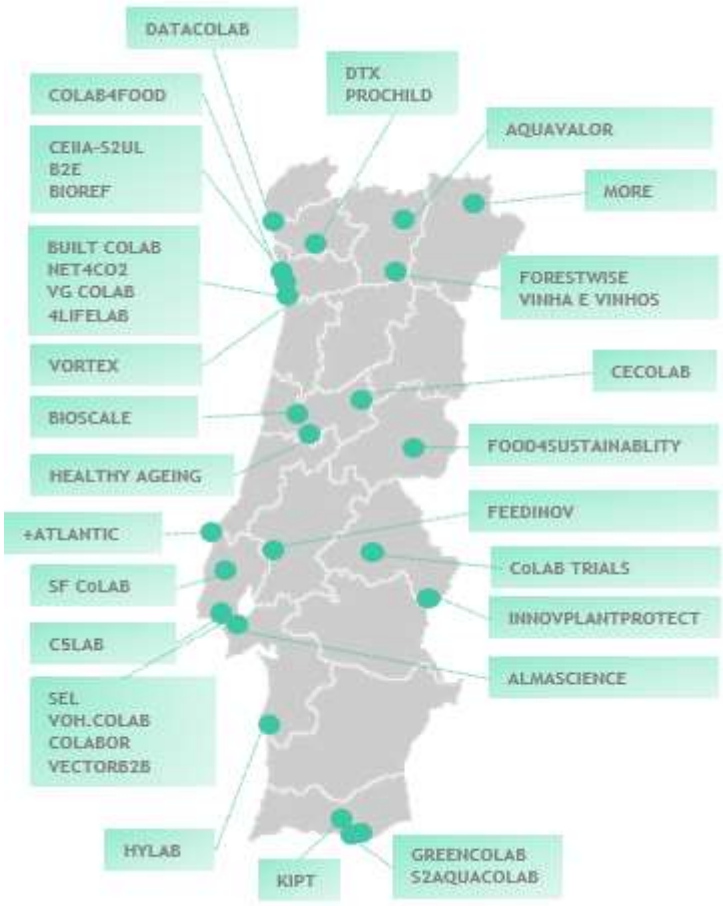
1st Evaluation (nov 2017)	2nd Evaluation (jul 2018)	3rd Evaluation (jun 2019)	4th Evaluation (mar 2021)
DTx – Digital transformation	AlmaScience – Paper electronics	VG CoLAB – Energy storage	Healthy Ageing@LAB – Ageing
+Atlantic – Space and ocean	C5LAB – Cements		
GreenColab – Algae processing	VOH.CoLAB – Medical devices and therapies	BUILT CoLAB – Built environment	HyLAB – Green hydrogen
MORE – Mountains of research	BIOREF – Biorefineries		
Vines&wines – Vines and wines	Net4Co2 – Chemical processes	Smart Energy LAB – Energy services	KIPT - Tourism
ForestWISE – Fire and forest	CoLab4Food – Food products and networks	Food4Sustainability – Sustainable agriculture	CoLAB TRIALS - Health
	VectorB2B – Medicines and Pharmaceuticals		AquaValor – Water technologies
	VORTEX – Artificial intelligence	FeedInov – Sustainable animal production	
	COLABOR – Labour and social innovation		Data CoLAB – Data science
	S2ul – Cities and mobility		
	CECOLAB – Circular economy		S2AQUAcoLAB – Smart and sustainable aquaculture
	SFColab – Smart agriculture		
	InnovPLantProtect – Seeds and plants		BioScale – Medicines and Pharmaceuticals
	B2E – Blue economy		
	Prochild – Child protection and social innovation		4LifeLab – Medical devices

This process culminates with the legal constitution of CoLABs as private non-profit institutions or companies, whose associative structure or shareholder must be constituted by at least one company and one entity of the scientific and technological system and may also include other research units, associate laboratories, higher education institutions, interface centres, technology centres, business associations, among other productive, social or cultural national or international entities. No associate, partner or shareholder may hold less than 5% or more than 49% of the assets or share capital.

Once the CoLABs are constituted as entities with legal personality, the second phase corresponds to the monitoring of the implementation of the research and innovation agendas of the CoLABs and the related funding processes. This phase is monitored by the National Innovation Agency (ANI), the entity responsible for monitoring the CoLABs installation and performance.

Currently, the national network of CoLABs comprises a diversified set of 35 institutions with territorial expression in all regions of the continent (NUTSII), as illustrated in Figure 1, corresponding to initiatives in various areas of knowledge, with impact in the densification of the territories in terms of knowledge-based activities in regional and/or national strategic areas.

Figure 1. CoLABs Network, 2021



By requiring the establishment of relationships between knowledge producers and industry, the CoLABs ensure new forms of collaboration, co-responsibility and risk sharing between the public and private sectors, encouraging cooperation between research and

development (R&D) institutions (including research units, state and associate laboratories, interface centres), higher education institutions and the productive, social and cultural sectors in the implementation of their research and innovation agendas.

From the analysis of the associative structure of the CoLABs, it is possible to count on a total of 299 entities engaged in the constitution and operationalization of the existing 35 CoLABs. As shown in Figure 2, 51 of these entities are engaged in two or more CoLABs from which 39% are companies.

Figure 2. Entities with 2 or more participations as associates of CoLABs, 2021

The top entities with more than one participation is led by U.Porto (13), followed by INESCTEC (10), IST and U.Minho (9), U.Coimbra (8), NOVA (7) and U.Aveiro (6). As shown in Table 2, the enterprises with more participations, through its subsidiary companies, in different CoLABs are GALP, SONAE and EDP.

Table 2. Entities participating in more than one CoLAB, 2021

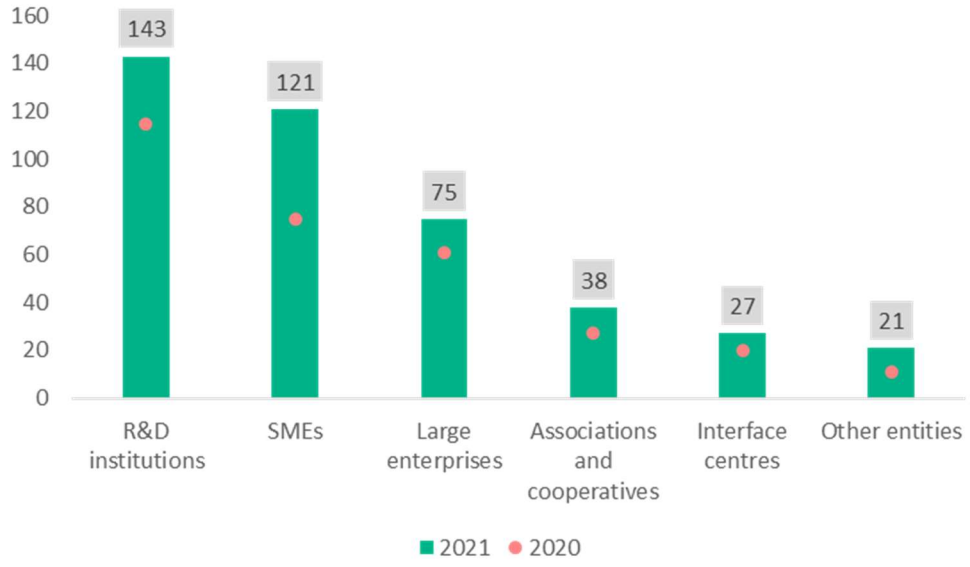
Entity	Participations
Universidade do Porto	**13**
Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência	**10**
Instituto Superior Técnico	**9**
Universidade do Minho	**9**
Universidade de Coimbra	**8**
Universidade Nova de Lisboa	**7**
Universidade de Aveiro	**6**
Instituto Nacional de Investigação Agrária e Veterinária, I.P.	5
Instituto Politécnico de Leiria	5
Universidade Católica Portuguesa	5
Universidade de Évora	5
Universidade de Trás-os-Montes e Alto Douro	5

GALP	4
Grupo SONAE	4
Grupo EDP	4
Laboratório Nacional de Energia e Geologia, I.P.	4
Centro de Engenharia e Desenvolvimento	4
Instituto Politécnico da Guarda	3
Instituto Superior de Agronomia	3
ISCTE - Instituto Universitário de Lisboa	3
SGS Portugal - Sociedade Geral de Superintendência S.A	3
TMG, S.A.	3
Centro de Computação Gráfica	3
Instituto de Soldadura e Qualidade	3
SPAROS LDA.	3
Mota-Engil, SGPS, S.A.	3
Raiz - Instituto de Investigação da Floresta e Papel	3
Centro de Estudos Sociais da Universidade de Coimbra	2
Faculdade de Ciências da Universidade de Lisboa - IDL-Instituto Dom Luiz	2
Faculdade de Medicina Veterinária da Universidade de Lisboa	2
Instituto Politécnico de Bragança	2
International Iberian Nanotechnology Laboratory	2
Laboratório Nacional de Engenharia Civil, I.P.	2
REQUIMTE - Rede de Quimica e Tecnologia	2
Universidade do Algarve	2
Allmicroalgae - Natural Products, S.A	2
BLC3 Evolution Lda.	2
INGREDIENT ODYSSEY	2
Living Seeds Sementes Vivas SA	2
Mendes Gonçalves SA	2
Necton - Companhia Portuguesa de Culturas Marinhas, S.A.	2
SYSADVANCE, Sistemas de Engenharia S.A.	2
SECIL - Companhia Geral de Cal e Cimento, S.A.	2
SORGAL - SOCIEDADE DE ÓLEOS E RAÇÕES, S.A.	2
The Navigator Company S.A.	2
Associação Fraunhofer Portugal Research	2
Santa Casa da Misericórdia de Lisboa	2
A400 - Projetistas e Consultores de Engenharia, Lda	2
A4F - Algafuel, S.A.	2
Efacec - Energia, Máquinas e Equipamentos Elétricos, S.A	2
CCMAR - Centro de Ciências do Mar	2

Considering the evolution of the network of 35 CoLABs, it's possible to verify that all types of entities reinforced their participation in CoLABs in 2021 (Figure 3). However, it should be noted that the most significant increase occurred among small and medium-sized

companies (61% more than in 2020), revealing the growing interest of the industry in the activities developed by CoLABs.

Figure 3. Number of associates by type of entity, 2020

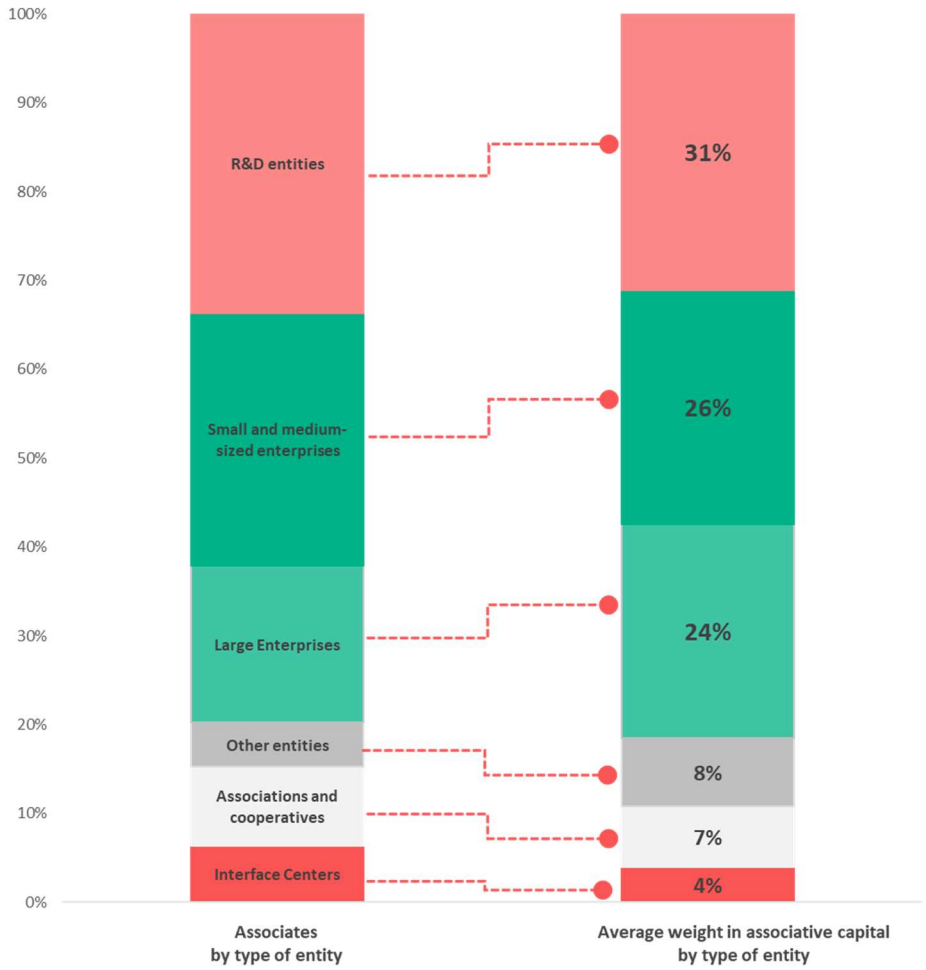


In fact, counting the members by type of entity, companies assume a greater predominance in CoLABs, representing 46% of its associates (29% SMEs and 18% large companies), while Research and Development (R&D) institutions represent 34%. Associations and cooperatives represent 9% of CoLABs associates, interface centres 6% and other entities such as municipalities or public administration organizations represent 5%.

Considering the nature of the activities developed by the CoLABs, it is also important to assess the weight of each type of entity in the associative structure of CoLABs. To this end, the average weight of the different type of entities in the associative structure (distribution of shares) was determined. This exercise is represented in Figure 4 and shows that enterprises hold 50% of the shares of CoLABs, while R&D institutions hold 31%.

Although each CoLAB has its own specificities in terms of institutional architecture, this fact is particularly relevant as it can indicate that, in addition to being interested in integrating the CoLAB structure, companies are also interested in maintaining a prominent position in the distribution of the CoLABs shares.

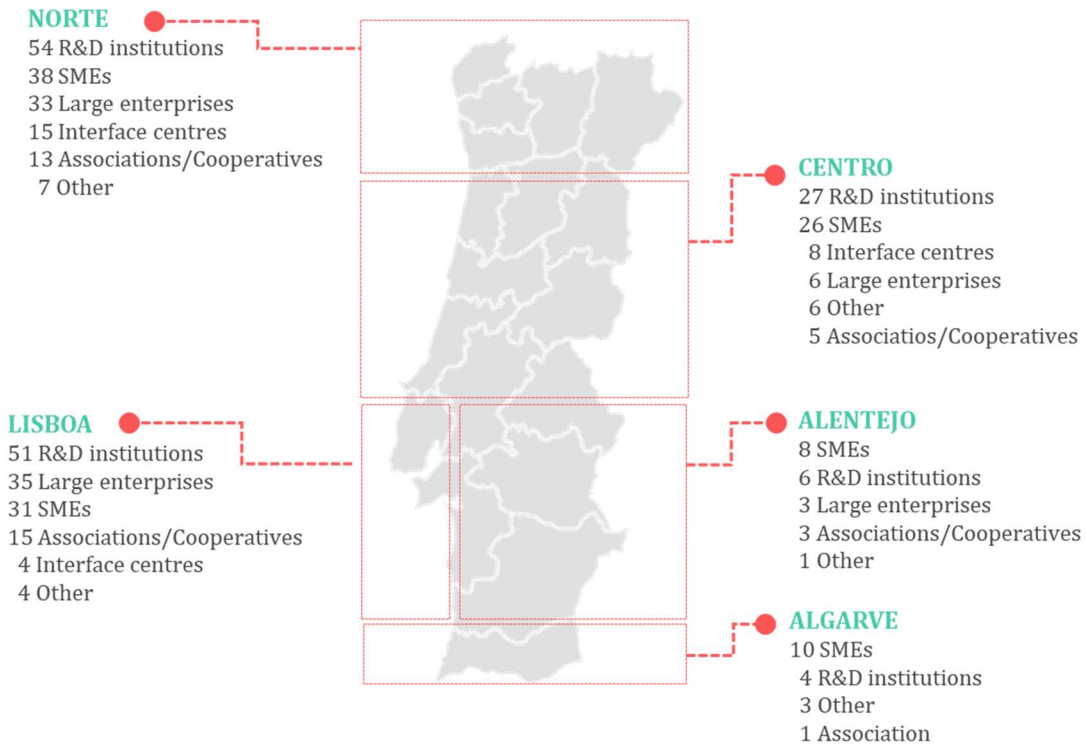
Figure 4. Distribution of CoLABs shares by type of entity, 2020



We can observe that large companies represent 18% of the associates, while hold 24% of the shares, thus presenting the greatest difference between the number of associated entities and their weight in the associative capital of CoLABs.

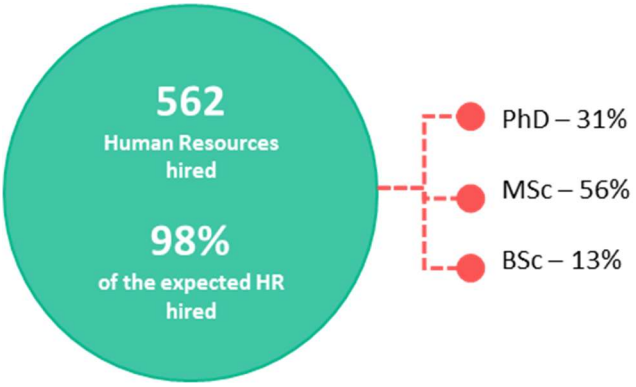
Regarding the geographic location of CoLABs associates, entities located in the North region (38%), in the Metropolitan Area of Lisbon (33%) and in the Centre region (18%) predominate, while entities located in the Algarve and Alentejo region have a smaller representation, hosting, respectively, 5% and 4% of the associates, as illustrated in Figure 5.

Figure 5. CoLABs Associates by NUTS II and type of entity, 2020



Inserted in this institutional environment, the ability to attract talent, recruit and retain highly qualified human resources is crucial for the success of CoLABs in creating a unique identity, distinct from academic research units and companies, through the development of their own skills in knowledge-intensive activities. In this context, CoLABs have already contributed to the direct creation of 562 highly qualified jobs (31% of which are PhDs), corresponding to a 98% of what was targeted until 2022, which is illustrated in Figure 6.

Figure 6. Employment created by CoLABs



The CoLABs also participate actively in attracting competitive funding with increasing success. In the 259 applications to competitive funding in 2020 that CoLABs integrated as partners, a total investment of 573.9 million euros was requested to the different funding programs available, showing a diversification of the programs used. As Table 3 summarizes, during 2020, this competitive effort resulted in the approval of 53 projects, representing 30.5 million euros of investment raised to CoLAB's activities.

Table 3. Submitted applications, by funding program - 2020

Program	Applications Submitted (Nr.)	Total investment requested (M€)	Total CoLAB investment (M€)	Approved applications*	Approved investment CoLAB*	Approved investment CoLAB*
PT2020	76	158.6	23.5	28	132.5	14.2
FCT	59	11.2	3.6	5	0.80	0.22
H2020	53	317.2	17.8	6	57.8	3.2
EEA Grants	9	6.3	0.78	3	2.6	0.28
Fundação La Caixa	9	3.6	0.82	n.a.	n.a.	n.a.
PRIMA	8	7.9	0.95	1	0.91	0.07
Fundação Calouste Gulbenkian	4	0.77	0.49	n.a.	n.a.	n.a.
Other Programs	41	68.4	6.1	10	14.9	12.5

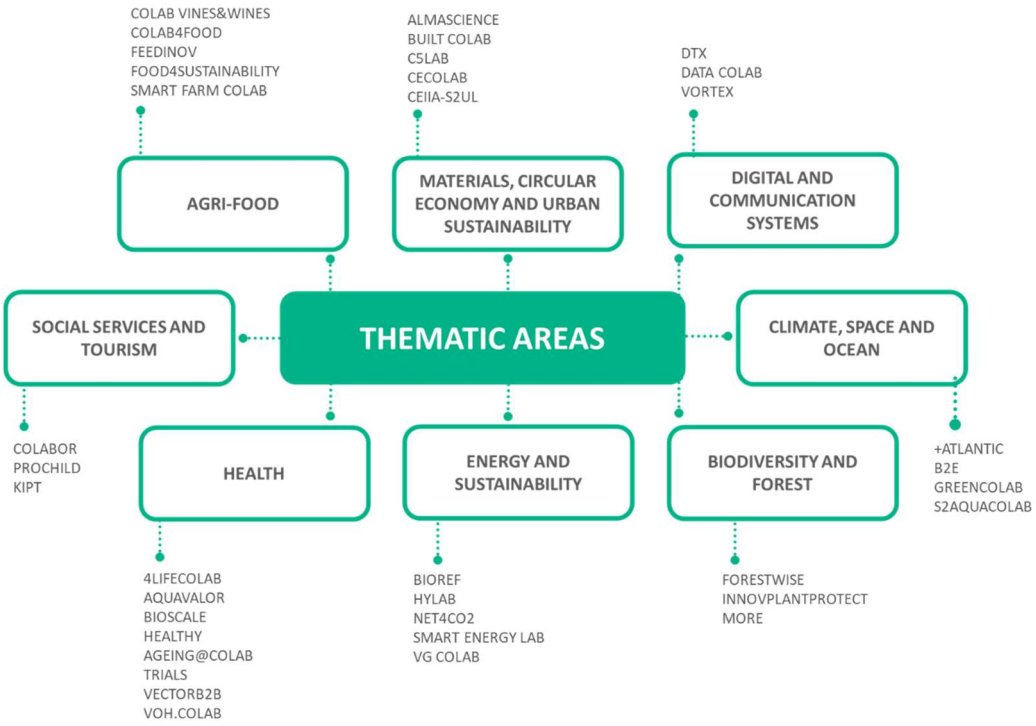
*Approved in 2020. Some of the submitted applications were under evaluation when the information was collected.

THE THEMATIC SPECIALIZATION OF COLABS

As mentioned in the previous section, the main objective of the CoLABs is to create skilled jobs and economic and social value by promoting the development of knowledge-intensive activities based on the implementation of medium-term research and innovation agendas. These agendas, which are designed in the dialogue between R&D units, higher education institutions and the productive, social and cultural sectors, must result in the implementation of effective solutions with socio-economic impact.

The network of CoLABs has been evolving to its specialization in 8 main thematic areas that are strategic for the sectors and the territories in which the CoLABs and its associates operate in: 'Agri-food', 'Biodiversity and Forest', 'Climate, Space and Ocean', 'Digital and Information Systems', 'Energy and Sustainability', 'Health', 'Materials, Circular Economy and Urban Sustainability', and Social Services and Tourism. The distribution of the CoLABs by thematic area is represented in Figure 7.

Figure 7. CoLABs Thematic Areas



Although the exercise of arranging the 35 CoLABs into broad thematic areas is somewhat difficult, it allows a global perspective of the main fields and challenges in which CoLABs and its associates intend to developed knowledge-intensive activities and create social and economic value.

Agri-Food

The agri-food sector has been facing significant changes at a global level, driven by internal and external structural challenges with impact on its value chain, such as the demographic growth, leading to increase and changes in consumption patterns; the environmental challenges associated with the scarcity of natural resources, climate change and food waste; emergence of diseases in human, animal and plant; population aging and depopulation in rural areas; and, the need for digitalisation of the sector.

To respond to these challenges, the need to introduce more innovation in the productive processes of companies is being increasingly highlighted. In fact, in Portugal, the Agri-food sector contributed to 5% of the total R&D expenses in 2019 (DGEEC, 2020)[1]. Enterprises contributed to 51% of the R&D expenses in the sector, followed by the higher education institutions, which account for 38% (IPCTN, 2020). In this context, in an attempt to answer, locally and internationally, some of the main challenges of the sector, the network of Collaborative Laboratories integrates 5 CoLABs: 1) Vines&Wines, 2) Colab4Food, 3) FeedInov, 4) Food4Sustainability and 5) Smart Farm CoLAB. They are located in the North and Centre regions as represented in the map in Figure 8.

Figure 8. Location of Agri-Food CoLABs

[1] https://www.dgeec.mec.pt/np4/206/

The Agri-Food CoLABs are responsible for **10% of the employment created** by CoLABs until September 2021 and involve the participation of **65 entities**, from which **51% are enterprises** (42% SMEs and 9% large enterprises), **32% are R&D institutions** and **11% are associations and cooperatives**. Table 4 below present the list of enterprises that are connected with the installation and consolidation of the aforementioned CoLABs.

Table 4. Enterprises Agri-Food CoLABs Shareholders

	CoLAB
A4F - Alga Fuel SA	Food4Sustainability
Allmicroalgae - Natural Products, S.A	FeedInov
Avenal Petfood, S.A	FeedInov
BGI S.A	Food4Sustainability
Bluegrowth, Lda	Food4Sustainability
Eurocereal-Comercialização de Produtos Agro-Pecuarios, S.A	FeedInov
Finançor - Agroalimentar, S.A	FeedInov
Frulact Indústria Agro-Alimentar, S. A.	Colab4Food
Grupo Primor, SA	Colab4Food
Hortas D'idanha, S.A	Food4Sustainability
HVCZ Properties Lda	Food4Sustainability
Iberponics, Lda	Food4Sustainability
Impactwave Lda	Smart Farm CoLAB
INGREDIENT ODYSSEY	FeedInov
Living Seeds Sementes Vivas SA	Food4Sustainability
LUIS VICENTE S.A.	Smart Farm CoLAB
Mendes Gonçalves SA	Colab4Food; Food4Sustainability
Optimizeplanet Lda	Smart Farm coLAB
QUINTA DO PINTO, SA	Smart Farm CoLAB
Racentro, Fábrica de Rações do Centro S.A	FeedInov
Raporal S.A	FeedInov
Rico Gado Nutrição S.A	FeedInov
Sense Test, Lda.	Colab4Food
Sgs Portugal - Sociedade Geral de Superintendência S.A	Smart Farm CoLAB
SORGAL - SOCIEDADE DE ÓLEOS E RAÇÕES, S.A.	FeedInov
Stagric, Lda	Smart Farm CoLAB
SUMOL+COMPAL Marcas, SA	Colab4Food
SUPER BOCK BEBIDAS SA	Colab4Food
Tecnipec - Serviços Pecuários, S.A	FeedInov
Tecnologia e Nutrição Animal, S.A	FeedInov
Tomix - Indústria de Equipamentos Agrícolas e Industriais, Limitada	Smart Farm CoLAB

Transportes Paulo Duarte, Lda	Smart Farm CoLAB
Zoopan, Produtos Pecuários, S.A	FeedInov

In consortium with its associates, shareholders and external partners, the Agri-Food CoLABs integrated 34 proposals to competitive programs in 2020 with a total requested investment of 94.3 million euros. From these, 4 were approved for funding, representing a total investment of 5.5 million€. In these proposals, the Agri-Food CoLABs raised 600 thousand euros, which represent 12% of the total investment approved.

The VINES&WINES CoLAB is an initiative of the Portuguese Vine and Wine Cluster - ADVID, and it has the mission of producing and reporting technology and knowledge to support the expressed ambition of this sector on the growth of exports, while building a resilient national winery system and respecting the main challenges to be overcome, like the climate changes and the lack of labour force. In this sense, this CoLAB aims to shape the future of the sector, accordingly to the Sustainable Development Goals and the Green Deal of the European Union, taking advantage of the Industry 4.0.

Areas of Expertise: Vineyard: genetic resources; zoning; soil; smart and precise viniculture; automation; water and climate challenges; Wine: oenological science; circular economy; environment, water and sustainability.

Examples of ongoing activities:

- ReWine, an educational program to promote good practices in Circular Economy already implemented by some companies from the wine sector.
- Evaluation of the climate in the Douro Region, a study and analysis of how climate works in the Douro region, with the objective of looking for local and regional solutions to answer the climate change problem, to project future scenarios and to anticipate the adequate approach to this new climate reality.

Associates:

- ADVID - Associação para o Desenvolvimento da Viticultura Duriense (All members of ADVID are members of the CoLAB, comprising 163 Wine companies, 10 Services suppliers, 1 Certifying companies and other entities of the national scientific system)
- INESCTEC - Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- ISA - Instituto Superior de Agronomia
- UCP - Universidade Católica Portuguesa
- U.Porto - Universidade do Porto
- UTAD - Universidade de Trás-os-Montes e Alto Douro

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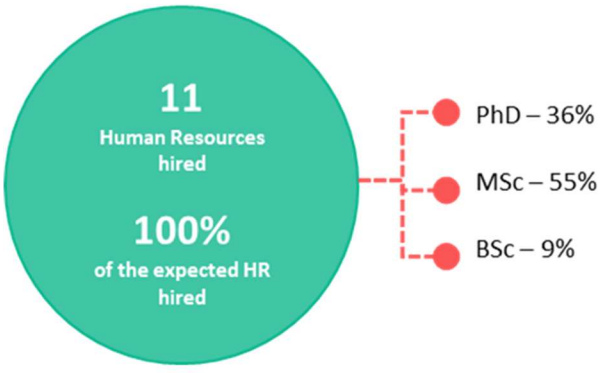

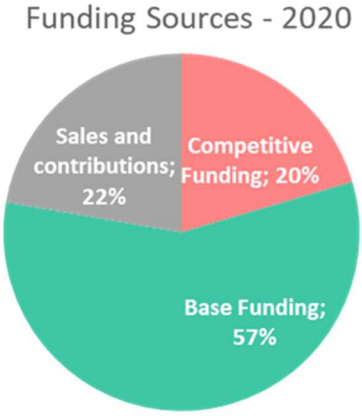

Colab4Food aims to redefine how the most advanced scientific knowledge is applied to support the food industry in developing new, improved and sustainable processes and products that delight consumers and contribute to improving their health and nutrition. Building on three main pillars - Food safety and sustainability; Food for health and well-being; and, Safe and high-quality food, Colab4Food will contribute to the sustainability and competitiveness of the Portuguese food sector.

Areas of Expertise: Sustainability and food safety; food for health and well-being; high quality and safe food.

Examples of ongoing activities:

- Prototyping new and tailor-made formulations**.**
- New ingredients and formulations for the development of more nutritious and value-added products for the consumer.

Associates:

- Frulact Indústria Agro-Alimentar, S. A.
- Grupo Primor, SA
- Instituto Nacional de Investigação Agrária e Veterinária, I.P.
- Instituto Politécnico de Viana do Castelo – CISAS
- Instituto Superior de Agronomia
- Mendes Gonçalves SA
- Associação Integralar - Internvenção de Excelência no Setor Agroalimentar
- REQUIMTE - Rede de Química e Tecnologia
- SUMOL+COMPAL Marcas, SA
- SUPER BOCK BEBIDAS SA
- Sense Test - Sociedade de estudos de análise sensorial a produtos alimentares, Lda.
- Universidade de Aveiro
- Universidade de Coimbra
- Universidade Católica Portuguesa
- Universidade do Minho
- Universidade do Porto
- Universidade de Trás-os-Montes e Alto Douro

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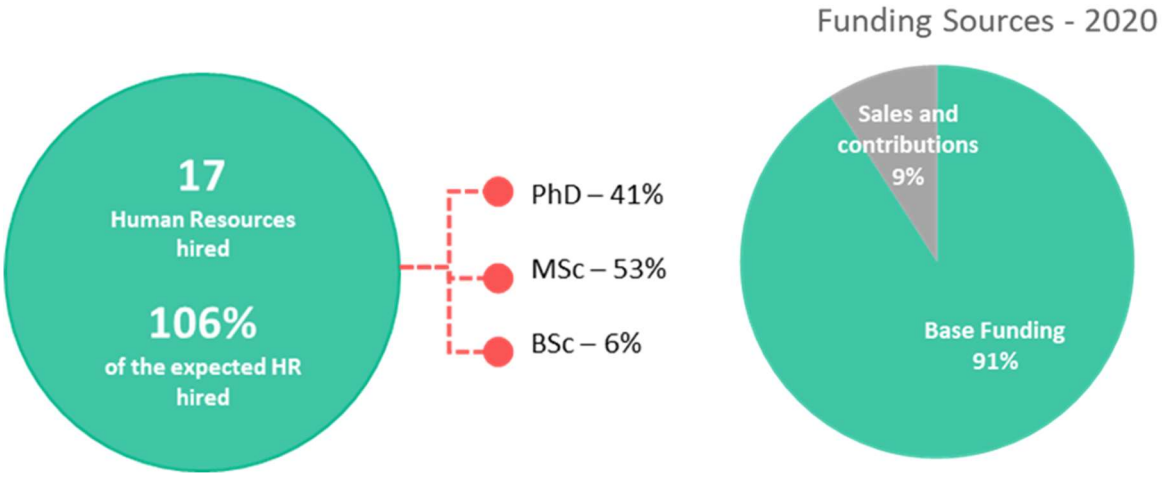

FEEDINOV

FeedInov CoLAB aims to improve safety along the food chain, with an impact on the safety of animal products, increasing consumer confidence in national production and reinforcing the role of the animal feed industry in the production of healthy, sustainable and environmentally friendly products. FeedInov CoLAB's strategy and motivation are based around four main topics: Analysis of trends in meat consumption; Optimising the efficiency of nutrient resources; Healthy animals for healthy humans; Socially responsible livestock from a nutritional perspective.

Areas of Expertise: Safety, quality, and sustainability of feed and food production; Competitiveness of the livestock sector; Environmental sustainability.

Examples of ongoing activities:

- Analysis of trends in the consumption of animal origin products.
- Optimization of the efficiency of nutritional resources.
- Evaluation of residues of pharmacologically active substances in non-target feed – determine the maximum level of crossed contamination by active substances in non-targeted feed.

Associates:

- Allmicroalgae - Natural Products, S.A
- Avenal Petfood, S.A
- Eurocereal-Comercialização de Produtos Agro-Pecuarios, S.A
- Finançor - Agroalimentar, S.A
- Faculdade de Medicina Veterinária da Universidade de Lisboa
- Associação Portuguesa dos Industriais de Alimentos Compostos para Animais
- Instituto de Ciências Biomédicas de Abel Salazar da Universidade do Porto
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- Instituto Nacional de Investigação Agrária e Veterinária, I.P.
- Ingredient Odyssey
- Racentro, Fábrica de Rações do Centro S.A
- Raporal S.A
- REQUIMTE - Rede de Quimica e Tecnologia
- Rico Gado Nutrição S.A
- SORGAL - Sociedade de Óleos e Rações, s.a.
- Tecnologia e Nutrição Animal, S.A
- Tecnipec - Serviços Pecuários, S.A
- Universidade de Trás-os-Montes e Alto Douro
- Zoopan, Produtos Pecuários, S.A

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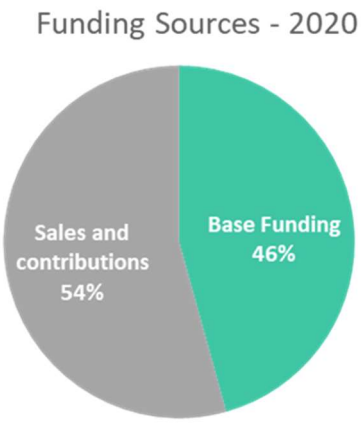

food for sustainability

Food4Sustainability aims to facilitate the adoption of innovative healthy food production systems by reusing agricultural and food waste as feedstock, combining new and/or traditional innovative techniques and facilitating their adoption and dissemination. With the goal of contributing to sustainable land use, it aims to develop food systems based on biological products (e.g., fish, algae, vegetables) for climate resilience (e.g., energy used from solar panels, precision farming controls, smart irrigation).

Areas of Expertise: Safety, quality, and sustainability of feed and food production; Competitiveness of the livestock sector; Environmental sustainability.

Examples of ongoing activities:

- Sustainable Agricultural Demonstrator, an agricultural living lab, comprising 13 hectares. A dynamic and demonstrative testing ground, where sustainable agricultural techniques are developed and tested. Testing, implementing, and diffusing new approaches to agricultural systems and its value chains to achieve economic, social and environmental sustainability.
- Food4Sustainability academy, a program that bring together experts from different institutions and universities around the world, to share knowledge on topics gravitating sustainable agriculture.

Associates:

- A4F - Alga Fuel SA
- Associação Recursos Ambientais Alternativos Portugal
- Bgi S.A
- Bluegrowth, Lda
- Centro Municipal de Cultura e Desenvolvimento de Idanha-A-Nova
- Cooperativa Agricola dos Olivicultores do Ladoeiro Crl
- Hortas D'idanha, S.A
- Iberponics, Lda
- Instituto Politécnico de Castelo Branco
- Instituto Politécnico da Guarda
- Instituto Politécnico de Viseu
- Mendes Gonçalves SA
- Living Seeds Sementes Vivas SA
- Universidade da Beira Interior
- HVCZ Properties Lda

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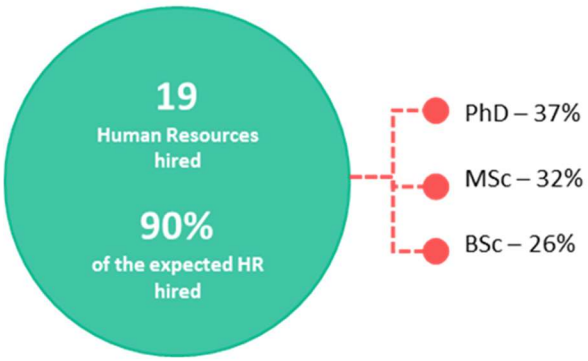

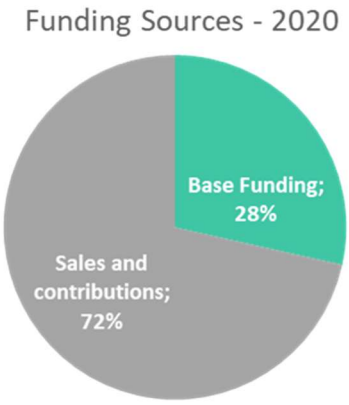

SMART FARM COLAB
LABORATÓRIO COLABORATIVO PARA A INOVAÇÃO DIGITAL NA AGRICULTURA

Smart Farm COLAB is based in Torres Vedras (Lisbon region, Portugal) aiming to boost the Digital Innovation in Agriculture. Within the global Agro challenge of producing more with less by decreasing and optimizing the resources and decreasing the carbon footprint, the SFCOLAB strategy focus on the generation of integrative cutting-edge of high-tech solutions for the efficient management of resources such as soil, water or phytosanitary products and to maximize the added value of the horticulture, viticulture and fruticulture products. The SFCOLAB set the grounds to be the first reference of Digital Agriculture in Portugal and to further extend this knowledge internationally and to assist the agro sector in the transition into Digital Agriculture, allowing competitiveness in the new and challenged agricultural environment.

Areas of Expertise: Plant Biology; Agronomy; Sustainable Use of Resources; Electronics and Sensors; Robotics and Automation; Artificial Intelligence; Informatics; Tourism; Marketing; Social Sciences and Education.

Examples of ongoing activities:

- SOFIS, customized low-cost sensors. These sensors that are in a prototype stage, have already started to be applied in real production scenarios (avocado production) and are also intended to be applied in a field monitoring laboratory to be installed at INIAV – Dois Portos facilities as a demonstration field test for the Agro-community.

Associates:

- Associação para a Valorização Agrária
- Munícipio de Torres Vedras
- Centro operativo tecnológico Hortofrutícola Nacional
- Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa
- Faculdade de Ciências da Universidade de Lisboa - IDL-Instituto Dom Luiz
- Impactwave Lda
- Instituto Nacional de Investigação Agrária e Veterinária, I.P.
- Instituto Politécnico de Leiria
- ISCTE - Instituto Universitário de Lisboa
- LUIS VICENTE S.A.
- Optimizeplanet Lda
- QUINTA DO PINTO, SA
- Sgs Portugal - Sociedade Geral de Superintendência S.A
- Adega Cooperativa de São Mamede da Ventosa Crl
- Stagric, Lda
- Tomix - Indústria de Equipamentos Agrícolas e Industriais, Limitada
- Transportes Paulo Duarte, Lda

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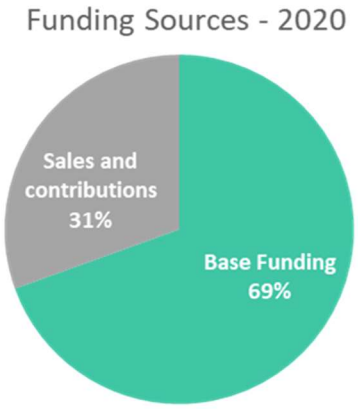


THE COLABS IN THE THEMATIC AREA "AGRI & FOOD": REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Kees de Gooijer
Dr.Ir. C.D. ("case") de Gooijer, Topconsortium for Knowledge and Innovation Agri & Food
The Netherlands

Your excellency, dear Manuel.

Today you will be taking 200 decisions on food and drink. All of us in Europe do, actually, and fortunately. It is the Agri & Food (A&F) sector enabling that. Moreover, if you would add all jobs counting fisherwoman, farmers, the complete processing industry, SME's, craftswoman, restaurants workers, bars, and caterers, there is no other conclusion than that A&F is the largest employer in Portugal. Larger than the government, and larger than the number two and three sectors together.

So, we're good?

No, we are not. Globally, food production has to rise by 60% by the year 2050. The Paris Climate Agreement will have a dramatic effect on A&F, reducing all greenhouse gas emissions (we have three of them) to near-zero. There will be shifts in demands, novel processing techniques, total use production, zero food waste, minimal to zero inputs in crop protection and fertilizers, reclaiming BAD AGRICULTURAL land, smart farming in order to reduce labor, a necessary shift towards a more plant-based diet, and a reduction of intake of animal protein. And, last but most certainly not least, eating habits should change in order to have more resilience in the population. Let's call this the pandemic preparedness. So work on food and health is needed, too. Does anyone dare to say A&F is not sexy?

The answer…

Well, at least, part of the answer. We can do research without ending, we can make policies without limits, but nothing will change if the entrepreneurs don't take steps. And we have to take those steps together. This is where you, Manuel, come in. Embracing public-private partnerships and setting up the CoLABs. And you are serious: I have never seen or heard of a minister spending the largest part of his weekend in an online conference...

And, does it work?

Yes. No. Well, actually, we are mid-term now. And three years is way too short to

say anything – an average PhD student needs four years…

Just after the start of the CoLABs a pandemic hit us in the face. Considering that, a tremendous effort has been achieved in setting up the CoLABs and get them operational. From my perspective, they all did a hell of a job. And they are indeed running in the rain and willing to get wet!

Colab4Food made a 180 degree major step. From careful wordpicking in the Q1 2020 meeting to a full swing discussion in October 2021. Miguel is doing a great job. And, by the way, they did 7 product launches.

InnovPlantProtect is finalizing their own (!) modern laboratory facilities, Pedro has got a great team together, and work is in progress.

FeedInov Ana has a highly motivated team, perhaps the industry -even if they are competitors- should get a wake-up call.

Vines&Wines Tim continues to work in close coordination with ADVID, pursuing the Agriculture 4.0 agenda.

Smart Farm are on the new premises, installed an enthusiastic team. With a title "executive secretary" Catia shows you can still be the boss. Team is very keen on cost-competitiveness of their solutions.

Food4Sustainability moved to a new office, started work on their experimental 13 ha field, and got much more focus in their agenda. Well done, Nuno!

What should be noted is that all of them excel in having a great hands-on mentality, as we say in my country they work with their boots on in the clay. So, the interaction with farmers is one aspect that is outstanding, and unlikely to be found elsewhere. This also helps in attracting the new generation, since they are generally speaking paying extra attention to having a purpose (or impact) in their jobs.

There are three extra observations here: a) many interactions exist already between the CoLABs in this area, which is good, also in attracting international funds; b) already now the CoLABs are approached by new (private) stakeholders to join; c) all CoLABs are very active in stakeholder engagement or reach out activities.

Learnings.

This process is at a very early stage. Having stated that, a few learnings can be identified:

a) A CoLAB in itself, with the 1/3 1/3 1/3 model, is the dot on the horizon in the longer run. Since building it with bricks and mortar is beyond any budget, a CoLAB uses

other facilities as well. What my observation is, is that in direct “control” on people hired and setting up the CoLAB, there is the emergence of a second circle which is not under direct control, but through enthusiasm and maybe even the FOMO attracts a much wider set of stakeholders.

b) Coming to the three thirds financing model: reaching the last 1/3 is a matter of trust, and timing. As long as the first 1/3 is doubled, some flexibility could be accepted, even more when a CoLAB is active in a common good, like soil health. For the timing, the CoLAB setting will not fail because of the co-workers, and also not because of the public funding. It is the private funding that is the issue. Maybe a “captain’s dinner” could help, where the captains of industry are invited to respond to the slow start of private funding, having a meal with you, Manuel.

c) The respective agendas of the CoLABs seem partially connected. A national agenda – well aligned with the Farm to Fork strategy (and actually it should be even one step deeper, from seed to post-saliva, since we talk human health here), that is mission driven in itself, might be worth considering.

d) ANI is following the EU schemes of financing projects (advance pay, check by the year, final payment of 10%, so a 30-30-30-10 scheme). The European social funds however are distributed by the regions in Portugal, who do not follow this scheme but work with reimbursements. This creates cash flow problems and consumes too much management time. Hopefully a harmonisation towards the 30-30-30-10 is possible, which needs to be done at the national level.

e) Consider cross-cutting (food chain) aspects over CoLABs. An example: the blue economy, fisheries is in Oceans, (novel) processing might be in Food, data infrastructure in SmartFarm, aquaculture in Food4Sustainability.

Dear Manuel,

on special occasions, a good number of your 200 daily food decisions will either stay in your mind, or provide you with an instant time travel to earlier days (smell and taste can do that). Our community is working hard to modernize, meet climate targets, and at the same time continue to enable time travelling. At your health!

Biodiversity and Forest

The 'Biodiversity and Forest' thematic area intends to address transversal challenges related to low population density and geographical dispersion in territories, climate change impacts in ecosystems and the low productivity of agri-food systems. The CoLABs that integrate this area – ForestWISE, InnovPlantProtect and MORE – have as main objective the development of knowledge-intensive activities and the introduction of innovation in the productive processes associated with the sustainable management of forest, the protection for specific crops and the management of mountain environment, ecosystem and resources. They are inserted in the North, Centre and Alentejo regions, as illustrated in Figure 9.

Figure 9. Location of Biodiversity and Forest CoLABs

ForestWISE, InnovPlantProtect and MORE are responsible for **89 of the employments created** by the CoLABs, 10% of which are foreigners.

Involving the participation of **40 entities**, from which **18 are enterprises**, **15 are R&D institutions**, **8 are associations and cooperatives, 3 are other entities from Public Administration**. In Table 5 the list of enterprises is presented.

Table 5. Enterprises Shareholders of Biodiversity and Forest CoLABs

	CoLAB
Altri, S.G.P.S., S.A.	ForestWISE
Amorim Florestal, S.A	ForestWISE
Bayer Cropscience (Portugal) - Produtos para a Agricultura, Lda.	InnovPlantProtect

Deifil Technology Lda	MORE
Ds Smith Paper Viana, S.A	ForestWISE
E-Redes - Distribuição de Eletricidade, S.A	ForestWISE
FERTIPRADO, SEMENTES E NUTRIENTES, LDA	InnovPlantProtect
Living Seeds Sementes Vivas SA	MORE
OldCare Unipessoal Lda.	MORE
REDES ENERGÉTICAS NACIONAIS, S.G.P.S., S.A.	ForestWISE
Sonae Arauco Portugal, S.A	ForestWISE
Syngenta Crop Protection - Soluções para a Agricultura, Lda.	InnovPlantProtect
Tecnologia e Produtos para Pastelaria e Panificação, Lda.	MORE
The Navigator Company S.A.	ForestWISE
Altri, S.G.P.S., S.A.	ForestWISE
Amorim Florestal, S.A	ForestWISE
Bayer Cropscience (Portugal) - Produtos para a Agricultura, Lda.	InnovPlantProtect
Deifil Technology Lda	MORE

The Biodiversity and Forest CoLABs participated in 28 proposals to competitive programs in 2020, from which 5 were approved representing a total approved investment of 15.3 million€. 6% of the total approved investment corresponds to investment to Biodiversity and Forest CoLABs' activities.

ForestWISE develops applied, multidisciplinary and innovative research and knowledge transfer activities through the converging efforts of industry, universities and public administration. The CoLAB operation seeks to promote sustainable forest management in Portugal, enhance competitiveness of the Portuguese forest sector and reduce the negative consequences of rural fires. The R&D&I Agenda is the basis of the CoLAB's activity and is based in four lines of intervention: Forest and fire management; Risk management; Circular economy and value chains; and, People and policies.

Areas of Expertise: Sustainable Forest Management.

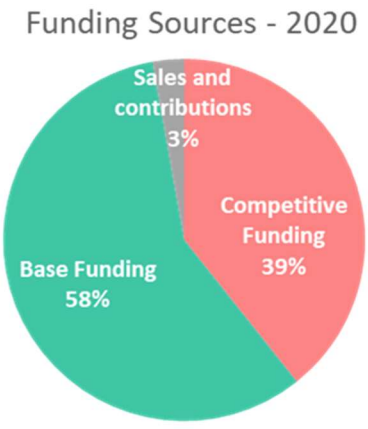
Examples of ongoing activities:

- **aGiL.TerFoRus**, financed by ICNF through the Permanent Forest Fund, it is a pilot whose results will set the basis for the first national LiDAR coverage. The pilot focuses on seven target territories, covering about 45 thousand hectares (from Monsanto to Vila Pouca de Aguiar).
- **Replant** is a large-scale project prepared by ForestWISE, involving most of its associates aiming to produce innovative technology-based products and services for forest management, risk mitigation, digitization/automation of forest operations (forest 4.0)

Associates:

- Agência para a Gestão Integrada de Fogos Rurais, I.P.
- Altri, S.G.P.S., S.A.
- Amorim Florestal, S.A
- Ds Smith Paper Viana, S.A
- E-Redes - Distribuição de Eletricidade, S.A.
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- Instituto Nacional de Investigação Agrária e Veterinária, I.P.
- Instituto Superior de Agronomia
- Redes Energéticas Nacionais, S.G.P.S., S.A.
- Sonae Arauco Portugal, S.A
- The Navigator Company S.A.
- Universidade de Aveiro
- Universidade de Coimbra
- Universidade de Évora
- Universidade de Trás-os-Montes e Alto Douro

Main figures:



InnovPlantProtect develop innovative solutions to provide targeted protection for specific crops. The solutions presented by InPP consist in the formulation of biopesticides and the development of new plants resistant to pests and diseases, thus allowing a substantial reduction in crop losses and an increase in productivity, always within a framework of environmental responsibility. The impact of InPP will be observable in terms of the products it develops (new biopesticides and new resistant plants) and the services it provides (new methods of diagnosis and monitoring), as well as at the social and regional level, as it positions itself as a pole of investment attraction for the Alentejo region.

Areas of Expertise: Bio-pesticides; New plant ideotypes; Diagnostic and monitoring methods; Risk and pesticide application models.

Examples of ongoing activities:

- Develop a biopesticide to control Xylella in planta
- Develop a molecular strategy to control the brown spot of pear
- Develop GIS tools to assist in public and private decision making to control pests and diseases
- Develop an early detection system based on artificial intelligence and remote sensing of the decline of cork and holm oak by Phytophthora cinnamomi in “montado” ecosystems

Associates:

- Associação Nacional de Produtores de Proteaginosas, Oleaginosas e Cereais
- Associação Nacional dos Produtores de Milho e Sorgo
- Bayer Cropscience (Portugal) - Produtos para a Agricultura, Lda.
- CASA DO ARROZ - Associação interprofissional do Arroz
- Centro de Biotecnologia Agrícola e Agro-Alimentar do Alentejo
- Câmara Municipal de Elvas
- Fertiprado, Sementes e Nutrientes, LDA
- Federação Nacional das Organizações de Produtores de Frutas e Hortícolas
- Instituto Nacional de Investigação Agrária e Veterinária, I.P.
- Syngenta Crop Protection - Soluções para a Agricultura, Lda.
- Universidade de Évora
- Universidade Nova de Lisboa

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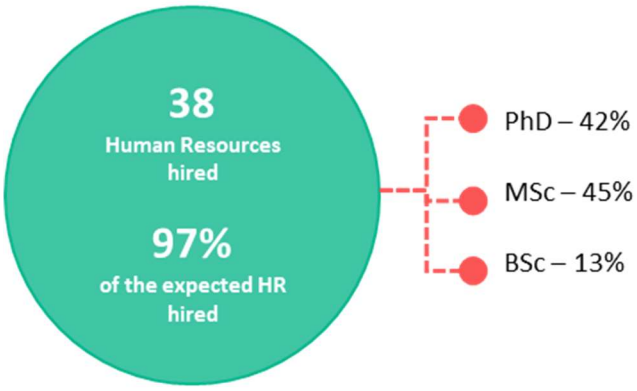
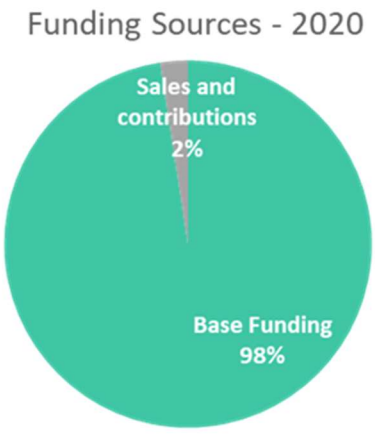




montanhas de investigação

MORE

MORE is a non-profit association that implements a long-term R&D&I agenda in the Mediterranean mountain areas in order to create economic, social, environmental and cultural value by joining scientific and academic institutions in close collaboration with economic, social, and cultural stakeholders. Its team renders specialized services, executes innovation projects, and facilitates knowledge and technology creation and transfer to the market and to the public sector. MORE focuses on the mobilizing complete value chains, leveraging innovation (bio-based products and processes), industrialization (technology and clean energy) to strengthen the primary sector (agriculture and forestry) and services (cultural heritage, tourism and well-being).

Areas of Expertise: Food and bio-based products; Mountain environment and ecosystem management; Health, welfare, cultural heritage and tourism; Mountain cleantech.

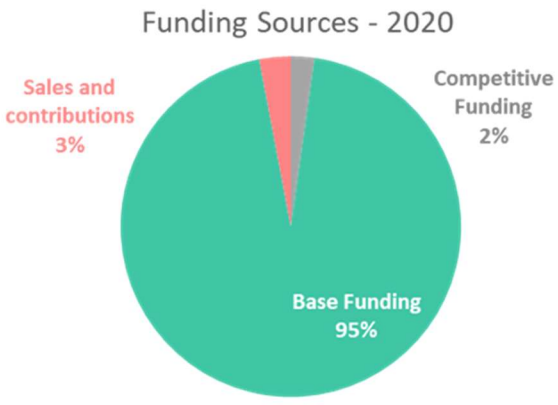
Examples of ongoing activities:

- Olive BIOextract, Sustainable use of olive bagasse in an integrated recovery chain using innovative processes.
- BIO4DRINKS: develop a sustainable process in terms of cost-benefit and low environmental impact to obtain extracts, valorising at least two by-products of the wine sector and two of the chestnut sectors with environmental impact, in ingredients of high economic value.

Associates:

- Associação dos Produtores Em Protecção Integrada de Trás-Os-Montes e Alto Douro
- Associação BLC3 - Campus de Tecnologia e Inovação
- Associação para o Desenvolvimento do Brigantia Ecopark
- Centro Nacional de Competências dos Frutos Secos - CNCFS
- Deifil Technology Lda
- Coa Parque - Fundação para a Salvaguarda e Valorização do Vale do Coa
- ICETA - instituto de ciências, tecnologias e agroambiente da universidade do porto
- Instituto Politécnico de Bragança
- Instituto Politécnico da Guarda
- Instituto de Soldadura e Qualidade
- OldCare Unipessoal Lda.
- Resíduos do Nordeste, EIM, SA
- Living Seeds Sementes Vivas SA
- Tecnologia e Produtos para Pastelaria e Panificação, Lda.
- Universidade do Porto

Main Figures:



THE COLABS IN THE 'BIODIVERSITY AND FOREST' AREA: REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Hélène Kirchner, Bernd Göckener and Thuy Le Toan[2]

1. The CoLAB programme

The CoLAB initiative was launched in 2017 by the Portuguese government, namely the Minister of Science, Technology and Higher Education, and the President of the Portuguese Science and Technology Foundation, then monitored by the National Agency for Innovation. By strengthening the collaboration between universities and companies, the expectation was to develop innovation in industry through the implementation of joint research and innovation agendas, and to create qualified employment in Portugal, increasing Portugal's development and competitivity in global economy. The initiative was well-received by academic institutions and companies in various sectors as witnessed by the number of submissions received and the number of CoLABs created. Clearly it was a real need at the national level and this fully justifies the considerable efforts and investments made by the government.

The strategic vision and R&I Agenda of most of the CoLABs are well based on the national and international priorities, as well as on the industrial and market-driven priorities. CoLABs serve as an important connection between research, industries and governmental bodies. As applied research services often cannot be conducted by SMEs or single companies, the CoLABs' services and products are improving the competitiveness and sustainability of the Portuguese industry. In the particular context of biodiversity and forests, nature's resilience against climate change and other hazards can be greatly improved by the CoLABs' contributions in this area.

In the next section, we examine how three CoLABs have implemented up to now this concept and which are the current pitfalls.

[2] Hélène Kirchner, Emeritus Research Director, Inria, France
Bernd Göckener, Senior Scientist, Fraunhofer Institute for Molecular Biology and Applied Ecology IME, Germany
Thuy Le Toan, Senior Researcher, Cesbio, France

2. Presentation of three CoLABs

Some characteristics of these three CoLABs worth mentioning are, first, that they are located outside urban areas, which contributes to a better regional coverage of the programme. Second, some of them are not yet taking full advantage of digital technology which is probably due to insufficient training and expertise in the digital domain. Third, all three encountered difficulties with the required **balance between base funding, competitive projects, and own revenues.**

ForestWise

Related to the national priorities, ForestWise seeks to promote sustainable forest management in Portugal, enhance competitiveness of the Portuguese forest sector and reduce the negative consequences of rural fires. In association with 15 organisations from academic, private and public sectors, four work lines are defined for 2020-2025: forest and fire management, risk management, circular economy and value chain, people and policies.

In 2020, ForestWise has a fully set-up governance and a team of 13 people. ForestWise has obtained two projects that contribute to its activities: rePLANt, co-financed by Portugal and the European Union to produce innovative products and services for forest management, risk mitigation, digitization/automation of forest operations. This 3-year project (2020-2023) is therefore a strong pillar for the development of ForestWise. It is complemented by another project financed by ICNF through the Permanent Forest Fund. This is a pilot whose results will set the basis for the first national LiDAR coverage and thus contribute to the acquisition of forest information needed by the CoLAB.

For ForestWise, the reduction of forest fires and reduction of their negative impacts are topics of strong public, political and social interest. The solutions (e.g., revised land use/land cover plan, establishment of fire breaks, planting of species resilient to fires...) appear relevant mainly for the public sector. Although they succeed in getting national and European support, difficulties they meet are to get funding from the industry and private sector. Due to high interests of society on forest fires, it is important that ForestWise develops and communicates to society an innovative strategy to reduce occurrence of forest fires while valorising forest resources, which would be considered as “Innovations made by the CoLAB”.

But more generally, a crucial question is how to reconcile the interest of industry, focused on the market introduction of monoculture of more productive species generating higher incomes, with the need to have higher biodiversity mixed forest less prone to fires and pests. ForestWise should address this question and the balance between the two options could be the target of the business plan to adopt.

MORE

The CoLAB MORE (Mountains of Research) is aiming to strengthen the rural mountain regions in the north of Portugal by diverse research and development actions. A team of more than 40 highly motivated and educated people with different academic backgrounds was recruited since the funding of the CoLAB was approved. They are working on different approaches to promote innovation, digitalization and industrialization in the mountain regions. A special focus is put on the primary sector such as the agriculture and forestry that are important economic branches in these rural areas. Another goal of MORE is the promotion of the cultural heritage and tourism.

Within the internal projects as well as in the first publicly funded projects and services already sold to the industry, the CoLAB's team is working e.g., on the valorisation of bio-based products from the primary sector and the usage of bio-based products or IT-based technologies to minimize the usage of pesticides, e.g., in the cultivation of chestnuts. With these approaches, MORE is actively working on increasing the sustainability as well as the resilience of the rural economy. Thereby they are also promoting the biodiversity in these regions because agricultural land and forests can be used more efficiently and pesticides can be used in a more selective manner instead of as in broadband and excessive applications as often performed today. The currently running work as well as the obvious potential of the team to pursue their efforts, render us optimistic that MORE will further contribute to the strengthening of the economy and the environment in the mountain regions as well as all over Portugal and in other countries.

InnovPlantProtect

The InnovPlantProtect CoLAB (InPP) started in 2020 as a private non-profit association regrouping public institutions, private companies and professional associations. Its mission is to develop innovative biological and digital solutions for plant protection, especially of

Mediterranean cultures, in collaboration with farmers, phytopharmaceutical and seed companies, research institutions and local and national authorities. With the growing knowledge of genomics and combining molecular techniques, monitoring and modelling of emerging pests and diseases, InnovPlantProtect develops innovative solutions to provide targeted protection for specific crops: new biopesticides, new plants resistant to pests and diseases, new methods of diagnosis and monitoring, thus allowing a substantial reduction in crop losses and an increase in productivity, always within a framework of environmental responsibility. Targeted customers are mainly agricultural companies, producer associations, municipalities and phytopharmaceutical companies. The knowledge transfer strategy is to develop the biological and digital products and services until they are ready for registration, protect them intellectually and negotiate the resulting patents with third parties. In some particular cases, the possibility of placing products on the market by the CoLAB can be explored.

While the renovation works on the part of the INIAV building in Elvas where the CoLAB is installed has been delayed by the pandemic outbreak, InPP is already functioning with a well set-up governance, a very committed team of 38 highly qualified people (10 managers and 28 researchers) and valuable projects starting to generate revenues.

InnovPlantProtect is facing difficulties related to its financing situation where regional and European social funds used to hire people have to be reimbursed and are not yet balanced by competitive funds and own revenues. These difficulties cannot be resolved in short term, so public and regional funding need to be maintained to sustain employment.

3. Recommendations

Biodiversity and forests play an important role for environmental health and resilience against climate change and other hazards, as well as for human health and well-being. Both biodiversity and forests are in direct relation to the global challenge of climate change and both were explicitly addressed in the EU Green Deal. Biodiversity was also addressed in the recent EU's Chemicals Strate. They are important fields of research already and will be of increasing importance in the future. The political momentum in many countries, in the EU and in the whole world sets a basis for current and future funding.

It is quite relevant to support this area for

which there is a clear need for innovation and new approaches, several funding opportunities at the European level, and also an international stimulating competition.

Although both topics have an innumerable value for humanity and the environment, they are fields of research with limited interest for industries so that the main financial contributions are expected from national and international governmental bodies and sometimes NGOs. In order to improve the competitiveness and sustainability of the Portuguese industry, these CoLABs therefore should seek for additional ways to promote their research fields to the industry and to obtain new sources of revenues. A possibility is to motivate industrial and service provider associates to fund projects in the CoLAB. Another one is to **develop products based on new digital methods and progress in data analysis, modelling and simulation, decision making and learning, etc.** that should attract more users and companies.

Due to the expectable limitation of direct industrial applications for biodiversity and forests, it should be discussed during the shaping of the re-evaluation criteria for the CoLAB program in what strictness the three thirds approach should be applied for topics with such a high societal relevance. When industrial funding is too low or reduced, additional public funding and business plan should be revised according to the situation. **More flexibility of the actual CoLAB funding model (balance between base funding, competitive projects, and own revenues) is to be considered in such situations. Financial reliability for the allocated base funding is crucial to maintain employment.**

There is an urgent need in short and medium term, to train new and existing professionals in some specific scientific areas such as, in the area considered here, forestry engineering, remote sensing, digital transformation and the complete data value chain, etc. **Face to the scarcity of qualified human resources for specific research topic, and the needed interface between research and development applications, the launch of CoLABs Academies to train people in specific domains should be considered and supported.**

There are some CoLABs with overlaps in their thematic areas and fields of research. To avoid competition between CoLABs or inefficiency (e.g., by duplication of work), cooperation and communication between the CoLABs of similar interest is necessary. They also need sharing of methods,

approaches, business plans, training. After this was addressed in the very first meetings, the CoLABs have already set up networks for communication and cooperation. An example is the “Raiano” axis of science, technology and innovation for Agro-Food. **The thematic aggregation of CoLABs as reflected in this document should be evaluated by the CoLABs themselves to understand if it fits their expectations.**

To conclude, a delicate question **is how to evaluate the impact of CoLABs**. More precisely, how to compare the CoLAB’s results with what associates are currently doing by themselves? How to evaluate its action as an innovation driver?

Climate, Space and Ocean

Space and Ocean are central areas to face major societal challenges, including climate change, resources and environmental sustainability and food availability. In this context, the need to increase efforts to develop breakthrough knowledge and technologies in the interaction Climate-Space-Ocean, fostering the introduction of innovation in companies, is deemed as critical. The Portugal Space 2030 strategy states that the development of Space-based solutions can benefit many sectors, such as agriculture, fisheries, urban development, land, rail or maritime transport, tourism, or even the public health sector, while the National Ocean Strategy 2030 was designed based on the importance of scientific knowledge and technology development to protect the Ocean, to increase the value of marine ecosystem services and to strength the traditional and emerging sectors of the blue economy.

The 'Climate, Space and Ocean' thematic area integrates 4 CoLABs that are responsible for **15% of the employment created** by CoLABs +Atlantic, B2E, GreenCoLAB and, most recently, S2AQUAcoLAB, geographically represented in Figure 10.

Figure 10. Location of 'Climate, Space and Oceans' CoLABs

Dedicated to some of the challenges mentioned, the 'Climate, Space and Oceans' CoLABs engaged **42 entities** as associates, from which **57% are enterprises** (43% SMEs and 14% large enterprises), **26% are R&D institutions** (including interface centres), **7% are**

associations and cooperatives and 2% are other entities from Public Administration. Table 6 lists the companies participating in these CoLABs as shareholders.

Table 6. Enterprises Shareholders - Climate, Space and Oceans CoLABs

	CoLAB
ACUINOVA - Actividades Piscícolas, S.A.	S2AQUAcoLAB
ÁGUA, AMBIENTE E ORGANIZAÇÃO, LDA	B2E
Algaplus - Produção e Comercialização de Algas e Seus Derivados Lda	GreenCoLAB
Allmicroalgae - Natural Products, S.A	GreenCoLAB
Asm Industries, S.A.	+Atlantic
Atlantik Fish - Pescado de Mar Lda.	S2AQUAcoLAB
Bivalvia - Mariscos da Formosa, Lda.	S2AQUAcoLAB
Deimos Engenharia S.A.	+Atlantic
Empresa de Serviços e Desenvolvimento de Software S.A. - Edisoft	+Atlantic
Gmvis Skysoft, S.A	+Atlantic
Hidromod-Modelação Em Engenharia Lda	+Atlantic
INGREDIENT ODYSSEY	B2E
Necton - Companhia Portuguesa de Culturas Marinhas, S.A.	GreenCoLAB
Oceano Fresco, S.A.	S2AQUAcoLAB
PVL - Piscicultura do Vale da Lama, Lda.	S2AQUAcoLAB
Riasearch, Lda.	S2AQUAcoLAB
Safiestela - Sustainable Aqua Farming Investments, S.A	B2E
SAVINOR - SOCIEDADE AVÍCOLA DO NORTE, S.A.	B2E
Sonae Mc - Serviços Partilhados, S.A	B2E
SORGAL - SOCIEDADE DE ÓLEOS E RAÇÕES, S.A.	B2E
SPAROS Lda.	B2E; GreenCoLAB
Tekever Asds, Lda	+Atlantic
Viveiros da Espargueira, S.A.	S2AQUAcoLAB

In consortium with its associates, shareholders and external partners, the 'Climate, Space and Oceans' CoLABs integrated 9 proposals to competitive programs in 2020 with a total requested approved investment of 27.8 million€. These CoLABs raised 600 thousand € to their activities, representing 2% of the total approved investment.

+ATLANTIC aims at advancing knowledge on the interactions between the Ocean, Atmosphere, Climate and Energy in the Atlantic, through an integrated and holistic approach from deep sea to space. By developing a better understanding of the Atlantic system, we pave the way for the sustainable use of its resources and create a framework to unleash its potential for society, promoting blue growth and highly qualified employment. The +ATLANTIC will be a relevant piece for the operationalization of national strategies for the sea and for space, in articulation with the vision built through the Atlantic Interactions process, later materialized in the Atlantic International Research Center (AIR Center) of which the +ATLANTIC is the national node, as well as with Portugal Space (Portuguese Space Agency).

Areas of expertise: Ocean; Atmosphere; Climate; Energy.

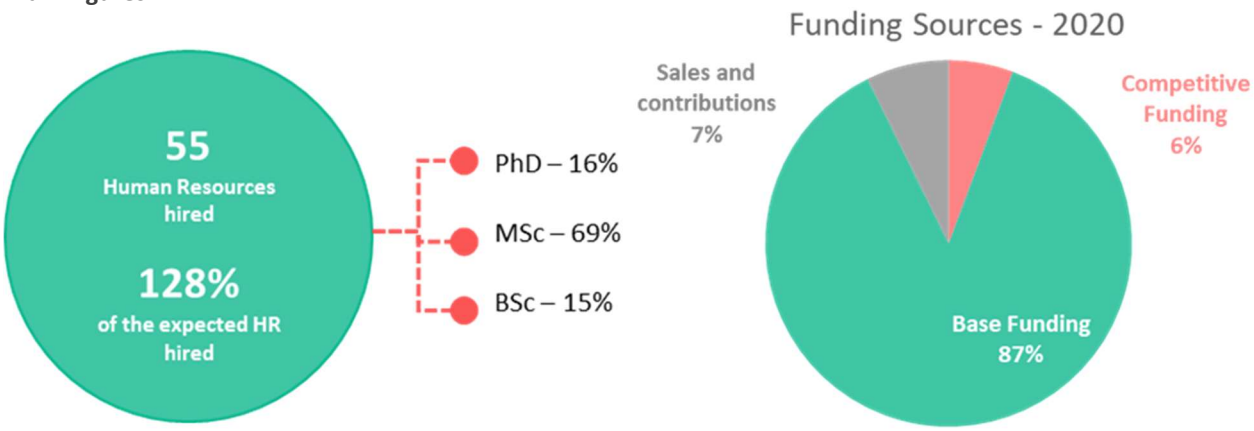
Examples of ongoing activities:

- COAST.Sense, Use of AI in the detection and prediction of urban heat islands from satellite images complemented with *in-situ* data. The methods used are augmented with additional data and parameters to increase the resolution of current predictions by about an order of magnitude.
- FISH-AI, Use of convolutional neural networks (CNN) and deep neural networks (DNN) models in the detection and automatic classification of vessels in optical satellite images.

Associates:

- Asm Industries, S.A.
- Centro de Engenharia e Desenvolvimento
- Deimos Engenharia S.A.
- Empresa de Serviços e Desenvolvimento de Software S.A. - Edisoft
- Gmvis Skysoft, S.A
- Hidromod-Modelação Em Engenharia Lda
- Instituto Politécnico de Leiria
- Instituto de Soldadura e Qualidade
- Instituto Superior Técnico
- Associação RAEGE Açores
- Tekever Asds, Lda
- Universidade do Porto
- WavEC Offshore Renewables – Centro de Energia Offshore

Main Figures:



COLLABORATIVE LABORATORY FOR BLUE BIOECONOMY

Under the motto "Ocean-Inspired - Market Driven - Knowledge Fuelled" CoLAB B2E aims to promote the creation of highly skilled jobs that will actively contribute to increasing the economic and social value of products and services, based on new and existing biological processes, including processes of internationalisation of national scientific and technological capacity, thereby supporting two of the blue growth sectors with the most potential: biotechnology and aquaculture. B2E will pursue its objectives based on three axes of action: (i) market dynamics for sector products; (ii) knowledge sharing and transfer; (iii) internationalisation, and (iv) funding for the Blue Bioeconomy sector.

Areas of expertise: Marine Living Natural Resources; Marine Biotechnology; Sustainable Aquaculture; Animal Health, Nutrition and Welfare; Human Health, Nutrition and Welfare.

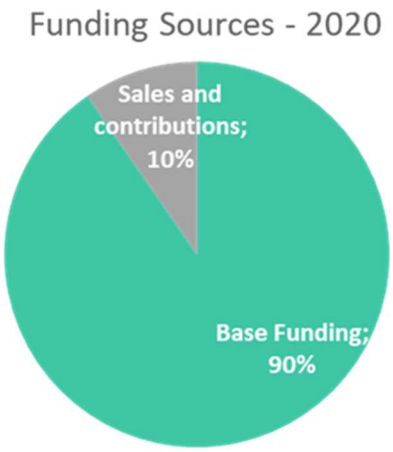
Examples of ongoing activities:

- OMEGAFISH: Fortification of aquaculture fish with long chain Omega-3 fatty acids to produce differentiated fish with high nutritional value, in particular with a high content of omega-3 LC-PUFA, focusing on species of great relevance and value in Southern Europe: turbot and European seabass.
- Ocean literacy campaigns.

Associates:

- Água, Ambiente e Organização, Lda
- Centro Interdisciplinar de Investigação Marinha e Ambiental
- FÓRUM OCEANO - Associação da Economia do Mar
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- INGREDIENT ODYSSEY
- Safiestela - Sustainable Aqua Farming Investments, S.A
- SAVINOR - SOCIEDADE AVÍCOLA DO NORTE, S.A.
- Sonae Mc - Serviços Partilhados, S.A
- SORGAL - SOCIEDADE DE ÓLEOS E RAÇÕES, S.A.
- SPAROS LDA.
- Universidade de Aveiro
- Universidade do Minho
- Universidade do Porto

Main Figures:



GreenCoLAB aims to be a catalyst for sustainability and economic performance by bringing together the interests of the scientific community and industry, driving innovation and economic diversification in the field of seaweed biotechnology. Its research and innovation agenda is based on two phases: i) Development of biological resources and characterisation of biomass and downstream processing; ii) Development of new products and markets. GreenCoLAB will develop its activities in a bottom-up approach by leveraging resources and developing the necessary efforts to establish strategies to accelerate industrial and market development in priority areas, such as food and feed, sequestration and mitigation of CO2, wastewater treatment and use of bio-fertilisers for soil recovery.

Areas of expertise: Marine algae biotechnology

Examples of ongoing activities:

- ALGAESOLUTIONS: to provide innovative solutions to common problems of algal producers by increasing the productivity, quality and market value of the biomass produced and develop five products with high commercial value.
- PERFORMALGAE: to develop microalgae strains targeting relevant metabolites to obtain novel and highly valued products for agriculture biostimulants and aquafeed functional ingredients.

Associates:

- Algaplus - Produção e Comercialização de Algas e Seus Derivados Lda
- Allmicroalgae - Natural Products, S.A
- Centro de Ciências do Mar do Algarve
- Laboratório Nacional de Energia e Geologia, I.P.
- Necton - Companhia Portuguesa de Culturas Marinhas, S.A.
- SPAROS LDA

Main Figures:

The sustainable and intelligent aquaculture collaborative laboratory intends to have an active role on the knowledge and technology transfer and provide services that increase the food safety and diversify aquaculture products. The main objective of S2AQUAcoLAB is to foster the development of aquaculture through research on production optimization, with the identification of health and welfare bio-indicators and to address climate change by adapting production systems. The ultimate goal is to generate new products, drive technological development, and explore new market prospects. S2AQUAcoLAB will strengthen knowledge/technology incorporation and transfer, as well as reinforce the strategic cooperation of partners, in a more focused way, through the development of on-site training activities.

Areas of expertise: Sustainable and intelligent Aquaculture.

Associates:

- IPMA - Instituto Português do Mar e da Atmosfera
- Universidade do Algarve
- CCMAR - Centro de Ciências do Mar
- Câmara Municipal de Olhão
- Instituto Politécnico de Leiria
- ACUINOVA - Actividades Piscícolas, S.A.
- PVL - Piscicultura do Vale da Lama, Lda.
- SPAROS, Lda.
- NECTON - Companhia portuguesa de Culturas Marinhas, S.A.
- Atlantik Fish - Pescado de Mar Lda.
- Formosa - Cooperativa de Viveiristas da Ria Formosa
- Viveiros da Espargueira, S.A.
- Bivalvia - Mariscos da Formosa, Lda.
- Oceano Fresco, S.A.
- Riasearch, Lda.

Approved in March, 2021.

THE COLABS IN THE CLIMATE, SPACE AND OCEANS AREA: REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Dr Nick Veck
Satellite Applications Catapult, UK (ret'd)

Opening Thoughts

It has been an honour and a pleasure to have been part of a small team, working together with Portuguese and international colleagues, to construct a new innovation community in Portugal, bringing together some of the best business and scientific minds across all the Portuguese regions. The CoLAB community is rapidly becoming a real Portuguese strength and although still relatively immature compared to some other programmes in Europe, is I believe on the cusp of becoming seen as one of Europe's leading fora for innovation.

Remarks on the CoLABs that have been visited by the Mentor

I have had the pleasure of visiting four CoLABs, once each during their initial development phase, then more recently, as they have begun to make their presence felt in their respective markets. I have also had the opportunity to meet each of them virtually during the intervening COVID period. Although CoLABs share an overall objective, each CoLAB can adapt to its own ecosystem, reacting to its markets and supply constraints to provide its own approach to build success in its chosen field.

CoLABs can be very different. Although both addressing opportunities in the blue economy, +ATLANTIC and B2E are very different places. With 55 staff, +ATLANTIC has quickly needed to evolve effective internal processes to manage the wealth of ideas and opportunities that have emerged from having so many connections into its broad community of market players. In contrast, B2E, with a staff of only 10 highly effective subject experts, is able perhaps to be more flexible, changing and adapting quickly to new opportunities that emerge in its marketplace. The SmartFarm (SFCOLAB) is similar in that respect. Each of these organisations though recognise the strengths and benefits of being able to work in this new type of ecosystem in Portugal, where conversations between business and academia become much more productive and new ideas can

flourish, potentially generating new wealth and employment in regions and thematic areas that may otherwise struggle.

General remarks on the overall development of the CoLABs as an initiative to develop and support innovation in Portugal

The CoLAB network is still new. The oldest CoLABs have only recently celebrated their 2nd anniversaries. It takes time for something as ground-breaking in a country as the CoLAB network has been, to come to fruition and to begin to deliver the full benefits that will undoubtedly ensue. The CoLABs are addressing issues that are fundamental to the Portuguese economy and to our global ability to live safely and comfortably on this planet. We must retain our confidence that the initial, forward-thinking decision to create this network was the right one. We must retain faith that this ongoing financial investment is generating activity that will make a real, positive difference to people's lives and livelihoods in Portugal. The CoLABs can and should work together and separately to showcase their early results, to promote the understanding that innovation is an exciting and necessary activity that can improve society locally and across communities.

We see the CoLABs meeting innovation needs in eight distinct thematic areas, with already between 3 – 7 CoLABs in each area. And the network will grow in the coming months. That is already a challenging total number of organisations in the network. In a relatively small country such as Portugal, it might be too many perhaps, given the public resources and capacity to manage them. The approach to creating the CoLABs has rightly been a very competitive process. Some proposals have not succeeded in meeting their ambitions of becoming a CoLAB. Some CoLABs may not become sustainable in a timescale that the public purse can afford. That is not a bad thing, as we learn which markets and which approaches are successful, there will be winners and sadly, losers. Success demands that risks must be taken. The risks must be understood, recognised and managed. In starting this process, we have been deliberately non-prescriptive, we have let the market determine which thematic areas can benefit from the CoLAB approach. We are providing public support to enable connections to be made that otherwise would not happen. In the coming years, it will become evident that some areas will flourish. Continuing public investment will not be needed there, releasing funds for new areas to be

seeded. We must also take the brave decisions to stop funding in certain areas, perhaps because the CoLAB model may not be appropriate for certain industries or communities. Perhaps because industry itself is not stepping up and investing enough. That is fine, different approaches are available. The important thing is to use the limited public funding as efficiently and effectively as possible, delivering the greatest socio-economic benefits to Portugal in the short, medium and longer terms, finally benefiting from the foresight and undoubted strengths of all the CoLAB associate partners, coming together, each investing in a shared vision to create an innovative and sustainable Portuguese community reaching out internationally and being recognised as a leader in solving global problems locally.

Success stories and failures

It is still way too early to see the full economic impacts that I know will emerge in due course from the CoLAB programme. But each CoLAB I have visited has impressed me by the way they have taken this new model of collaboration, moulded it to suit their own market and used it to create a brand, increasingly successfully, such that diverse organisations, some previously completely unknown to the CoLAB are now requesting to "join the club".

Have there been "failures"? To me, a disappointment has been the lack of substantive investment so far (with some significant exceptions!) from industry. I hope this has been due to a lack of understanding of the programme and the fact that this is all "very new" to Portugal. So, I am hopeful, that as the real impact of the programme soon becomes evident, the business community will see the benefits and increase their subsequent investment.

Lessons learned and pitfalls

Many lessons have been learned, I think by everybody, in every aspect of our CoLAB development experience! Setting up a new ecosystem, across such a wide breadth of markets, scientific areas and geographic regions was never going to be easy. And yet it has been achieved, through the hard work and commitment of all involved: in government, in academia and in business. As a member of the international panel, involved in the initial evaluation and subsequently in mentoring for certain CoLABs, I have seen CoLABs develop in different ways, at different speeds. Some CoLAB communities have needed help in understanding exactly what CoLAB objectives could be. CoLABs are not simply

more collaborative research projects for academia, nor are they a way for industry to get a subsidy to support their pet R&D projects. They are much more than that – each CoLAB building connections within and across communities, creating places where innovative ideas and approaches can flourish. Knowledge Transfer, or as I prefer, Knowledge Exchange, is a vital part of every CoLAB's activity and service offering. It is a "contact sport", which thrives on diverse people (and organisations) constantly interacting, developing new conversations which turn into new ideas and innovation. Of course, this has been made much more difficult because of the COVID experience, for everyone, not just for the CoLABs, but this challenge has been met by the innovative CoLABs, developing new ways of networking, using technology to bring people together. As we hopefully emerge from this experience, these new ways of working will add to the more traditional approaches.

It has not always been easy for CoLABs to grow within the constraints of their Associate Partner Boards. For a CoLAB to be relevant in its community, it should have engagement with multiple businesses, not just with a single company. But this often means working with businesses who are competing with each other. Gaining and retaining the trust of all of these organisations is key – respecting and understanding their intellectual property issues is of paramount importance. Meanwhile, the CoLAB has to be aware that it might also be seen as competitor itself, so a clear definition of the CoLAB's role and strategic direction must be in place from a very early stage. A successful CoLAB is one which provides clear benefit to its partners – particularly if they are making substantive financial or in-kind investments, but also uses the partners' capacities to the full to make its own way in the world, bringing further prestige and recognition to the whole of its ecosystem, its region and to Portugal in general. And businesses, having seen the benefits of CoLAB association must rise to the challenge and invest more themselves. Constraints brought on by the funding mechanism itself and by the consequent but necessary involvement of local, regional, national and EU processes have been little short of a nightmare for many of the CoLABs, as they have struggled to understand how to engage with these sometimes quite complex rules and regulations, often for the first time in their individual experience. This has meant that many aspects have been much slower in

development than perhaps were originally expected. Recruitment particularly was often slow to start, and as CoLABs have grown, cash-flow has become an issue for some of them because of the systemic issues with a lack of advance payments as well as the time taken to turn around invoices.

Expected evolution and related priorities of the Research and Innovation Agendas for the "Climate, Space and Oceans" Thematic Area

As I write this article, the 26th UN Climate Change Conference of the Parties (COP26) is beginning in Glasgow, Scotland. Securing net-zero and protecting communities and natural habitats are both key ambitions for COP26, for Portugal and for the CoLAB network. COP26 recognises that these goals can only be achieved "through collaboration between governments, businesses and civil society". The CoLAB programme is thus the perfect vehicle to support Portugal's objectives in this area.

The CoLABs have been working with their respective communities to prepare substantive agendas with the scope of the new Portuguese Recovery and Resilience Plan (PRR). Through 2021-2026, some 16.6 billion euro should be available, with 38% of that devoted to measures that support climate objectives. A sustainable bioeconomy is specifically mentioned. Space systems are recognised as vital tools for climate understanding. Although not surprisingly, the total fund is initially substantially oversubscribed, I hope the strengths of the CoLABs will enable some exciting new projects to emerge.

Recommendations for the future development of the CoLABs

It is natural now to look back, as well as forward, to review the CoLAB experience so far, to learn and to make changes if and where needed, to ensure that the CoLAB programme is able to continue its journey in the right direction, delivering the objectives set out in the initial thinking. We must avoid government "picking winners", but we also should not spread the funds too thinly. It will probably be necessary to adjust the CoLAB portfolio. To make space (and crucially, to provide new funding) for new areas to be addressed, we may need to merge some CoLABs, or even to lose some altogether, where their path to sustainability is perhaps best served by a different mechanism to a CoLAB. I hope some CoLABs will become sustainable, losing the need for substantive continued public investment, before their initial target dates, but we must accept that it is

still early days and most CoLABs will still need patience, trust, faith and that all-important continued government support for some time to come.

Any other views considered important and not included in the items listed above. The collection and subsequent reporting of Key Performance Indicators (KPI's) has been an element of CoLAB management from the outset and should be an important tool for those investing in the Programme to determine the success (or otherwise!) of that investment. Often the KPIs measure the number of each type of output from the CoLAB (eg. No. of collaborations, No. of SME's engaged, etc.). As my final thought in this paper, I would advocate that this approach could be made more valuable through the development of a logic model, where each CoLAB's long-term economic and societal impact might be better understood, with traceability from each CoLAB's activities, their outputs (e.g., dissemination of knowledge), and consequential outcomes (e.g., no. of new businesses created).

Digital and Communication Systems

Digital transformation can be seen as a profound and accelerating evolution of business activities, processes, competencies and models, leveraging massive and radical changes and opportunities across society.

The 'Digital and Communication Systems' thematic area integrates 3 CoLABs dedicated to smart manufacturing, advanced materials, and human factors, social and ethical-legal issues, cybersecurity and cyber-physical systems and data sciences. Located in the North region, they have generated **12% of the CoLABs employment.** The CoLABs DTx, VORTEX, and, most recently, DATA CoLAB, are mapped in Figure 11.

Figure 11. Location of 'Digital and Communication Systems' CoLABs

The Digital and Communication Systems CoLABs involves **32 entities** as associates, from which **56% are enterprises** (41% large enterprises and 15% SMEs), **41% are R&D institutions** (including interface centres) and **3% are associations and cooperatives and other entities from Public Administration**. The enterprises committed to these 3 CoLABs are listed in Table 7.

Table 7. Enterprises CoLABs Shareholders - 'Digital and Communication Systems'

	CoLAB
Accenture Technology Solutions - Soluções Informáticas Integradas S.A.	DTx
Altranportugal S.A.	VORTEX
Bosch Car Multimedia Portugal	DTx
Bridgepoint – Engenharia de Sistemas Lda.	DATA CoLAB
Cachapuz, Equipamento para Pesagem, Lda.	DTx
Celoplás, Plásticos para a Indústria S.A.	DTx
Dst - SGPS S.A	DTx
Embraer Portugal S/A	DTx
F.Iniciativas, Consultadoria e Gestão, Lda.	DATA CoLAB
IKEA Industry Portugal, S.A.	DTx
Neadvance Machine Vision, S.A.	DTx
NOS Inovação, S.A.	DTx
Primavera - Business Software Solutions, S.A.	DTx
Sgs Portugal - Sociedade Geral de Superintendência S.A	DATA CoLAB
Simoldes Plásticos, S.A.	DTx
SmartWatt Energy Services S.A.	DATA CoLAB
TMG - Tecidos plastificados e outros revestimentos para a indústria automóvel, S.A.	DTx
WeDo Consulting - Sistemas de Informação, S.A.	DTx

In a collaborative effort with its associates, shareholders and external partners, DTx and VORTEX integrated 13 competitive proposals in 2020. From these, 4 proposals were approved in 2020, representing a total approved investment of 12 million€. 4% of the total approved investment is dedicated to DTx and VORTEX activities within these projects.

The Digital Transformation Collaborative Laboratory Association - DTx, is a private, non-profit association that develops its activity by conducting applied research in different areas associated with digital transformation. DTx aims at being a reference player in the scope of digital transformation and focuses its research on the intersection of physical, digital and cybernetic domains, with the purpose of creating the next generation of advanced cyber-physical systems.

Areas of Expertise: Software and information systems, Hardware and sensors, Smart manufacturing, Advanced materials, and Human factors, social and ethical-legal issues.

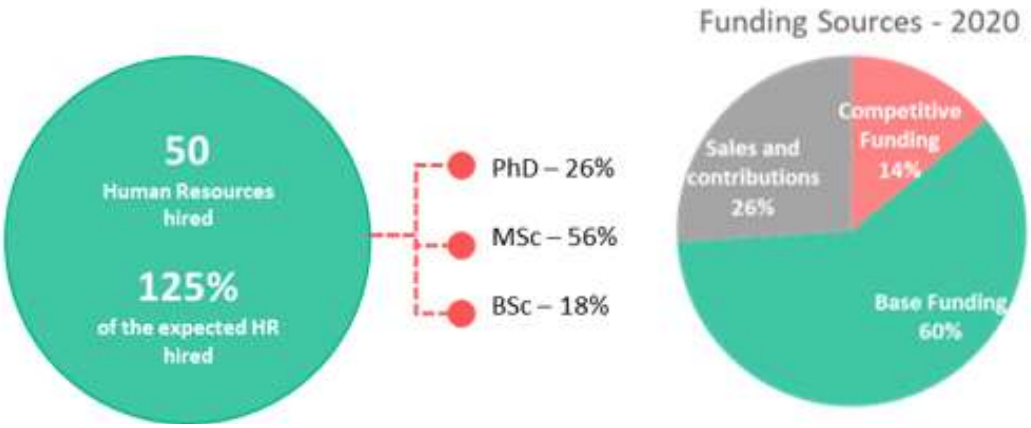
Examples of ongoing activities:

- SMART WEIGHING: Development of an innovative weighing system with varied data acquisition that will then be processed in order to identify customer profiles, increase traceability and reduce weighing fraud.
- MOULDED ELECTRONICS: The project aims to increase the consortium's know-how in in-mould electronics (IME) technology and integrate it in the respective production processes of the associates.

Associates:

- Accenture Technology Solutions - Soluções Informáticas Integradas S.A.
- Bosch Car Multimedia Portugal
- Cachapuz, Equipamento para Pesagem, Lda.
- Associação C. C. G. / Zgdv - Centro de Computação Gráfica
- Centro de Engenharia e Desenvolvimento
- Celoplás, Plásticos para a Indústria S.A.
- Dst - SGPS S.A
- Embraer Portugal S/A
- IKEA Industry Portugal, S.A.
- International Iberian Nanotechnology Laboratory
- Neadvance Machine Vision, S.A.
- NOS Inovação, S.A.
- Pólo de Inovação em Engenharia de Polímeros
- Primavera - Business Software Solutions, S.A.
- Simoldes Plásticos, S.A.
- TMG - Tecidos Plastificados e Outros Revestimentos Para a Indústria Automóvel, S.A.
- Universidade Católica Portuguesa
- Universidade de Évora
- Universidade do Minho
- WeDo Consulting - Sistemas de Informação, S.A.

Main Figures:



Combining the potential of academic and industry research models, Vortex aims to become the largest hub for accelerating innovation and knowledge and technology transfer in the areas of cybersecurity and cyber-physical systems on an international scale. In this way, Vortex will actively contribute to accelerating innovation and the development of cutting-edge technologies, closing the current gap between research institutions, public laboratories, industry, the market, the economy, and society. Promoting innovation acceleration programmes that are capable of streamlining the transfer of the most fundamental research and development carried out in academic institutions (TRL 1-3), their incorporation through experimental development in partnership with business entities (TRL 4-7), with a view to its preparation for rapid and efficient market introduction (TRL 8-9), thus valuing the entire chain of generating new scientific knowledge and creating technological value.

Areas of Expertise: Cybersecurity and Cyber-Physical Systems;

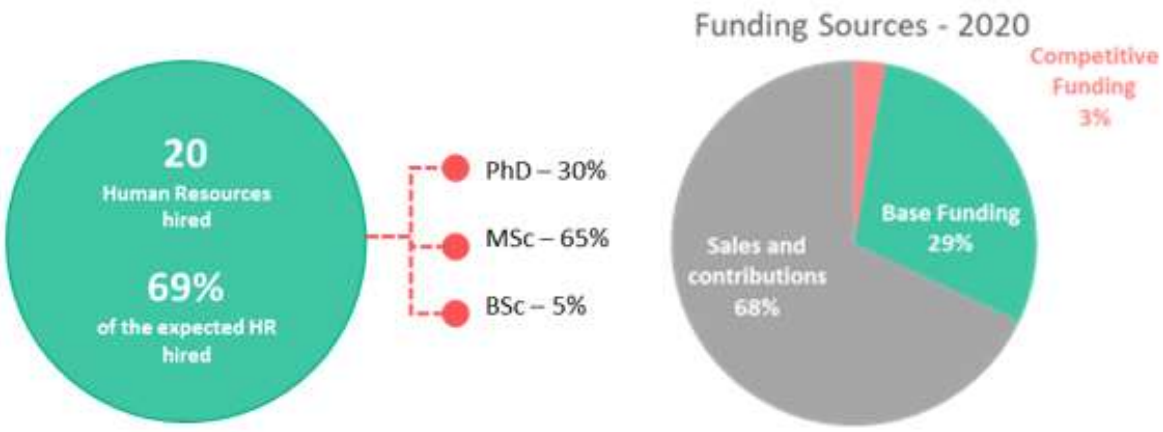
Examples of ongoing activities:

- New Device Design Services; Co-creation and Technology Transfer Services for industry, covering the full product development cycle.
- AI-POWERED LABELING FOR ADAS - Semi-automated labelling tool powered with Artificial Intelligence to address the challenge of ground truth measurements in ADAS applications

Associates:

- Altranportugal S.A.
- Associação para a Promoção da Inovação e do Empreendedorismo
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- Instituto Superior de Engenharia do Porto
- Universidade Nova de Lisboa

Main Figures:



The Collaborative Laboratory for data oriented innovation services aims to develop a cross-sectoral ecosystem that will adopt a holistic and integrated approach, providing data-driven services based on the complete data flow value chain. Focusing on data in the domain of industry, Green Deal, mobility, health, energy; agriculture; public administration, among others, Data CoLAB has the following main objectives:

1. Increase data-based innovation services by catalysing collaboration and knowledge sharing, without duplicating existing work.
2. Ensure that data is available to all by producing guidelines, best practice recommendations and services.
3. Mobilize and constitute consortia involving key players with complementary knowledge (scientific and technological) capable of achieving practical goals and ensuring the correct and broad application of the results generated.
4. Support the implementation of data-related frameworks, encouraging new synergies between communities and between technical and political stakeholders.
5. Develop data-driven decision models to support business and the public sector by ensuring that data is used responsibly, implementing value-added solutions.
6. Support the development of sector-specific legislation and the implementation of the Digital Europe program strategy.
7. Establish interface and knowledge transfer models capable of promoting effective collaboration between technological and engineering centres, with scientific and higher education institutions, such as participation in international data events and networks.

Areas of Expertise: Data Science; Innovation services.

Associates:

- Bridgepoint – Engenharia de Sistemas Lda.
- Câmara Municipal de Viana do Castelo
- F.Iniciativas, Consultadoria e Gestão, Lda.
- Instituto Politécnico de Viana do Castelo
- Sgs Portugal - Sociedade Geral de Superintendência S.A
- SmartWatt Energy Services S.A.
- Universidade do Minho
- Instituto de Desenvolvimento de Novas Tecnologias
- Universidade do Porto

Approved in March, 2021.

THE COLABS IN THE "DIGITAL AND COMMUNICATION SYSTEMS" AREA: REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Wolfgang Wahlster

Professor of Artificial Intelligence (AI), German Research Center for AI, Berlin, Germany

1. The Birth of the CoLABs Model

On the 21st of May 2017 Minister Manuel Heitor, Professor Paulo Ferrão, Professor José L. Encarnação and myself as the CEO of the German Research Center for AI (DFKI) met for a working dinner in Berlin. After Minister Heitor had introduced his vision for Collaborative Labs in Portugal, I was asked to explain the basic principles behind the success of DFKI since 1988. I'm a little proud, that two important principles of DFKI were adopted by the CoLABs: First, the PPP principle, that academic partners should form together with industrial partners a non-profit association and both sides should be represented in the governance boards. Second, the three thirds principle, that the budget should be based on public base funding, competitive funding programs, and revenues from services or contract research for industrial clients – as three more or less balanced sources of income. I'm happy that these two principles, which have been applied successfully at DFKI for more than 33 years, have been adopted in the CoLABs program. Thus, in my personal view, DFKI was one of the important sources of inspiration for the very effective CoLABs model. Today, CoLABs are drivers of innovation and digitalization in Portugal.

2. The Second Wave of Digitalization

The first wave of digitalization has reached all facets of our economies, societies and daily life. All data is now stored digitally, transmitted over digital networks and processed by digital systems in a machine-readable form.

But the second wave of digitalization is now already arriving like a Tsunami. New AI methods allow software to understand the digital data, so that actions of autonomous systems can be based on the collected data and inferences can be drawn so that the semantic data content can be used in practice, valorised and monetized. Thus, in the near future all data is not only machine-readable but becomes also machine-understandable. Research and

innovation processes are disrupted by the first and second wave of digitalization. Thus, it was very important for Portugal to launch digitalization lighthouse projects in three CoLABs: DTx, VORTEX and the Data CoLAB. In addition, it is important to note that all the already existing 35 CoLABs, distributed over 8 thematic areas are heavily involved in the digitalization of their domains and use state-of-the-art digital tools such as cloud and edge computing, cyber-physical systems, mobile apps, advanced visualization, machine learning, digital twins and the internet of things and services in their daily operation. Thus, digitalization is a horizontal, cross-sectional technology with a high impact on all CoLABs.

Digitalization is democratizing technology. No-code platforms, data-driven machine learning, and natural language dialog systems are adding a grassroots layer to innovation processes. With democratized technology, every student can become a successful researcher, every employee can become an innovator, and every citizen can become an entrepreneur empowered to create insights, innovations and business models on their own at a low cost by mobile work.

3. The Impact of CoLABs on Digitalization

One of the most important grand challenges in industry is the transformation of manufacturing by smart factories based on the revolutionary principles of Industry 4.0, a concept that I invented in 2010 and published first in 2011. In Portugal the *DTx CoLAB* was the first significant initiative to use cyber-physical production systems, plug-and-play technology, digital twins, collaborative robots, and AI-based production planning and quality management on the shop floor of the next generation of manufacturing plants. DTx has important international companies like Bosch and Embraer as industrial affiliates. The innovation ecosystem around the CoLAB gives these companies the confidence to extend their activities in Portugal and thus guarantee important industrial jobs in their Portuguese subsidiaries.

Without cyber-security solutions and safety guarantees the acceptance of user communities cannot be achieved for complex distributed and embedded IT systems. The *VORTEX CoLAB* is tackling these challenges with a brilliant team of experts and the support of the industry leader Altran, now acquired by Capgemini. The focus on applications in automotive industry was not helpful for the planned growth of VORTEX, since this sector

operates in a crisis mode due to the pandemic situation and the parallel mobility transition due to the Green Deal. But hopefully the new second application area of VORTEX dealing with drones will be a good alternative for use cases. Here perception on the edge as one of their areas of expertise plays a key role.

Data-driven innovation is one of the most promising side-effects of digitalization. The R&I agenda of the DataCoLAB addresses the complete data value chain: data generation, data collection, data analytics, and data security. This CoLAB is very important to support the implementation of the European Strategy for Data in Portugal. DataCoLAB is led by the multinational company SGS and co-sponsored by FI Group Portugal and SmartWatt. It is the most recent CoLAB in this thematic area and was officially opened in July 2021. This CoLAB is the first in Viana do Castelo, the centre of the most northern region of Portugal and an example for the excellent regional coverage of the CoLABs.

It is important to note that the CoLABs have already stimulated the creation of more qualified employment in Portugal, especially on the PhD and Master level. In addition, CoLABs are beginning to attract foreign job-creating investments in innovative fields in Portugal.

4. Recommendations for the future development of the CoLABs

4.1 Competitive Salaries for IT Experts

Especially for CoLABs in the field of Digitalization it was very difficult to hire experienced IT experts for their projects. The main reason is the extreme worldwide competition for experts with an academic background in computer science. In Germany 86.000 open positions for software specialists could not be filled in 2020. The success of home-working in industry during the pandemic situation, has led global companies from the US and China to recruiting compaigns, in which they offer very high salaries for “remotely working software experts”. This solution allows these companies to tap into global talent pools including Portugal. Thus, the IT experts can stay in Portugal with their families but earn a much higher salary than any Portuguese employer in industry or academia is used to pay. This is a new form of “digital brain drain”. The only effective countermeasure in the short run is a special allowance for the CoLABs to offer competitive salaries (e.g., using their

income from industrial projects) for IT experts and attractive long-term contracts.

4.2 More Focused Calls for Proposals

The rejection rate of proposals submitted by the CoLABs in competitive funding programs of FCT, ANI and the EU is much too high. This oversubscription of funding programs leads to a huge waste of efforts in proposal writing in the CoLABs. Due to the relatively low success rates, there is a tendency to submit many proposals, even if they are not good enough, or don't fully meet the call criteria. The submission of half-baked proposals also overloads the reviewing system and leads to delays in the funding pipeline. One recommendation is to narrow the scope of calls for proposals drastically so that CoLABs can tailor their efforts to calls for which they really have a unique expertise.

4.3 More Reliable Cash-Flow

During my mentoring visits of the CoLABs I heard a lot of complaints about cash-flow problems due to very late payments of the promised funding tranches. In extreme cases the CoLABs had to lend money from their associates. This has meant that many aspects like equipment purchases and lab furnituring have been much slower than were originally planned. Particularly, the recruitment of key scientists and staff was slowed down. It was proposed that advance payments in the first month of a year should be increased to 50% of the base funding of that year. Financial reliability for the allocated base funding must be a top-priority for the retention of top-talent, in particular in the IT domain with its extreme lack of experts.

5. Next Steps and Expected Evolution

There are important worldwide mega-trends in this area, which should be addressed in the next phase of the corresponding CoLABs:

1) From **binary** towards **quantum** computing
2) From **cloud** towards **sky** computing
3) From **5G** to **6G** communication
4) From **brute-force machine learning** to next generation **cognitive AI systems**

Quantum Computing is based on the design of hardware and software that replaces Boolean logic by quantum law at the algorithmic level. For complex optimization, big data-driven machine learning or genetic simulation in biotechnology this promises dramatic speedups. For fighting climate change and for the future of new energy systems the

use of the first generation of error-correcting quantum co-processors are promising, but for IT security based on cryptography they present a challenge.

Sky computing goes beyond individual clouds by providing a universal software platform with a compatibility layer that abstracts away the services of individual clouds by masking low-level technical differences. An intercloud layer routes the jobs to the right cloud automatically. The European GAIA-X initiative is a first example of such a new interoperability infrastructure for Cloud computing.

6G communication networks are based on photonic technologies and AI methods so as to exploit the abundant spectral resources in terahertz and visible light bands, especially in indoor optical wireless coverage, to meet the exponentially growing demand on higher system capacity, peak data rates and positioning precision. It will become a connected intelligent platform that maximizes the synergy between AI and mobile networks and will facilitate over-the-air AI applications.

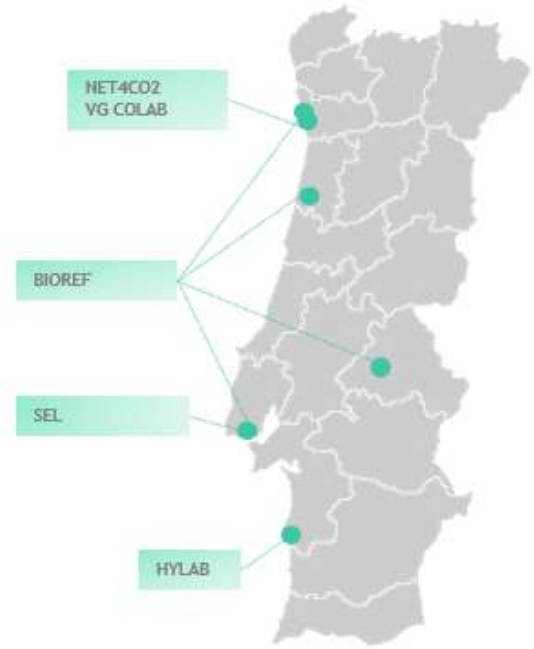
Next generation AI will provide more than just tools that generalize from human-curated data sets by neural machine learning. Rather, they will function more as colleagues than as tools. The third wave of AI that brings forth machines that understand and reason in context will acquire knowledge not only from large training data sets, but from textbooks and conversation with teachers and experts. This will be an important step from black-box AI systems towards explainable glass-box systems.

In the next round of CoLABs some of these new megatrends should be addressed and the current CoLABs should also try to cover some aspects of these recent developments.

Energy and Sustainability

The 'Energy and Sustainability' thematic area integrates 5 CoLABs dedicated to carbon capture and sequestration and CO2 Circular Economy, biorefineries, bioenergy and bioproducts, energy management systems and storage and hydrogen. Located in the North, Centre, Lisbon and Alentejo regions, these CoLABs are responsible for **10% of the employment created** by CoLABs. BIOREF, NET4CO2, Smart Energy LAB, VG CoLAB and HyLAB are represented in Figure 12.

Figure 12. Location of 'Energy and Sustainability' CoLABs



The Energy and Sustainability CoLABs involves **42 entities** as associates, from which **half of them are enterprises** (29% SMEs and 21% large enterprises) and the other **half are R&D and interface institutions**. Companies who are part of CoLABs in this thematic area can be seen in Table 8.

Table 8. Enterprises CoLABs Shareholders 'Energy and Sustainability'

	CoLAB
A400 - Projetistas e Consultores de Engenharia, Lda	VG CoLAB
A4F - Algafuel, S.A.	BIOREF
Accenture, Consultores de Gestão S.A.	Smart Energy LAB

Bio Dourogás - Produtora de Gás Combustível, S.A.	BIOREF
Biotrend - Inovação e Engenharia Em Biotecnologia S.A	BIOREF
BLC3 Evolution Lda.	BIOREF
Bondalti Chemicals, S.A.	HyLAB
Change Partners, SCR, SA	VG CoLAB
Charge2C - Newcap Lda	NET4CO2
Edp Comercial-Comercialização de Energia, S.A	Smart Energy LAB
EDP Inovação S.A.	VG CoLAB
EDP - Gestão da Produção de Energia, S.A	HyLAB
Efacec Energia - Máquinas e Equipamentos Eléctricos S.A	VG CoLAB
Galp Energia, S.A.	NET4CO2; HyLAB
PETRÓLEOS DE PORTUGAL - PETROGAL S.A.	BIOREF
REN GASODUTOS, S.A.	HyLAB
SilicoLife, Lda	BIOREF
Solvay Portugal - Produtos Quimicos S.A.	BIOREF
SYSADVANCE, Sistemas de Engenharia S.A.	BIOREF
Transportes Aéreos Portugueses, SGPS S.A	BIOREF
TRATOLIXO - Tratamento de Resíduos Sólidos, E.I.M., S.A	BIOREF
Visblue Portugal, Unipessoal Lda	VG CoLAB

In 2020, the 'Energy and Sustainability' CoLABs participated in 11 competitive proposals with a total requested investment of 23 million€. From the participation in these proposals, 11 million euros were raised to Energy and Sustainability' CoLABs activities, which represent 40% of the total approved investment.

BIOREF
Laboratório Colaborativo para as Biorrefinarias

The BIOREF Association - Collaborative Laboratory for Biorefineries was formed with the aim of becoming Portugal's benchmark scientific and technological entity to support both the implementation of the National Plan for the Promotion of Biorefineries - Horizon 2030 (PNPB) and the new European Bioeconomy Strategy. For this purpose, 5 priority axes for innovation activities were defined creating technological and market conditions for: the production and sustainable use of renewable gases (methane, hydrogen) in the transport sector; the use of biomass thermo-chemical conversion technologies (e.g., pyrolysis, hydrothermal liquefaction and gasification) for commercial applications (renewable gases, energy, liquid biofuels); the commercial viability of bio-refineries with added value bioproducts from different residual biomasses and of using biomass, in particular microalgae, in biorefineries of liquid biofuels, in particular aviation; the development of purification and downstream processing methodologies for industrial products derived from biomass.

Areas of Expertise: Biorefineries; Bioenergy; Bioproducts.

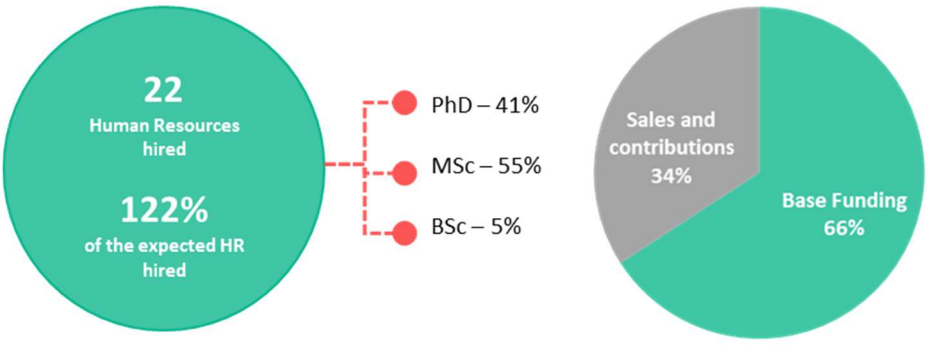
Examples of ongoing activities:

- Move2LowC project will allow the development of technological rationale, up to TRL 6, and a technological exploitation plan that supports investment in the production of biofuels on a commercial scale. The main objective is biofuel production for the air and heavy road freight and passenger transport sectors.

Associates:

- A4F - Algafuel, S.A.
- Bio Dourogás - Produtora de Gás Combustível, S.A.
- Biotrend - Inovação e Engenharia Em Biotecnologia S.A
- BLC3 Evolution Lda.
- Faculdade de Ciências da Universidade de Lisboa
- Instituto Politécnico de Portalegre
- Instituto Superior Técnico
- Laboratório Nacional de Energia e Geologia, I.P.
- PETRÓLEOS DE PORTUGAL - PETROGAL S.A.
- Instituto de Investigação da Floresta e Papel
- SilicoLife, Lda
- Solvay Portugal - Produtos Quimicos S.A.
- SYSADVANCE, Sistemas de Engenharia S.A.
- Transportes Aéreos Portugueses, SGPS S.A
- TRATOLIXO - Tratamento de Resíduos Sólidos, E.I.M., S.A
- Universidade de Aveiro
- Universidade do Minho
- Universidade Nova de Lisboa
- Universidade do Porto
- Universidade de Trás-os-Montes e Alto Douro

Main Figures:



The Net4CO2 CoLAB is a network of R&D competencies and new technologies aiming to create new products and processes to contribute to a sustainable CO2 circular economy. All the partners are aligned to contribute to the solution of the CO2 problem through two strategic action vectors: First, CO2 capture and separation from industrial flue gases; and secondly, by CO2 transformation into added-value products such as synthetic natural gas, clean liquid fuels, or blue hydrogen. The development of the novel NETmix micro-technology applied to the capture and transformation of CO2 into synthetic fuels is expected to result in a "green route" to obtain less pollutant fuels and promote the circularization of CO2. Several players can benefit from using this technology, namely, power plants, cogeneration plants, refineries, Oil & Gas (O&G) producers, glass and cement industries.

Areas of Expertise: Carbon Capture and Sequestration; CO2 Circular Economy

Examples of ongoing activities:

- Syngas production via NETmix technology.
- Net4GtL – Fischer-Tropsch synthesis via NETmix technology.
- HGtS4H2 – Hydrogen separation from Syngas via hydrates.

Associates:

- Change Partners, SCR, SA
- Galp Energia, SA
- International Iberian Nanotechnology Laboratory
- Instituto Superior Técnico
- REQUIMTE - Rede de Quimica e Tecnologia
- Universidade do Porto

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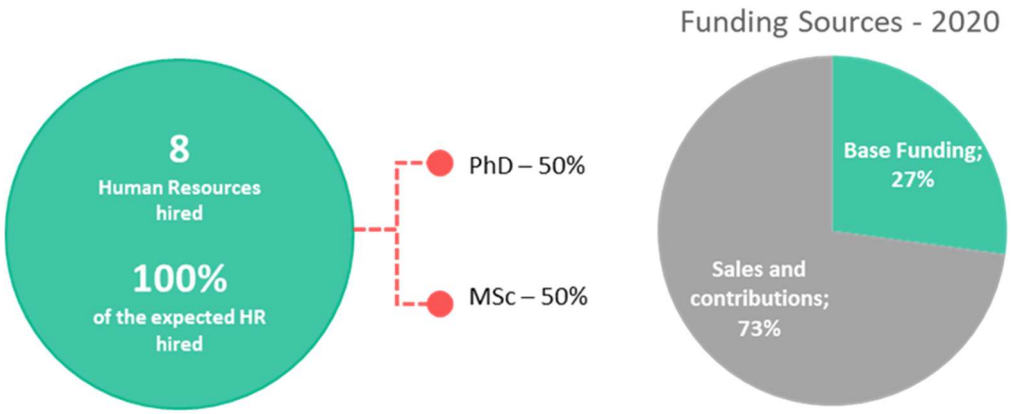


Smart Energy LAB ("SEL") strategic vision is to be an international reference on new energy downstream solutions. This CoLAB's research and innovation agenda emerges from the development and convergence of knowledge about key verticals in the industry, along with key multidisciplinary skills, including a) Industry Verticals: The distributed Management of Energy Resources; Power management; Flexibility; Storage; Mobility; b) Horizontals: Engineering; IoT; Computer hardware and software; Big Data and Artificial Intelligence; Cyber security; Service Design and Design Thinking; UX/UI.

Areas of Expertise: New Energy management systems.

Examples of ongoing activities:

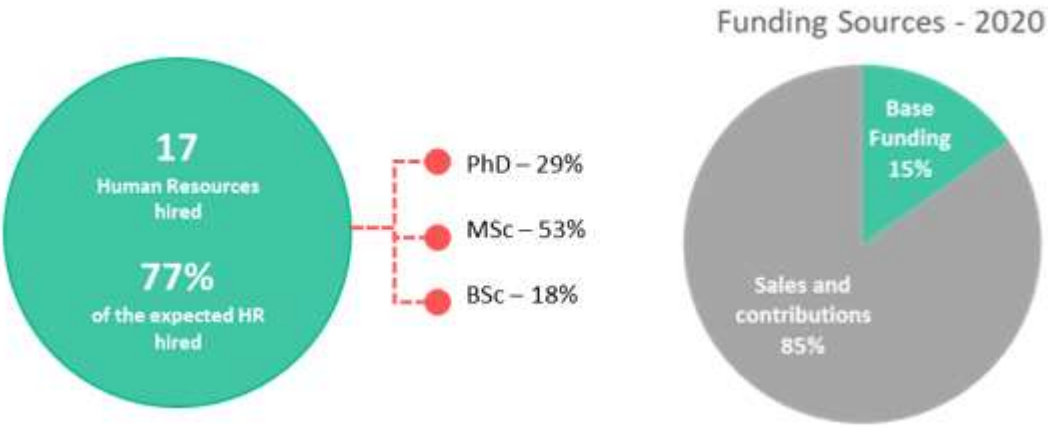
- EV Charging for Condos - Redesign ev client charger experience in condominiums to improve customer experience.

- Budget Generation - Develop remote digital budgets to speed up the electrification rollout. Based on data, machine learning and Customer Experience.

Associates:

- Accenture, Consultores de Gestão S.A.
- Edp Comercial-Comercialização de Energia, S.A
- Faculdade de Ciências da Universidade de Lisboa - IDL-Instituto Dom Luiz
- Instituto de Engenharia de Sistemas e Computadores, Investigação e Desenvolvimento Em Lisboa
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- Instituto Superior Técnico
- Universidade de Coimbra

Main Figures:



Vasco da Gama CoLAB (VG CoLAB) aims at developing world-leading solutions in the field of energy storage with emphasis to the electrochemical systems, connected power electronics and energy management. Developments in this domain will allow countries (as Portugal) to take advantage of its intrinsic nature of most of renewable energy sources, which are not dispatchable (e.g., solar irradiation). In this context, VG COLAB is strongly committee with the following three main Pillars and corresponding cross R&D&I:

- Redox Flow Batteries (RFB).
- Supercapacitors (SC).
- Power Electronics (PE) and intelligent Energy Management Systems (iEMS).

Areas of Expertise: Electrochemical energy storage; Electronic energy conversion; Intelligent energy management.

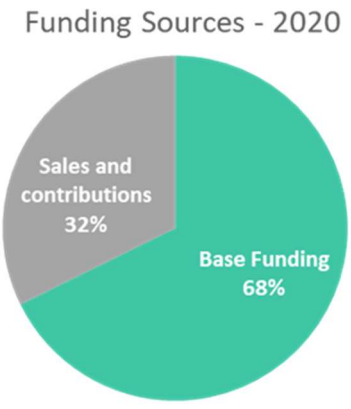
Examples of ongoing activities:

- New methods for production of components for redox flow batteries
- Tailor made supercapacitors: Self-healing and flexible electrodes, exploration of new design architectures.
- Hybrid energy storage stationary system based on redox flow battery, supercapacitor, and power electronics.

Associates:

- A400 - Projetistas e Consultores de Engenharia, Lda
- Charge2C - Newcap Lda
- Edp Inovação, S.A
- Efacec Energia - Máquinas e Equipamentos Eléctricos S.A
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- Instituto Superior Técnico
- Universidade do Porto
- Visblue Portugal, Unipessoal Lda

Main Figures:



HyLab

HyLAB aims to bring research activities closer to industrial ecosystems on the theme of implementing the green hydrogen economy to accelerate the energy transition along the entire hydrogen value chain. The activities that will be developed are structured along 4 pillars: i) Hydrogen Production; ii) Transport, Distribution & Storage of Hydrogen; iii) End Uses of Hydrogen; iv) Transversal focusing on the promotion of partnerships and new business models within the Hydrogen economy.

The implementation of this CoLAB allows, not only to boost new R&D areas with potential to export knowledge and technology to other geographies, but also to create qualified jobs with skills and new development areas associated with the value chain that should be boosted in the scope of this CoLAB, namely:

- Maximize the efficiency of electrolyzers (reduce electricity consumption per kg of H2 produced);
- Possibility of producing hydrogen from salt water and wastewater.
- Injection of H2 into the natural gas grid (P2G);
- H2 liquefaction and storage;
- Liquid Organic Hydrogen Carrier (LOHC).
- Use of hydrogen gas/coal-fired electricity generation turbines currently in operation;
- H2-fired boilers for heat production in industrial processes;
- Fuel Cells for the transport sector (road, rail, sea, air);
- Industrial uses as feedstock (e.g. green ammonia, green methanol).

Areas of Expertise: Energy, Green Hydrogen.

Associates:

- Bondalti Chemicals, S.A.
- Centro de Engenharia e Desenvolvimento
- EDP - Gestão da Produção de Energia, S.A.
- Galp Energia, S.A.
- Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial
- Instituto de Engenharia de Sistemas e Computadores, Tecnologia e Ciência
- International Iberian Nanotechnology Laboratory
- Instituto Superior Técnico
- Instituto de Tecnologia Química e Biológica António Xavier
- Laboratório Nacional de Energia e Geologia, I.P.
- REN GASODUTOS, S.A.
- Universidade do Porto

Approved in March, 2021.

THE COLABS IN THE ENERGY AREA: REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Dr Egbert-Jan Sol

Smart Industry Program Director, TNO Industry, Netherlands

Running COLAB is not an easy task. Every Research & Technology Organisation (RTO) knows that is active at the crossroads of academic research, industrial needs and societal interest/public entities is already a challenge. And for CoLABs, being in the start-up phase adds an extra challenge. In this note I share some lessons of value for today's CoLABs as learned elsewhere, followed by a more in-depth view on the challenges for the energy CoLABs.

Play simultaneously on 5 chess boards

Ultimately a Colab, as any RTO, must play simultaneously a minimum of 5 different games on a 5-chessboard level.

1. First there is the internal organization, although small today, it takes a lot of energy to start up.
2. Then there are the national and regional funding level where one must deal with these governmental organizations with their rules, financial regulations, reporting and own dynamics.
3. At the third level, there are European funding of research calls with other regulations, rules of the games, competition, closing dates, etc.
4. Not to underestimate level four: the university competition. This is the chessboard with again different rules of the games in the form of universities which compete to do the same industrial research by offering PhD students for very low costs. A few universities are partners, but they are competitors for the same financial streams too.
5. Then finally, at level five, there are the private entities or companies, sometimes as partner, else as customers who are driven by their own opportunistic interest to make money. But in the end, they are the most important player regarding the continuation of a CoLAB.

The fifth board is the most important chess board, but don't forget the other four, but also don't get lost on one of the other boards, in particular level 4 by trying to be or competing with a university and forget the fifth one.

It is normal that team members have experiences at two or three levels. And for a professor or a company manager job that is fine. But for a Colab it will take a year or two before every team member has experienced the dynamic and yearly cycles, mechanisms,

and motivations of players at the other two levels. And a Colab management team, as a team, knows how to play which game on which chessboard level along with its specific rule set. This 5-level simultaneously chessboard game is a unique challenge for a Colab[3]. Let's start with some views on the **first level**.

The start-up of a COLAB requires the recruitment of only the very best people. Don't go any one less, don't go for filling the target number of positions. Years of experiences learns you that you can better continue to search for the best person, then to accept less. Some CoLABs did this and are behind the optimistic recruitment schedule. Don't mind. Build your COLAB DNA first, in the long run people and their qualities determine the success of any COLAB. There are also CoLABs with many employees on the payroll already, running through their ANI budget fast. Realize you can't spend an ANI euro twice and spent on not the right people is a loss you can not recover.

Then there is the issue of building a team at one central physical place, way of working, legal statutes, agreeing on bylaws, etc. Most CoLABs are beyond that phase, but it took, as always, more time and effort than expected. Now challenges as cashflow are becoming central. There is, as of yet, no investment fund for equipment. If that would have been the case, the purchasing costs of today (and draw on the balance/cash position) could be changed into a multiple year write-off. So, either limit the employee growth or capitalize on the relations with your partners for using their equipment on a temporary basis for a small fee.

The last aspects on the internal cashflow shift already the focus to level 2 challenges. As an international external mentor, I don't know the problem details you face at **level 2** but at least someone in your Colab can probably tell already some horror stories. At least, that is common practice elsewhere in any bureaucratic world. You are not alone. Cope with it. You must execute the instructions precisely. It is like corvee, drudgery, just like any other job 20% could make you crazy, but it needs to be done, so the best advice is to handle it directly such that you can concentrate on the 80% of the activities that generate positive energy. One small advice read the published rules of the Portuguese government yourself such that you understand them too. The ANI people must stick to them and if you know them too you will not be surprised once they are applied.

At **level 3** Brussel or EU rules are again a different game. Yet they are as bureaucratic as rules on national/regional level, and sometimes even more complicated, as e.g., regarding state-aid aspects as subsidy level,

[3] There is a seventh level: politics and public relations to safeguard the long-time public funding. That is not a challenge for a Colab right now. It will become one but the time one has conquered the other levels. The sixth level will be explained at the end.

IPR rules, etc. But specific for EU's Horizon Europe and for some Digital Europe the competition in calls far higher than in national programs. Several universities are well experienced in writing proposals, but hit rate of 5-10% (i.e., writing 10 to 20 proposals for only one to be successful) is an activity any industry will step out after one try. Without anyone experienced in EU calls the same will happen to a CoLAB. The best advice is to leverage on one of your industrial partners. But for industry the problem with these calls is their long preparation and execution time. Already in year minus 1-2 the concept of the call text is formulated. That is the only moment to steer it. Then a year before the launch date the topics are frozen. If yours it not in it, it will take at least a year or two before the next windows of opportunity opens. Then at year 0 the call is open, but you should be active in proposal consortia months before, contribute to discussions and writing and submission halfway year zero to get an acceptance result by the end of year zero. If successful halfway year 1 you can start with the work and making costs for in general 3 to 4 years. And then by year 5 the final payments arrive. Image that at the beginning of year 2 the strategy of the Colab must adapt to changing market/partner situations. You are stuck. Two years of preparation is gone, and you still must match work for several years for which you are only partly paid but which hardly contributes to your (new/adapted) strategy. For a university that is less a problem, there will still be a PhD thesis and some publications, but for a CoLAB it is far more serious problem.

The **fourth level** is the level where universities can be competitors and partners. Worst is a situation that a university is steering a CoLAB. A CoLAB IS NOT A UNIVERSITY. Some future reviewers or evaluators will value the list of CoLAB publication in reviewed journals as a sign of high scientific value. This author has a different opinion. Scientific publications are sensible for the individual career of CoLAB employees which pursue a future academic career. That is an activity a CoLAB should support, if alone to spread and share public open scientific knowledge. But it is not the main goal of a CoLAB. A goal of a university is to conduct research and expand the pool of public knowledge/science. But the goal of a Colab is …. in my view and the TNO law in the Netherlands, …. Is to support innovation of society and its actors (as government, industry, etc.). Translated towards the Colab, or in particularly the energy Colab the energy transition we face as society. If the outcome is a paper as requested by the partners that is fine, but more often the partners want results delivered as proven way of working, new technologies. A university will stop or should stop once a certain topic reaches TRL level 44.

[4] TRL Technology Readiness Level (1 = an idea, … 9 = commercial product 2-8 in between levels)

A Colab as any RTO is meant to fill TRL 4-7 gap. Given the public funding TRL 9 (a commercial offered services or product) and even TRL 8 is not allowed by EU state-aid ruling as it then must be offered either a private activity or one must prove there doesn't and will not exist a private market. The almost continuous "battle" which emerged the last decades is the vision that universities should do more than training young people and conducting (academic) research and should do more "valorisation" and to enter the same working and market area as RTO's. Whether this is good or not is up to politics. For the operation of a Colab the best way is to partner and cooperate with universities. But even then, you will encounter individual university actions targeted at the same customers/funding programs as a Colab. Deal with it by delivering better quality solution addressing the needs of paying customers, i.e., companies. In the long run quality always wins. Whereas a top-quality PhD thesis after 4 years of excellent research is of much value for a university, a company wants a cost effective, often multi-disciplinary solution within a much shorter time frame. Therefore, a Colab is not a university and neither a competitor, but it can be an excellent environment for a PhD student obtain industrial research experiences and its public results can be feedback into a PhD thesis/scientific publication. With Portugal establishing CoLABs as a new instrument to support innovations in the Portuguese society the setting of the tasks what a university is and what a Colab is, will take some time and discussion before everyone works in the most optimal way.

The above long discussion on level 4 is to make clear that a Colab should not compete to become a pseudo university research lab too. The reason of existence of a Colab, in particular the energy CoLABs, is mainly the **fifth level**: supporting companies and society in their much-needed innovation and energy transition. In due time every CoLAB will understand that the private cash funding of these partners, members and full paying customers is the source to leverage on. A common notion is the 1/3 base public funding, 1/3 competitive public funding, 1/3 private (industrial/commercial) funding. It provides private players a way to reduce the risks of innovations (in the TRL phase 4 to 7/8) before they are certain that a solution can be commercial offered. The reason of the public funding is that it accelerates innovations. Today's (industrial) research is so complicated that no individual companies, especially smaller one, can perform all needed research and development themselves, but that in public private partners and similar networks innovations are realized much faster. This fourth generation of R&D in the form of (regional) innovation public-private partnership eco-systems is the reason of existence of the CoLAB concept. Formulated the other way around, if a Colab doesn't

capture private funding, there is no need to spend the public part. The competitive public funding is in between. In general, those funds demand a 50%/50% split, i.e., you get 50% funded, but the other 50% you must bring in yourself. A Colab could and will use the base funding, but the more the private partners contribute, either as (yearly) partner fee or as direct payment, the more sustainable the matching for e.g., leveraging EU programs realized.

Each CoLAB has to understand that in the end you are a very commercial entity. Every hour not covered by some private funding is an hour lost. To phrase it bluntly: if you don't get private funding or score paying customer projects there will be no CoLAB. As with every RTO, you are not a university, but a public organization conducting industrial research. If your targeted industry stops to exist in Portugal, e.g., very fossil energy driven industry, there will be no reason of existence for a Colab for that industry. Whereas a science direction can evolve over decades, research topics in RTO follow a roughly 10-year growth cycle and then a 10-year phase where is gradually disappears as being important just like a product life cycle with a star and cash-cow phases. As a result, a Colab needs a very functional marketing/business development functions which interacts intensively with their industrial partners and the market to determine the future needs. And here, at this fifth and most important level, different set of rules apply. Companies are opportunistic. They want the CoLAB to run the risks (socialize the risk, privatize the rewards). In simple words, they would love to bring in 1% of the costs in cash and acquire 100% of the results. EU state aid forbids this and as a CoLAB you must charge them properly. And suddenly running your Colab and safeguarding its future become a commercial game of selling your research and development services to companies/partners who must pay the right price. Whereas it seems so attractive for a rather academic driven Colab to drop back on the activities they are good at, as a Colab they will not survive. The minimal condition for a Colab is a regular stream of private funding, be it in yearly fees and/or cash contributions for project doesn't matter. It is this sense of urgency on fulfilling an effective business development role and acquiring private funding that several of the Colab must improve soon. Once the start-up phase is over (level 1), governmental base funding (level 2) is taken care of, some EU project proposal are in the pipeline (level 3) and the right way of working with academia is understood at both sides, being successful at level 5 by delivering results for paying private entities is the ultimate condition for a Colab to exist. And with the energy Colab one might expect that should be doable.

The energy transition CoLABs

Society uses a lot of energy and now needs to change within 30 years to renewable sources

and no CO2 (or greenhouse gasses GHG) emission. That requires not only a paradigm change to take place in a very short time frame, but it also required a rollout which is so very, very, very, very huge that one can hardly grasp the size of the challenge. Just image all oil and gas industry and replace them. Not all solutions are known or proven, and even if they exist, they need to be made cost effective and then to be deployed on an incredibly large scale. A simple roadmap would be something like 2040-2050 large scale rollout to 100%, from 2030-2040 make the solution cost effective by applying the learning curve to lower performance/price levels to enable any massive rollout and from today to 2030 to (further) develop the solutions. No single solution or silver bullet will do. Many and multiple solutions will be needed. Solar PV, wind and even biobased solutions exist. The main problem is shifting to long term energy storage and the earlier needed balancing of electrical power usage as well as the question what to do with CO2. Portugal is in a unique leading position of have a far larger renewable energy supply then elsewhere in the world and the lucky situation of a combination of wind and hydro, and a capability to exploit more solar PV. Electrical power balancing in this context will be more important at a national level in an earlier stage then elsewhere in the world and to develop leading edge solutions. The strategy of the SEL CoLAB fits excellent with its focus on solutions at the lowest level of the current distribution net that can scale to millions of users. In the VG energy storage work has started on technical solutions on multi forms of batteries (redox flow, super capacitors, etc.) and the management of them. The other two energy CoLABs are focused on the handling of CO2 and H2. Handling of CO2 is today seen as an intermediate solution to capture CO2 from fossil processes and transport and store it. In the long run CO2 might be a valuable source in a circular cycle with synthetic fuels as e.g., solar fuels where Solar PV electricity drives an electrolyzer producing H2 which is then used in a syngas/Sabatier process to produce with C02 a synthetic (hydrocarbon) fuel for long term storage and long-distance transport. But in all cases where high temperature is essential as in steel, process, glass, cement industries direct use of H2 is a necessity. The judge is still out whether H2 will be used directly for other usages as for example long distance/heavy transport. But for both these CoLAB there is a market need.

One might only worry, given the size of the challenge, the urgency of solutions and the opportunities for leading solutions, whether the size of these CoLABs is large enough to realize sufficient impact? These are more than enough reasons to account for a scenario of much larger and fast growth of these CoLABs compared to other topics. Society and industry will need much, much more people skilled in renewable energy, storage and energy

balancing technologies. They can recruit them away for the CoLABs, or the CoLABs can gains enough body to perform a part of the development activities for groups of companies themselves.

Being in the same sector it would be sensible to improve the cooperation and coordination and exchange of information, way of working, lessons learned between these CoLABs. In particular on the human resource/-personnel aspect mentioned above is important to deal with. In due time Colab employees will follow a career at the partner companies (and hopefully not at competitors) or for some it will be an academic career. In a certain sense this is another task, a sixth level to play, of any RTO and therefore also CoLAB: to train young people straight from university in industrial research before entering industry itself. In large organization and in countries one sees years, decade later that people who once worked together at RTO labs obtain key R&D management position in companies but still have a network in which they know each other, the role of RTO's and universities and are therefore in the position to ensure that each player gets the most suitable tasks to perform. Implicitly this leads to a recruitment requirement for the CoLABs today: select the best candidate (you don't steal them await from industry, as you will further educate them and then let them go industry), but also select them on their expertise and communication and organization capabilities. Five years from now they will stream to industry and another five years later they reach management position in which they know exactly when and for which job they should put an assignment at the Colab. Instead of moving to companies, experienced CoLAB employee can also move into start-ups. A Colab with a successful new solution or repeat services for the market should let experienced employees create a start-up company. Managing a Colab to shape people and create a profitable repeat business and moving it into a successful start-up/new company is a sixth level you must learn to deal with. Success with it.

Health

There is a critical need for introducing innovation in the health system, whether in the introduction of new technologies or in the organization of healthcare. To answer some of these needs, many of them related with the promotion of value-based healthcare, integration of data science and artificial intelligence approach in medical care processes, drug discovery and integration and collaboration of the multiple actors in the sector's value-chain, the 'Health' thematic area integrates 7 CoLABs located in the North, Centre, Lisbon and Alentejo regions, as illustrated in Figure 13: VOH.CoLAB, VectorB2B, 4LifeLAB, Aquavalor, AccelBio (former BioScale), CoLAB4Ageing (former Healthy Ageing@CoLAB) and CoLAB TRIALS.

Figure 13. Location of 'Health' CoLABs

These CoLABs are responsible for **5% of the employment created** by CoLABs until September 2021. It should be noted that 4LifeLAB, Aquavalor, AccelBio (BioScale), CoLAB4Ageing (Healthy Ageing) and CoLAB TRIALS are very recent as they have been approved in March 2021.

The CoLABs integrated in the thematic area 'Health' include **66 entities** as associates, from which **55% are enterprises** (43% SMEs and 12% large enterprises, Table 9), **23% are R&D institutions, 12% are associations and 10% are other entities such as municipalities or hospitals.**

Table 9. Enterprises CoLABs Shareholders 'Health'

	CoLAB
Águas Campilho Vidago SA	AquaValor

Águas de Carvalhelhos SA	AquaValor
Atlantis – Tecnologias em Saúde Unipessoal Lda	4LifeLAB
Balneario Rio Pambre S.L.	AquaValor
BeVAG - MANAGEMENT SOLUTIONS, LDA	VectorB2B
BSIM Therapeutics	BioScale
CellmAbs	BioScale
Centro de Medicina Laboratorial Germano de Sousa	TRIALS
Dispel	AquaValor
Efacec - Energia, Máquinas e Equipamentos Elétricos, S.A	4Life LAB
Gestão de Equipamentos de Município de Chaves EM SA- Termas de Chaves	AquaValor
Glintt - Healthcare Solutions, S.A.	Healthy Ageing
Grupo Hotéis Premium SGPS SA	AquaValor
Grupo Luz Saúde	TRIALS
ICNAS-Produção	Healthy Ageing
Infosaude - Instituto de Inovação e Formação em Saúde, S.A.	Healthy Ageing
José de Mello Saúde S.A.	VOH.CoLAB
LABORATORIO MEDINFAR-PRODUTOS FARMACEUTICOS S.A.	VectorB2B
LiMM Therapeutics	BioScale
Linde Saúde, Lda	Healthy Ageing
Magnify Afterburner Capital Partners –Sociedade de Capital de Risco	BioScale
NOS Comunicações, S.A	Healthy Ageing
Outsaucing, Lda	Healthy Ageing
Pena Aventura Organização de Atividades Desportivas Lda	AquaValor
Roche Farmacêutica Quimica	BioScale
SafetyDiversity	BioScale
SYSADVANCE, Sistemas de Engenharia S.A.	4LifeLAB
TargTex	BioScale
Technophage, Investigação e Desenvolvimento Em Biotecnologia S.A	VectorB2B
Tecnimede	Healthy Ageing
Termalistur – Termas de São Pedro do Sul EM SA	AquaValor
TMG - Tecidos plastificados e outros revestimentos para a indústria automóvel, s.a.	4LifeLAB
Uniksystem Sistemas de Informação Lda	AquaValor
VerticalSentinel	BioScale
VMPS – Águas e Turismo SA	AquaValor
Vodafone Portugal	VOH.CoLAB
WiseHs - Wise Healthcare Solutions, Lda	4LifeLAB

VOH.CoLAB and VectorB2B integrated a total of 8 proposals to competitive programs in 2020, with a total requested investment of 7.6 million€. In 2020, 5 competitive projects were approved representing a total approved investment of 1.08 million€. 23% of the total approved investment is dedicated to CoLABs activities within these projects.

Value for Health focuses on technology innovation to objectively monitor health outcomes and support patient literacy. In practice, this CoLAB allows patients to be monitored remotely and through technology, whose clinical outcomes are analysed, and the impact of interventions and their cost-effectiveness assessed. This CoLAB is responsible for including these methodologies in clinical training and seek to innovate by developing new technologies that have a real impact on health practices. In a long-term perspective, this laboratory will level the implementation of innovative Value Based Healthcare models in Portugal, presenting itself as an international reference in this field.

Areas of Expertise: Value-Based Healthcare.

Examples of ongoing activities:

- **CARDIOFOLLOW.AI:** Development of intelligent and adaptable tools for the patient monitoring process, through the development of modules based on Artificial Intelligence (AI) dedicated to longitudinal risk prediction and timely detection of complications.

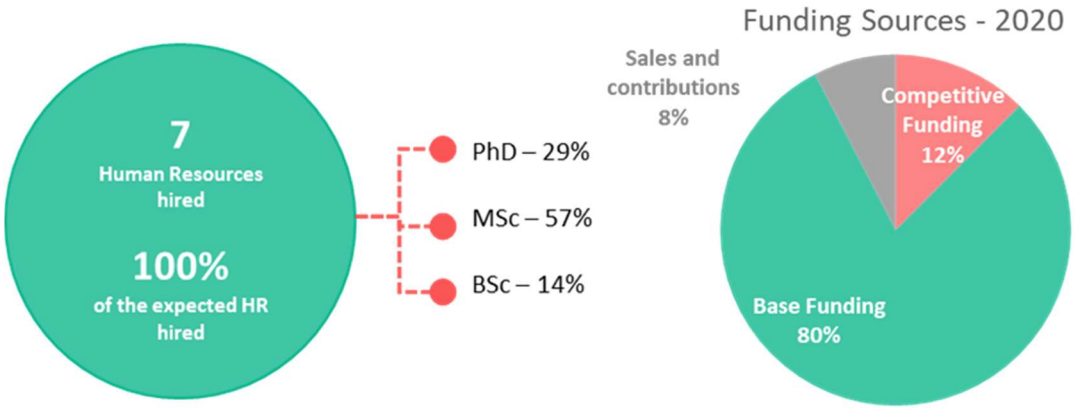
- EasyHealth4Covid - Digital solution for citizens at high risk of Covid-19 infection. Development of a Telehealth solution to monitor the population at risk the population at risk for COVID-19 infection, promote their safety, and facilitate communication with clinical teams.

- **Validation of products** such as medical devices, providing value analysis through pilot testing in real-world settings.

Associates:

- Associação Fraunhofer Portugal Research
- José de Mello Saúde S.A.
- Universidade Nova de Lisboa
- Vodafone Portugal

Main Figures:



VectorB2B - Drug Developing mission is to provide highly qualified drug discovery and development services from the research bench to the patient and the client. This Lab will be a one-stop shop for other companies and academic institutions involved in the discovery and development of biological medicines, providing highly qualified bench-to-patient (B2B) services. VectorB2B aims to bring together: (i) highly qualified human resources in Portugal with knowledge and experience in the discovery and development of biological drugs, (ii) instrumental power in pharmacodynamic and pharmacokinetic analysis and testing, and (iii) cross-cutting services such as systematic reviews, project planning and statistical decision evaluation. It will provide specialised services such as antibody screening, in vitro and in vivo efficacy assays in areas such as ophthalmology, oncology, CNS; GMP process development and production services (good manufacturing practices).

Areas of expertise: Discovery and development of biological medicines.

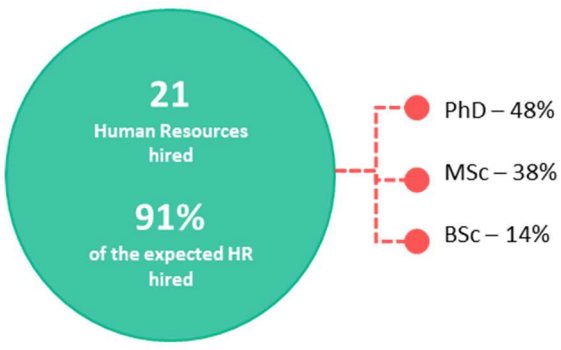
Examples of ongoing activities:

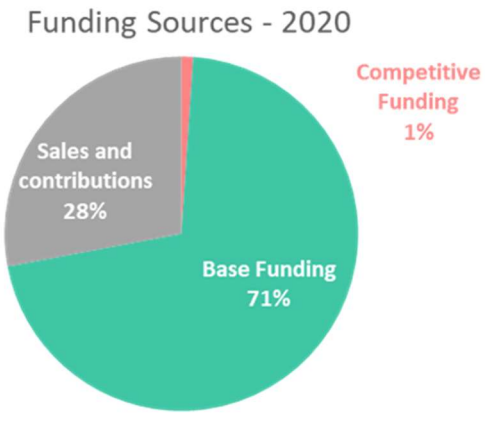
- **Bacteriophage-based products**: One-Stop Shop for Bacteriophage-based products including therapeutics, cosmetics and food supplements, provides fully integrated services in discovery and development from bench to bedside (B2B).
- Antibody screening, in vitro and in vivo efficacy assays in areas such as ophthalmology, oncology, process development and GMP (good manufacturing practice).

Associates:

- BeVAG - MANAGEMENT SOLUTIONS, LDA
- Faculdade de Farmácia da Universidade de Lisboa
- Faculdade de Medicina da Universidade de Lisboa
- Faculdade de Medicina Veterinária da Universidade de Lisboa
- Laboratório MEDINFAR-PRODUTOS FARMACEUTICOS S.A.
- Technophage, Investigação e Desenvolvimento Em Biotecnologia S.A
- Universidade de Coimbra

Main Figures:





4LifeLab aims to create an ecosystem to design, develop, produce and deploy advanced medical devices and related services, meeting global market standards and enabling innovative practices based on excellence in science, medicine, engineering and industry. 4LifeLab's activities include developing:

1. New approaches to diagnosis and treatment and/or health rehabilitation of patients, and in pandemic/disaster situations, including remote medicine, applied to new products and services.
2. New personal protection equipment, with functionality and comfort.
3. New medical devices, with innovative features and shorter development times, based on robust and reliable engineering methods and components.
4. Integration of new generation sensing, connectivity and communication technologies, enabling the improvement of telemedicine practices, as well as teamwork, in face-to-face or remote contexts.
5. Integration of data science and technologies, ensuring ethical and safe solutions.
6. New advanced systems and infrastructure for decentralized and remote healthcare and emergency response.
7. Construction and operation of a Medical Emergency Mobility Hub, allowing for the association of the research and development component with care practice, in the context of urgent healthcare transport, in its various dimensions.

Areas of expertise: Health; Mobility in Medical Emergency; Medical devices; Engineering; ICT and electronics.

Associates:

- 2CA - Clinical Academic Center Braga
- Atlantis – Tecnologias em Saúde Unipessoal Lda (em representação da Fundação Oswaldo Cruz - Fiocruz)
- CEiiA - Centro de Engenharia e Desenvolvimento
- CHUSJ - Centro Hospitalar Universitário de São João E.P.E.
- Fraunhofer AICOS - Fraunhofer Portugal Research Centre for Assistive Information and Communication Solutions
- ICVS - Instituto de Ciências da Vida e da Saúde da Universidade do Minho
- TMG – Tecidos Plastificados e outros Revestimentos para a Indústria Automóvel, S.A.
- WiseHS - Wise Healthcare Solutions, Lda

Approved in March, 2021.

AquaValor presents itself as a thematic but multifunctional interface infrastructure, which aims to support companies, involving them in its activity, responding to existing needs that are not being met by companies operating in the market and that it also aims to create new channels for the transfer and dissemination of knowledge to the economic fabric.

AquaValor operates essentially around the theme of water, in its various aspects, as a distinctive/identity value, aggregator and enhancer of economic growth in the Alto Tâmega sub-region, through the development of: i) Information and Communication Technologies (ICT) at the Service of Thermal Waters and Wellness Tourism; ii) Specialized Services dedicated to the Generation of Added Value; iii) Qualification of Highly Qualified Human Resources, namely Masters and Doctorates, as well as Higher Professional Technical Courses and training courses for tourism, hotel and restaurant operators.

Areas of expertise: Valorisation and transfer of water technology.

Examples of ongoing activities:

- Specialized services for assessing the quality of mineral waters.
- Analysis of market trends.
- Development of innovative offers in the area of health and well-being that boost the thermal concept.
- Specialized training.

Associates:

- Agrupamento Europeu de Cooperação Territorial Eurocidade Chaves-Verín, AECT
- Água Campilho Vidago SA
- Águas de Carvalhelhos SA
- AHP - Associação da Hotelaria de Portugal
- Associação das Termas de Portugal
- Balneario Rio Pambre, SL
- Centro Hospitalar de Trás-os-Montes e Alto Douro EPE
- CIM AT - Comunidade Intermunicipal do Alto Tâmega
- DISPEL S.C.P.
- Gestão de Equipamentos do Municipio de Chaves EM SA
- Grupo Hotéis Premium SGPS SA
- INESC TEC - Instituto de Engenharia de sistemas e Computadores, Tecnologia e Ciência
- IPB - Instituto Poilitécnico de Bragança
- Pena Aventura - Organização de Atividades Desportivas Lda.
- TERMALISTUR - Termas de São Pedro do Sul EM SA
- Uniksystem - Sistemas de Informação Lda.
- Universidade de Vigo
- VMPS - Águas e Turismo SAeVAG - MANAGEMENT SOLUTIONS, LDA

Approved in March, 2021.

AccelBio (former BioScale) aims to promote and carry out Research and Development (R&D) initiatives and activities aimed at capitalizing on scientific results in the biomedical area. AccelBio will prioritize three therapeutic areas: Oncology, Neurosciences and Immunology, areas of great importance, with unmet medical needs, capable of generating high investments and aligned with the capabilities and interests of its members. In order to guide and support the transformation of scientific discoveries into early drug development projects, AccelBio CoLAB will work on three highly synergistic goals:

1. Establish innovative tools and platforms that promote the discovery and development of new therapeutic targets and drugs.
2. Select promising projects from academia and start-ups and develop them in accordance with pharmaceutical and biotechnology industry standards, reducing the associated risk and creating strong assets capable of attracting investment.
3. Train the next generation of enterprising biomedical scientists, who can leverage the activity of drug discovery and development in Portugal, through advanced training programs.

Areas of expertise: Health; Translation and drug discovery.

Associates:

- Biocant – Associação de Transferência de Tecnologia
- BSIM Therapeutics
- CellmAbs
- Instituto de Medicina Molecular João Lobo Antunes
- Instituto Superior Técnico
- LiMM Therapeutics
- Magnify Afterburner Capital Partners –Sociedade de Capital de Risco
- Roche Farmacêutica Química
- TargTex
- Universidade de Coimbra
- VerticalSentinel

Approved in March, 2021.

COLAB4AGEING - HEALTHY AGEING@COLAB

The aim of CoLab4Ageing is to address a complex social, demographic and economic issue about aging that requires input from multiple stakeholders. To achieve this goal, CoLAB will accelerate the transformation of the Portuguese healthcare system, creating a strategic alignment between all stakeholders, laying the foundations for a geriatric culture at the scientific, technological, business and clinical level, fostering new leadership approaches by adopting a systemic approach, increasing patient and public involvement to become co-producers of health and supporting evidence-based policy that is timely and relevant.

CoLAB will demonstrate the transformation in 4 areas with different levels of complexity and differentiation: Active and Healthy Aging, Multimorbidity, Palliative Care and End of Life and Dementias. The first two areas accommodate a large number of individuals and are of interest to partner companies in the areas of IT, food, medical devices, pharmacology, while the others represent an unexplored market need from an innovation and technological point of view.

Areas of expertise: Innovative products and services in the field of aging.

Associates:

- Universidade de Coimbra
- Instituto Pedro Nunes
- Centro Hospitalar e Universitário de Coimbra, EPE
- Cáritas Diocesana de Coimbra
- Instituto Português de Oncologia de Coimbra, EPE
- Câmara Municipal de Penela
- Infosaude - Instituto de Inovação e Formação em Saúde, S.A.
- Tecnimede
- Outsaucing, Lda
- Linde Saúde, Lda
- Glintt - Healthcare Solutions, S.A.
- NOS Comunicações, S.A
- ICNAS-Produção

Approved in March, 2021.

COLAB TRIALS

CoLAB TRIALS aims to leverage clinical research to increase innovation in the healthcare sector, in clinically strategic areas such as medical devices, biomarker identification, personalized medicine, among others.

Seeking to create a framework of excellence in clinical research, optimizing the storage and access to harmonized health information and producing real-time data, it intends to:

1. Strengthen and promote knowledge and specialization in testing methodologies, to enhance the performance of clinical research in Portugal, facilitating the clinical development of new technological health products.
2. Explore and optimize the health information stored and generated by clinical trials of the investigators' initiative, to produce real-time data, increasing the opportunities for new projects and bringing novelties to clinical research.
3. Provide innovative solutions for conducting clinical research, developing new strategies for clinical studies and Information Technology-based tools useful for clinical research teams and for the pharmaceutical industry.
4. Disseminate the relevance and results of clinical research to target entities to deepen the knowledge and literacy of the community in this area of knowledge; expand the services provided by CoLAB TRIALS to other healthcare facilities and companies.

Areas of Expertise: Safety Assessment; Clinical Research management & Regulatory Affairs; Data & Information Management; Trainings and Literacy

Associates:

- Universidade Nova de Lisboa
- Centro Hospitalar de Lisboa Ocidental, E.P.E.
- Centro de Medicina Laboratorial Germano de Sousa
- Universidade de Évora
- Associação Portuguesa da Indústria Farmacêutica
- Grupo Luz Saúde
- Associação EUPATI Portugal

Approved in March, 2021.

THE COLABS IN THE THEMATIC AREA "HEALTH": REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Julian Florez
Professor Dr.-Ing., School of Engineering, University of Navarra
General Director Vicomtech

Health and wellness encompass a wide range of fields that involve a multidisciplinary ecosystem of professionals, technologies, institutions, and companies. There is an immense body of medical and policy literature, however, the sheer complexity of the health care system is appalling. In addition to practitioners, and caregivers, biologists, bioengineers, engineers, computer science professionals, economists and many others are involved. Likewise, in addition to primary care centres and hospitals, pharmaceutical companies, research institutions, telecom companies, engineering companies, medical device manufacturers, insurance companies, and many others participate. All of them need to be orchestrated seeking the welfare of citizens.

The CoLAB program

To solve complex and large-scale problems and applications of national interest and relevance (such as the Health Area) the CoLAB initiative was created, developing in Portugal a network of centers dedicated to developing the necessary innovations. This initiative intends to complement the landscape of Research & Innovation units in Portugal bridging the Innovation and Technology Transfer Gap between the University and Industry and complementing their missions. Another main objective is to create new highly skilled jobs, but also economic and social value in the country, by promoting employment through the development of knowledge-based activities.

Since their establishment in 2017, 35 Collaborative Laboratories distributed over 8 Thematic Areas, have been approved and most of them are at different stages of the bootstrapping process. For the Thematic Area of "Health" there are 7 CoLABs starting and successfully developing their operation: VOH.CoLAB, VectorB2B, Healthy Ageing@LAB, CoLAB TRIALS, BIOESCALE, 4LifeLAB, and AquaValor. Of these, the last five CoLABs have come into operation during the year 2021.

It is still premature to draw conclusions about the evolution of the CoLABs that

have started operating this year. However, most of the comments in this document are based on the experience of CoLABs that have already started their operations (even in other areas) and that reproduce similar situations. Therefore, they can be seen as lessons learned that can help mature CoLAB's structure, operations and management in order to fulfil the mission for which they have been created and to ensure their future success and sustainability.

The Thematic Area "Health"

As mentioned above, there are already 7 CoLABs that address different topics in Health that are briefly described below,

VOH.CoLAB *(Value4Health CoLAB), Value-Based Healthcare CoLAB*

This CoLAB focuses on technology innovation to objectively monitor health outcomes and support patient literacy. In practice, this will allow patients to be monitored remotely, using technology, and the impact of the interventions and their cost-effectiveness will be evaluated. This CoLAB will be responsible for including these methodologies in clinical training and will seek to innovate by developing new technologies aiming to produce a real impact on health practices, generate spin-off companies as well as new business sectors in the health industry.

VectorB2B*, Drug Discovery & Development Services for New Therapeutics*

VectorB2B - Drug Developing - mission is to provide highly qualified drug discovery and development services from the research bench to the patient and to the client. This Lab will be a one-stop shop for other companies and academic institutions involved in the discovery and development of biological medicines, providing highly qualified bench-to-patient services.

Healthy Ageing@LAB, *Collaborative laboratory for innovative products and services in the area of ageing*

The strategic vision of this CoLAB is to enhance the cooperation between companies, hospitals, primary care, social providers and municipalities and to contribute to an integrated platform in the area of healthy ageing. The initiative is based on four pillars: (i) unique integrated healthcare and social care, (ii) education excellence, (iii) notable R&D&I and (iv) technology and innovation management.

CoLAB TRIALS, *CoLAB to Transfer Research into Advanced Leadership Society*

The vision of CoLAB TRIALS is to create a unique framework of excellence in clinical research, optimizing the storage and access to harmonized health information, and producing real time and real-world data. Its mission is to leverage the clinical research and development to increase innovation in the health sector, in strategic areas as medical devices, biomarkers identification, and personalized medicine. The ambition of this CoLAB is to strengthen the skills of the multidisciplinary team in clinical research (clinical trials).

BioScale, *Collaborative Laboratory to foster translation and drug discovery*

The main goal of this CoLAB is to capitalize on existing innovative research at academia by leveraging new biological targets and platforms with a capacity for generating new drug candidates according to industry standards and ready to be invested. BioScale prioritize three therapeutic areas – Oncology, Neurosciences and Immunology -, which are fields with very high unmet medical needs, capable of generating large investments.

4LifeLab, *Collaborative Laboratory for improved health with knowledge and technology*

The main goal of this CoLAB is to create an ecosystem to conceive, develop, manufacture, and deploy advanced and future medical devices and related services, meeting global market standards and enabling innovative practices, based on the excellence of science, medicine, engineering and industry. It will also contribute to the cross-stakeholder dialogue that is critical to ensure that valuable medical innovations continue to reach professionals and patients as value-based care models take root and evolve.

AquaValor*, Center for Technology Transfer and Valorisation of Water*

Worldwide, natural mineral waters have been used for the treatment of several diseases (e.g., respiratory, skin, and musculoskeletal) as an add-on non-pharmacological and non-aggressive complementary therapy. The aim of this CoLAB is to boost mineral waters as anchor products for regional development and to promote health and tourist activity throughout the year, particularly in low-density territories.

Lessons learned so far and some recommendations

A very precise view of how the implementation of these CoLAB is evolving

was described by Prof. J.L. Encarnação, in his lecture entitled "Evolution and Challenges for CoLABs: the ongoing Mentoring Program", that was presented during the 1st annual meeting of Collaborative Laboratories held in Porto last October 2020.

Taking this document as a reference, general comments are made below and some ideas and recommendations about CoLABs considered in the Health area are presented.

Most of the CoLABs have the legal form of a private non-for-profit Association with one General Assembly, an Executive Board, and a CEO. They have very professional people in their government bodies. The functions of these bodies are clearly defined and differentiated. During the bootstrapping period, that may take from 3 to 5 years, the CoLABs must equip themselves with the necessary skills, especially, human teams and infrastructures, adequate to fulfil the mission for which they have been created and guarantee their sustainability over time. For that they are receiving direct Basic Public Funds that can help to make this happen.

Most of these CoLABs count with very enthusiastic, motivated, committed, and competent people in their research teams. During the pandemic, teams seemed to cope well, using online communication and working methods.

However, the governing and management bodies of the CoLABs must be aware of their intrinsic nature as private institutions, and that during the bootstrapping period, the institution must evolve to a "1/3-1/3-1/3" business and funding model to be sustainable over time. In these sense, three main concerns are visualized:

(a) Most of the CoLABs use and share public common facilities, premises, and equipment that belong mostly to the public shareholders of CoLAB (Universities, National Laboratories). Although this use apparently offers many advantages to the initial deployment of CoLAB, if they are not properly managed from the beginning of the activities, they can negatively condition the adequate evolution of CoLAB as a private institution (i.e., difficulties to fix priorities in own research projects, financial and legal conflicts, ….)

(b) Linked with the above concern, the mindset of the professionals of management and research teams tends to be oriented towards the academy and the search for public funds rather than to the market and industry. They are excellent researchers but overall the impression is that, in many cases, they do not yet have

the feeling and mindset of the market and industry needs. Thus, the financing philosophy that is behind the CoLAB mission: (1/3(FCT) – 1/3(competitive funding) – 1/3(projects with industry customers) is not yet visible.

(c) Similarly, concern is related to the professional career of the teams of the CoLABs. These teams are mostly embedded inside premises of public working environments (Universities, National Laboratories). In the medium and long-term stages, this ecosystem, if it is not properly managed, can jeopardize the evolution of the professional career and the work culture of the CoLAB team as a private center.

To tackle these pitfalls, five main recommendations are proposed for consideration:

(a) Operational and Administrative Management: As for the Operational Resources it is highly recommended that the team of the CoLAB involves, from the beginning, a person in their payroll that might give Administration including R&I Project and Service Management, Financial Accounting and Legal support to the Colab.

(b) Market Orientation (projects and services with industry customers): This is the most difficult task and it is something that must be done from the beginning. The CoLAB should design a short-term strategy to go to market to identify and to approach potential clients of the CoLAB. This strategy must be aligned with the foreseen income model of the CoLAB to guarantee its sustainability. On the other hand, CoLABs must be aware that the Health area is a highly regulated area, in which different regulatory and certification bodies participate to verify the validity and safety of the products and services offered. Thus, it is highly recommended that these regulations are also considered, from start, in the R&I agendas of CoLABs since they directly affect the services and products they are going to deal with.

(c) Transfer and Innovation activities: Linked with the above, it is highly recommended that the team of the CoLAB involves from the beginning, a person in their payroll that perform as a "Commercial director" in addition to the "Scientific Director" or else to hire a “market-oriented” Manager with a substantial “Technical-Scientific” background. This will be of central importance for the future success of the COLAB. To this extent, his or her market vision and scientific expertise must be brought into line with the strategic and substantive ideas of the initiators.

(d) Personnel and Professional Career: In addition, CoLAB personnel should be successively recruited and developed in accordance with the projects/work content acquired and follow a career path. The ambition should be to create a successful team of people who, shoulder-to-shoulder, support each other as they grow and go for the same goal.

(e) Infrastructure. Besides sharing stakeholder and infrastructure facilities, CoLAB should have the ambition to have its own premises, facilities, and infrastructure to prioritize its own research technology strategy, projects and services.

Expected evolution in Europe and some final recommendations

European healthcare systems, and Portugal is no exception, are facing unprecedented challenges. Ageing of the population and better treatments have led to a higher prevalence of chronic diseases that require a different approach and that are increasing the expense in public healthcare to unprecedented and difficult to sustain levels. Hospitals are the major centers for treating acute diseases and for diagnosis or treatments requiring advanced technologies. However, chronic disease management has transitioned from hospital to primary care.

The Covid-19 crisis has made evident that this transition should accelerate and there is a need of improving the access to a congested healthcare system with several inefficiencies. Many of the technologies that could support a better healthcare delivery and disease management, with approaches such as telecare or mobile health already existed. However, they were not widely adopted and prepared when most needed, as many barriers must be faced, including large investments in modernization of IT systems, privacy and security concerns, reluctancy of clinicians and citizens to use remote consulting or monitoring, etc.

It is worth mentioning the need for better communication in the health and care fields, which has contributed to wreaking havoc on residences, where clinical resources are scarce and inadequate. Overall, for the older population, there is a need to focus more on aspects related to frailty and dependency and not only on individual diseases. To make things worse, there is a shortage of clinical professionals, especially in settings such as primary care where they are most needed.

The focus should move to prevention, which requires yet another transition based on aspects related to health literacy

and awareness and self-management of health.

Beyond prevention, approaches dealing with mobile health technology for disease management are growing, and have been recognized as a therapy itself, that may be adjuvant, linked to a pharmacological treatment, or effective by itself. This paves the way to Digital Therapeutics, an evolution of the health apps transformed into digital treatments, that should be validated in terms of efficacy and safety as any other treatment or medical device. There is also a pushing regulatory environment, aligned with the new EU Medical device regulation, for clinically validating apps or decision support systems that are used in clinical practice.

Decision support system are not only used in chronic disease scenarios, but also expand other areas and complex diseases such as cancer. Disease models and advanced information must be built for various diseases in order to have a holistic view of patients that allows the development of a system that allows shared clinical decision-making and the exploitation of real-world data, through a coherent representation of the decisions and the results of the cases.

However, the major obstacle to the development of these systems has to do with information silos and lack of interoperability. Many subsystems, such as the EHR, the PACS imaging subsystems, the laboratory LIMS system, etc., must be interconnected. Unfortunately, this is far from reality, due to a lack of interoperability of subsystems and disparity of vendors promoting their own communication interfaces. The urgent need of EHR exchange mechanisms at the European level is evident, and efforts for its promotion have been started

Resilience of the healthcare systems has been especially tested in this crisis, putting upfront more than ever the need of developing mechanisms to deal with threats to public health that sometimes have global outreach. It is necessary to establish mechanisms to anticipate and prevent additional crisis, but also to alleviate the impact and accelerate the recovery. As we have seen, public health decisions during a crisis not only affects the healthcare domain, but also may have important socio-economic implications, revealing the need of shared public policy decision-making which also considers the needs and voices of the private sector.

The development of vaccines has been a heroic achievement of science and technology. Vaccines have been developed in a record time, leading to some

reluctancy in part of the population, and has put upfront the need of accelerating research and discovery in the biomedical world, with less rigid approaches to clinical trials and the support of novel technologies such as data science, AI and in silico models.

Another technological revolution is coming with precision medicine. We are now discovering that many diseases that we treated as a single one were in fact a range of disease phenotypes requiring different treatment approaches. The most evident example is cancer, but it also applies to other complex diseases. The development of precision medicine is enabled by techniques such as massive sequencing and the development of molecular biomarkers, but it also needs from other diagnostic technologies such as medical imaging or digital pathology, linked to the development of personalized treatments.

Medical research, and research in Health area, unlike scientific-technological research, can only be approached from a global international perspective. Technological scientific innovation can be more differentiated between countries as it is more linked to the economy and industry of each country, but research in Health affects people and these needs are similar all over the world. Innovations in healthcare may also require large investments for international companies with global outreach. The pandemic has been a clear example of this, with an international effort to handle the crisis and develop last-generation vaccines. Thus, the R&I activities must consider this clearly and the approach to innovations must be different.

The strategic vision of most of the 7 CoLABs involved in the Health area are well based on these national and international priorities and are pointing to the most promising issues in the field as above presented, however, in most cases the proposed R&I agenda and the proposed action plan are very broad. The R&I agenda needs to be more focused, the R&I activities must consider this clearly. The strategic vision must answer to where the CoLAB intends to be a singular agent (niche) in this broad landscape. To be competitive with innovative products and services a critical mass of staff and knowledge is needed in the expertise offered.

There are a large number of research centers in Europe and around the world that deal with R&I activities in Health that address the challenges posed by the health and well-being of citizens. In practice this implies that the R&I agenda of CoLABs

should focus and concentrate on specific (niche) topics on which to generate impact. It also opens the opportunity to interact with the best institutes/programs on the same topic that are world leaders and permits to exchange with them good practices, avoiding reproduction of the same work, closely monitoring and building alliances with them.

The current 7 CoLABs in Health area are still in a stage of bootstrapping and beginning activities, and they need time to mature. However, the advantages of having these types of centres to accelerate health innovation are evident. Their success, as well as the national and international alliances that can be developed in this complex panorama of the health area, will largely condition future innovations that will improve the health and well-being of citizens in Portugal and Europe.

Materials, Circular Economy and Urban Sustainability

The thematic area Materials, Circular Economy and Urban Sustainability integrate 5 CoLABs, answering specific sectorial challenges connected with decarbonization, circular economy and resources sustainability – AlmaScience, Built CoLAB, C5LAB, CECOLAB and CEiiA-S2uL can be seen in Figure 14. In the field of materials, the development of sustainable cementitious materials and the use of cellulose for intelligent and sustainable applications are highlighted. The incorporation of new techniques in construction sector, supported by data science and digitalisation, is also a target challenge within this area. In the field of sustainability, circular economy, resources efficiency and the development of smart and sustainable urban ecosystems are the main themes approached by these CoLABs.

Figure 14. Location of 'Materials, Circular Economy and Urban Sustainability' CoLABs

Distributed among North, Centre, Lisbon and Alentejo regions, this group of CoLABs are responsible for **24% of the employment created** by CoLABs until September 2021, and the involvement of **46 entities** as associates, from which **30% are SMEs** and **26% are large enterprises** (Table 10), **24% are R&D institutions, 12% are associations and 8% are other Public Administration entities.**

Table 10. Enterprises CoLABs Shareholders 'Materials, Circular Economy and Urban Sustainability'

	CoLAB
3 Drivers - Engenharia, Inovação e Ambiente, Lda	BUILT
A400 - Projetistas e Consultores de Engenharia, Lda.	BUILT
Alberto Couto Alves, SGPS S.A.	BUILT
André Brito Caiado - Arquitectura, Lda	BUILT
AQUITEX , SA	CECOLAB
BIMMS, Lda	BUILT
BLC3 Evolution Lda.	CECOLAB
Casais Engenharia e Construção, S.A.	BUILT
CIMPOR Portugal, SGPS, S.A	C5LAB
Clara Saúde	AlmaScience
EEA - EMPRESA DE ENGENHARIA AERONÁUTICA E AUTOMÓVEL, S.A.	CEiiA-S2uL
EFACEC ELECTRIC MOBILITY, S.A.	CEiiA-S2uL
INAPAL Metal, S.A	CEiiA-S2uL
MIND BRASIL - INDÚSTRIAS DA MOBILIDADE, LTDA.	CEiiA-S2uL
Mota-Engil Engenharia e construção S.A.	CECOLAB
Mota-Engil, SGPS, S.A.	BUILT
NORS S.A.	CEiiA-S2uL
OUZO- Engenharia Unipessoal, Lda	BUILT
PETRÓLEOS DE PORTUGAL - PETROGAL S.A.	CEiiA-S2uL
SECIL - Companhia Geral de Cal e Cimento, S.A.	BUILT CoLAB C5LAB
SIMOLDES - PLÁSTICOS, S.A.	CEiiA-S2uL
SONAFI - SOCIEDADE NACIONAL DE FUNDIÇÃO INJECTADA, S.A.	CEiiA-S2uL
Teixeira Duarte - Engenharia e Construções S.A	BUILT
The Navigator Company S.A.	AlmaScience
TMG - Tecidos Para Vestuário e Decoração, S. A	CECOLAB
TMG - Tecidos plastificados e outros revestimentos para a indústria automóvel, S.A.	CEiiA-S2uL

In consortium with its associates and partners, the 'Materials, Circular Economy and Urban Sustainability' CoLABs participated in 39 proposals to competitive programs in 2020 with a total requested investment of 223 million€. In 2020, 22 applications were approved representing a total approved investment of 120 million€. The approved investment for CoLABs activities in the referred period was 15 million€.

AlmaScience is an applied research organization focused on innovation on sustainable hybrid systems based on cellulose and other natural materials. One of the core activities of AlmaScience is on leveraging the IoTization of products and processes through the collaboration with start-ups, SMEs, Mid-Caps and large companies in the development and deployment of devices and systems enabled by nanotechnology, advanced functional materials and/or printed electronics techniques. AlmaScience aims to deliver ecologically, game-changing and universally accessible solutions in areas like security, environment, health, brand protection, electronics, logistics, food or marketing. Additionally, AlmaScience intends to foster the regional economy through the creation of highly qualified jobs, the promotion of scientific literacy, and the dissemination of the outcomes to the community in general. Its R&D program is structured around 3 vertical, business/market – oriented thematic areas (point-of—need, smart packaging, security) and a set of transversal areas (building blocks): paper technology, materials and processes, modelling, systems design, and integration.

Areas of Expertise: Cellulose for smart and sustainable applications

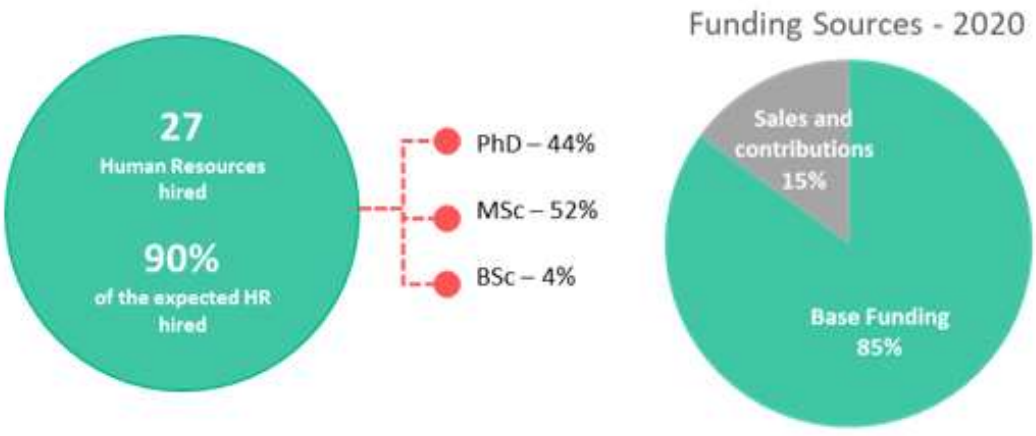
Examples of ongoing activities:

- Identification Smart Paper, to establish an integrated and innovative self-sustained green electronic system paper-based for wireless communication applications that addresses the ubiquitous security and low-cost green electronic sectors.

Associates:

- Clara Saúde
- Câmara Municipal de Almada
- Associação Fraunhofer Portugal Research
- Imprensa Nacional Casa da Moeda
- The Navigator Company S.A.
- NOVA.ID.FCT - Associação para inovação e desenvolvimento da FCT
- Instituto de Investigação da Floresta e Papel
- Universidade Nova de Lisboa

Main Figures:



BUILT CoLAB aims to develop research, innovation and knowledge transfer activities, with a view to increasing productivity, competitiveness and sustainable growth of the ecosystem of the AEC sector - Architecture, Engineering and Construction, promoting the digital and environmental transformation of buildings and infrastructures, making them adaptable, intelligent, resilient and sustainable.

The scope of BUILT CoLAB is the built environment as a whole, considering the distinctive types of buildings and infrastructures, including transportation, energy and water cycle infrastructures. Its R&D agenda covers the life cycle of the built environment, including architecture, design and data driven manufacturing, promoting the digitalization of the whole ecosystem, based on BIM methodology and technologies that promote the use of the digital twin, in factory or site environment, in the management and maintenance of infrastructures and buildings, and finally deconstruction and recycling.

Areas of Expertise: Architecture; Engineering; Construction.

Examples of ongoing activities:

- AUTOMATION, Optimization System and Digital Twin Architecture that allows real-time monitoring and control of construction activities (using any portable device), while constantly providing the user with several corresponding alternatives the optimal distribution of resources throughout all phases of a construction project.

Associates:

- 3 Drivers, Lda
- A400 - Projetistas e Consultores de Engenharia, Lda.
- André Brito Caiado - Arquitectura, Lda
- Alberto Couto Alves, SGPS S.A.
- BIMMS, Lda
- Casais Engenharia e Construção, S.A.
- INESCTEC
- Instituto Politécnico de Leiria
- Instituto Superior de Engenharia de Lisboa
- Instituto Superior Técnico
- ITECONS
- LNEC, I.P.
- Mota-Engil, SGPS, S.A.
- OUZO- Engenharia Unipessoal, Lda
- Associação da Plataforma Ferroviária Portuguesa
- Plataforma Tecnológica Portuguesa da Construção - Associação
- SECIL - Companhia Geral de Cal e Cimento, S.A.
- Teixeira Duarte - Engenharia e Construções S.A
- Universidade do Minho
- Universidade do Porto

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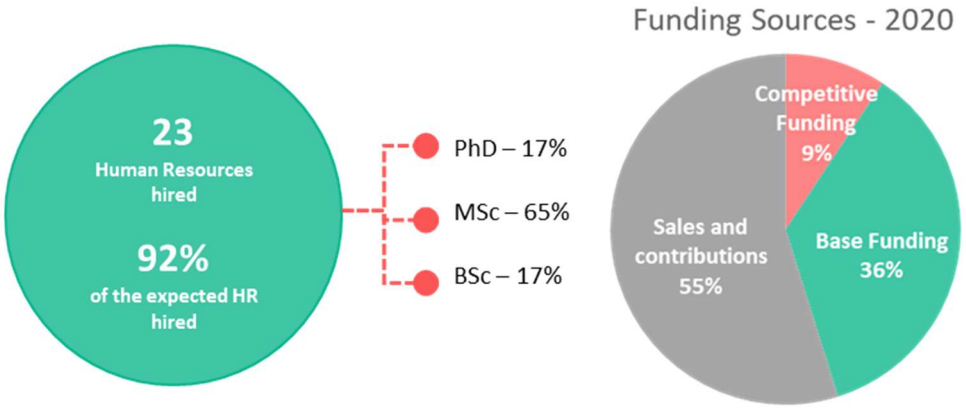

C5Lab intends to develop research and development activities to reduce carbon dioxide emissions from the cement industry, in order to contribute to the carbon neutrality of the national economy. Based on a holistic approach, its main objective is to develop innovative technologies for the sustainable production of cement, mortar and concrete focused on reducing carbon footprint. The carbon footprint reduction will be achieved throughout the complete industry value chain, from the cement plant quarry to the end of life of the concrete structures and their recycling. In this regard, various links in this industry's production chain will be investigated, such as raw materials and alternative fuels, CO2 capture and use (CCUS), conversion of CO2 into synthetic fuels and chemicals, renewable energy and energy efficiency, eco-efficient concrete, new cementitious materials, among

others.

Areas of expertise: Sustainable Cementitious Materials; CO2 capture and valorisation; Energy Efficiency and Energy Transition.

Examples of ongoing activities:

- Identification and comparison of potential solid sorbents CaO-based;
- Separate finish grinding of cement constituents
- Reducing clinker content in cement using calcined clay-limestone technology

Associates:

- Associação Técnica da Industria de Cimento
- CIMPOR Portugal, SGPS, S.A
- Instituto Superior Técnico
- Laboratório Nacional de Engenharia Civil, I.P.
- SECIL - Companhia Geral de Cal e Cimento, S.A

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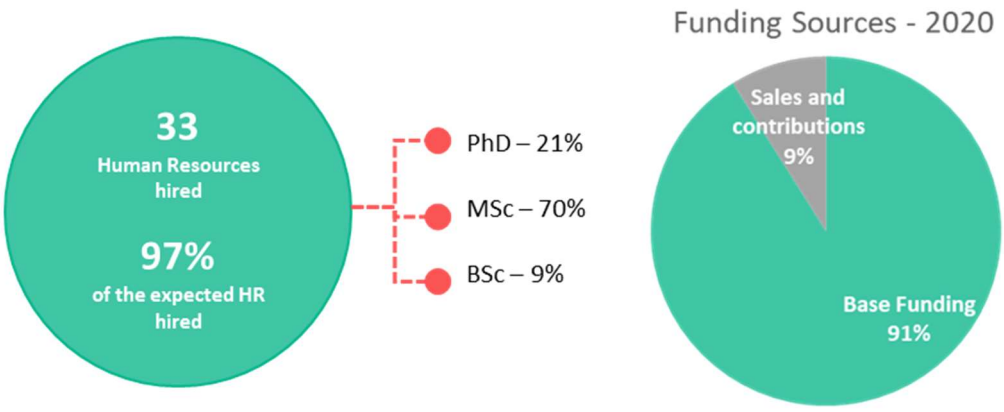

CECOLAB's mission is to support the transition from a linear economy model to (i) an economy responsible for resources and people, (ii) more efficient in its life cycle, (iii) developing and transferring knowledge and technology to the market, (iv) with the creation of scientific jobs and (v) assuming the leadership and positioning of Portugal in the Circular Economy. CECOLAB develops its activities in three technological platforms - industrial biotechnology, sustainable separation processes and green chemistry and ecodesign - with impact on the value chains of forestry, agribusiness, urban waste, water, industrial manufacturing, construction and services.

Areas of expertise: Circular Economy; Industrial Biotechnology; Ecodesign.

Examples of ongoing activities:

- StartUp Zero is an innovation and entrepreneurship project focused on the transition to a circular economy that combines the acceleration of circular business models by design to create market value, with consumer empowerment starting with young people from the 3rd cycle on.

- BeirInov proposes to ensure the sustainability of the value chain of sausage products, including smoked and cooked products, from the Serra da Estrela Region. This combines two aspects of sustainability, in the product (elimination of chemical preservatives) and in the packaging (100% recyclable film).

Associates:

- AQUITEX , SA
- BLC3 Evolution Lda.
- Instituto de Soldadura e Qualidade
- Serviço intermunicipalizado de gestão de resíduos do Grande Porto
- Laboratório Nacional de Energia e Geologia, I.P.
- Mota-Engil Engenharia e construção S.A.
- Raiz - Instituto de Investigação da Floresta e Papel
- TMG - Tecidos Para Vestuário e Decoração, S. A
- Universidade de Aveiro
- Universidade de Coimbra
- Universidade Católica Portuguesa
- Universidade do Minho
- Universidade Nova de Lisboa
- Universidade do Porto

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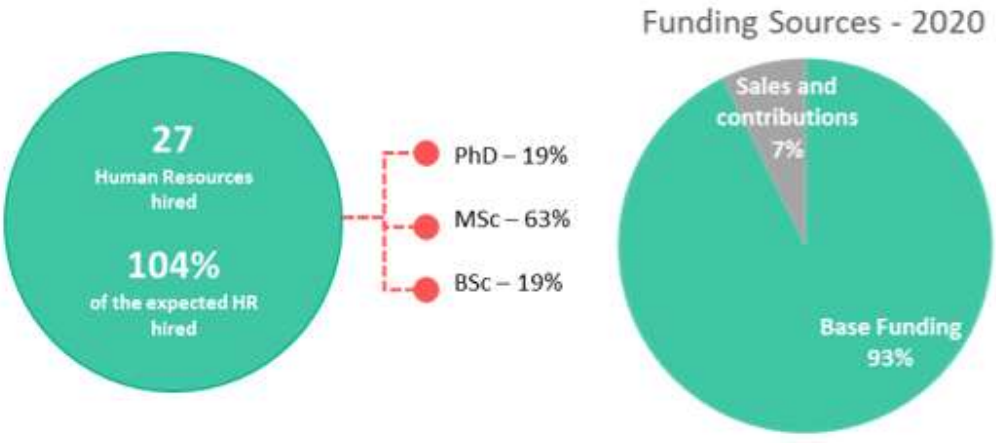

The collaborative laboratory for urban sustainability s2ul is a unit of CEiiA that aims to accelerate the transformation of cities into smart and sustainable urban ecosystems, contributing to promote the quality of life of citizens. The pursuit of this vision is achieved by:

i) developing knowledge to understand and address complex societal urban challenges.
ii) exploring opportunities derived from the integration of the physical, digital and social worlds, leveraged by increasing connectivity and disruptive technologies.
iii) generating, testing and bringing to market advanced solutions based on sustainability principles and user-centred design.

Seeking a mixed technology-push and market-pull approach, S2UL aims not only to develop knowledge and new technological solutions, but also to implement them in the urban fabric, in collaboration with its business partners. In this context, the R&D activities developed by the laboratory, of a prospective nature, focus on the integration of data science and physical engineering programs, to create innovative products and product systems, increasingly used as services - the so-called '4th Industrial Revolution'.

Areas of expertise: Data science; Physical engineering; Smart and sustainable urban ecosystems.
Examples of ongoing activities:
- AYR, a blockchain-based sustainability platform rewards carbon neutral mobility behaviour towards a new way of living in cities.
- Development of smart and sustainable mobility concepts.
- Development of digitalization of cities and human-technology interfaces

Associates:

- CENTITVC - Centro de nanotecnologias e materiais técnicos, funcionais e inteligentes
- EEA - Empresa de engenharia aeronáutica e automóvel, S.A.
- EFACEC ELECTRIC MOBILITY, S.A.
- IAPMEI - Agência para a competitividade e inovação, I.P.
- INAPAL Metal, S.A
- MIND BRASIL - Indústrias da mobilidade, LTDA.
- NORS S.A.
- PETRÓLEOS DE PORTUGAL - PETROGAL S.A.
- SIMOLDES - PLÁSTICOS, S.A.
- SONAFI - Sociedade nacional de fundição injectada, S.A.
- TMG - Tecidos plastificados e outros revestimentos para a indústria automóvel, S.A.
- Universidade do Minho

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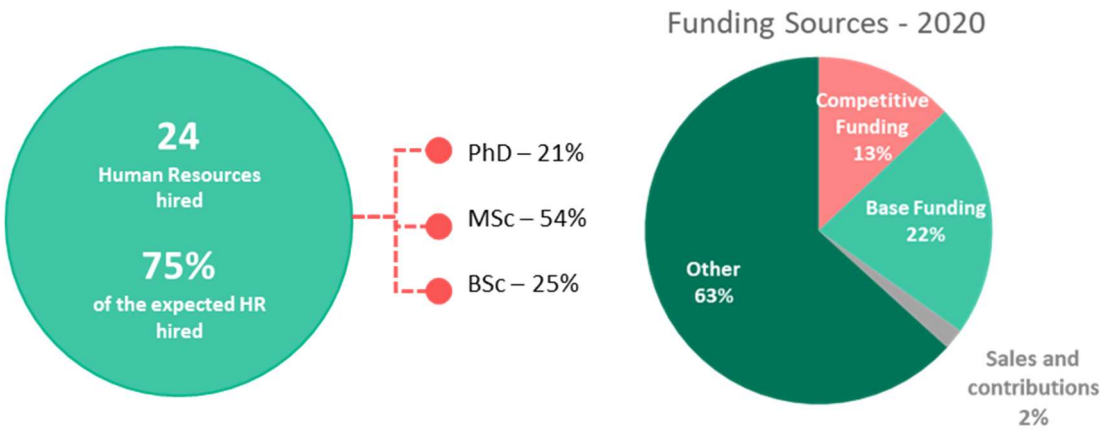


THE COLABS IN THE THEMATIC AREA "MATERIALS, CIRCULAR ECONOMY AND URBAN SUSTAINABILITY": REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by Max Mühlhäuser
Professor Dr.rer.nat., Technische Universität Darmstadt Telecooperation Lab
Computer Science Department, Germany

This Personal View Paper will briefly touch on all seven topics requested in the instructions the author received. However, a key focus will be put on nine recommendations listed in chapter 6. This means that chapter 6 is the "staging area" for the personal views requested; consequently, various re-marks that could be made in one of the other chapters will be found in chapter 6.

1. Remarks on CoLABs Visited

It must be noted that this Mentor visited only one CoLAB from the thematic area Materials, Circular Economy and Urban Sustainability (hereafter, coined as "Area Sustainability" for short): namely S2UL at CEiiA. However, the author has reviewed various documents and information sources about all five CoLABs in the thematic area Sustainability. Moreover, many findings can be carried over from CoLABs visited in the thematic area Digital and Communication Systems.

Generally speaking, all investigated CoLABs can be described as truly exciting: they are all highly innovative, driven by enthusiastic and dedicated personnel, which is keen to bring novel ideas to market fast and to grow their CoLAB beyond expectations.

2. CoLABs Initiative: General Assessment

The Portuguese CoLABs Initiative is already a huge success today. It is meanwhile obvious that the key approach of the initiative, namely to strengthen the innovation funnel in the notoriously fable phases TRL-3 to TRL-7, has the potential to boost the Portuguese industry and the nation's innovative power and competitiveness. Note that this middle TRL field where CoLABs (shall) operate will be coined as tech(nology)-transfer below for brevity (knowing that this term is not perfect).

This being said, the CoLABs experienced a very difficult time lately. The Corona pan-demic spoiled all time plans and erected

many hurdles, not to the least at the "receiving end" of the CoLABs' outcomes, with huge impact on the CoLAB's investments as well as employments. Recommendation "R.9: Mitigate Corona Consequences" (see chapter 6) will address this issue).

3. Success Stories and Failures

One of the model success stories witnessed by the author was the contribution of two CoLABs in the ultra-agile development of the Atena ventilator, against the background of an exploding number of seriously affected Covid-19 patients. Both the S2UL CoLAB from the thematic Area Sustainability and DTx (from the area "Digital … Systems") collaborated. (Note that both were not earmarked for health-related equipment before!) This agility aspect will be resumed as part of recommendation R.5 and R.7 in chapter 6. While no failures were encountered per se, some lessons learned and pitfalls actually became apparent during the mentoring process as follows.

4. Lessons Learned and Pitfalls

At the current stage, pretty much all CoLABs that this author inspected (i.e., investigated online or visited) can still be more or less compared to baby animals in the wild: they are surrounded by life threatening dangers. Among these dangers are some that are long known in the tech-transfer field, like problems in the innovation funnel inbound and outbound (see R.3 and R.4), problems to assess and connect to international competition and opportunities (see R.2), the decisive role of innovation pace (see R.7), and difficulties in building tangible assets (see R.6). During his visits to CoLABs and along the timeline of the Corona pandemic, the author realized further threats to the CoLABs that the initiative (and thereby, the FCT ministry and ANI) should help to mitigate. These additional threats include employment issues, economy innovation slow-down (more than its reduced growth per se), and the criticality of focus (which turns out to exhibit "two sides of the medal"). We will re-turn to these issues in chapter 6, partly intertwined with the recommendations mentioned above, partly in explicit ones.

5. Expected Evolution, Priorities for Area

The author, being an IT related person and hence, neither a materials expert nor a sustainability expert, does not feel qualified to recommend topical priorities for the area. Rather, he suggests to put great emphasis on the processes for

identifying and continuously monitoring the most promising topical areas and for reaching and/or staying at the competitive edge within these topics – recommendations R.2, R.5, and R.7 will return to this issue.

6. Recommendations

The author dares to express advice below only because he was explicitly asked for his personal view. This concerns in particular the sections marked with "FCT/ANI" where the author is convinced that the funding organization of the CoLAB initiative should consider additional help and auxiliary structures and regulations, sometimes also relaxation of regulations, to support the mitigation of threats to the CoLABs.

The author is well aware that the recommendations listed below are in part al-ready recognized and addressed by several CoLABs and by FCT/ANI. Nevertheless, the issues addressed became evident time and again, which means that even in cases where they are already recognized, making additional efforts is probably worthwhile.

R.1 Cultivate Organizational (In)Dependence

A major struggle perceived across many CoLABs concerns the dependence-independence pendulum w.r.t. organizational matters. In order to attract further business partners, CoLABs need true independence that can be credibly perceived by such potential customers. On the other hand, CoLABs embark into a fiercely competitive innovation landscape with limited funding that they want to invest in their core competencies. Therefore, CoLABs that receive ample support from a "mother organization" can grow without the (very heavy) burden of having to establish their own full operational infrastructure (HR, accounting, facility mgmt. etc.). CoLABs with more equal engagement of industrial partners will find themselves in a much less comfortable situation (because the partners will want to see their money go into development, not organization) – which is a major threat on the other "swing" of the pendulum.

FCI/ANI may investigate ways to help the CoLABs in explicitly fostering support from "mother organizations", both in cases with one dominant such organization and in cases with more equal industry shares. For the first category, contracts must reflect in-dependence but also the legitimate interest of the "mother organization" to benefit; for the second category, contracts should be established such that fair

contribution of all industry partners in the organizational burdens become transparent and compulsory (in-kind contribution should be fairly calculated and closely monitored).

R.2 Emphasize International Coopetition

Many CoLABs operate in highly competitive domains where innovation happens at in-credible pace globally. This is definitely true for the areas to which this author got involved (thematic "Area Sustainability" and thematic Area Digital and Communication Systems).

One issue that the author has often perceived as critical concerns a certain "distance" that CoLABs may have from this global technology race. To take one arbitrary example: Computer Vision is often re-quired as (maybe small, but often essential) part of the solutions investigated by CoLABs. In order to fill this need, CoLABs rightfully employ R&D personnel qualified in that field, who develop their share of the CoLAB's "products". Within just a year or two, such qualified personnel may miss major developments, catapulting the CoLAB out of (global) business. On one hand, CoLABs should not try to mitigate this threat solely by means of cooperation with local academic institutions. On the other hand, cooperation with "big shots" like the world's top universities may be based on cooperation agreements with a questionable cost-benefit ratio. In the opinion of the author, each CoLAB should devise a specific (credible) strategy for reaching, and staying at, the forefront of those research and technology areas in their field that are (i) particularly fast-moving and (ii) crucial for their success (independent of whether they are at the core or at an indispensable 'edge').

FCI/ANI could fuel such a development not only by requiring such an explicit strategy as part of the annual reports, but also by fostering an international network "above" the individual CoLABs: obviously, there are fields (with the characteristics described) of interest to many CoLABs, like Machine Learning, Computer Vision, Additive Manufacturing, and the like. Since the establishment of top partnerships with "the best of the world" takes efforts and money, a consolidated activity across CoLABs may be very helpful.

R.3 For Innovation Funnel Inbound: Co-Create, Co-Locate, Co-Employ

While R.1 and R.2 looked at a CoLAB's innovation network from an organizational perspective, R.3 and R.4 do so from a "con-tent" perspective. The reader is invited to consider an innovation funnel that is fed by

a “firework” of new ideas in the academic and research world that is “inbound” to the “tech-transfer” (middle-TRL) position of the CoLABs; the CoLABs then take the most promising and demanded such “new ideas” and turn them into much more close-to-market approaches; at the end of the funnel, there are high-TRL companies i.e. the CoLABs’ customer: they will succeed on the market with again a subset of the outcomes of CoLABs.

Against this background, R.3 is the recommendation to tighten the connections to the academic and R&D institutions that feed the funnel. Currently, most CoLABs in-volve such institutions as partners. How-ever, innovation happens mostly on the level of the young active researchers. Therefore, a maximally seamless interconnection of these must be strived for: joint point-to-point projects can be set up, several CoLAB employees and research institution employees may be co-located, a single person may have two 50% contracts and move back and forth between the two “worlds”, etc. Regarding international partners, research visits and exchanges can be established – again not only on the faculty level. These possibilities mentioned represent only examples that shall illustrate: creative thinking is required for tightening the cooperation of CoLABs with R&D institutions. This is necessary to ensure (a) that sufficient innovation knowledge flows into CoLABs (and that knowledge about practical needs flows back) and (b) that this flow occurs maximally fast – in light of the enormous innovation pace in many CoLAB domains.

R.4 For Innovation Funnel Outbound: Co-Develop but Demarcate

Again, R.4 looks at the relationship with the CoLABs’ “customers” not from an organizational perspective like R.1 but from a “content” related one. Similar to R.3, it is recommended to co-develop high-TRL solutions with industrial partners (and other “customers” like the public sector) even more cooperatively than maybe in the past. This being said, some CoLABs already demonstrated very tight coupling in project, leading to very fast and market-ready development and hence to improved skills of the CoLAB members regarding high-TRL outcomes. However, such co-development sheds even more light on an issue that is often not very well dealt with at CoLABs: the treatment of ownership, IPR, and li-censes. If all CoLAB partners get full access to all (FCT-funded) outcome and CoLABs get only restricted rights regarding open-market sales of products and solutions the developed by

furthering such FCT-funded developments, it will be hard for them to build up the corporate assets needed for long-term success (see also R.6). Often, CoLABs don't even have elaborate IPR measures in place for outcomes developed with non-FCT resources.

FCI/ANI can help to improve this situation by fostering the development of sample IPR related agreements for use by CoLABs. Like the consequence from R.2, this suggests the foundation of a "meta-CoLAB" structure. Btw., large multi-institute tech-transfer organizations like Fraunhofer do care about central support from which all member institutions can benefit.

R.5 Focus Radically, Diversify Wisely

Across different CoLABs one can find a huge difference concerning the breadth of the portfolio offered. It goes without saying that among two CoLABs of equal size and "power", the one that concentrates its resources on a smaller portfolio has bigger chances to become one of the world's most recognized and leading institutions. CoLABs in the technology Area Sustainability addressed in this report run less of a danger to broaden their portfolio too fast than, e.g., CoLABs from the IT and especially software domain, but the danger exists nevertheless. On the other hand, focus is not equally easy for the different CoLABs: for instance, the BUILT CoLAB has obviously decided to establish its unique strengths along the entire (digitalization-prone) lifecycle of sustainable building (except maybe the actual construction phase, where C5LAB has its focus): if expertise must be spread across many phases of a process, focus becomes a big challenge. Finally, too much focus may of course make a CoLAB entirely dependent on one market segment, which may fluctuate considerably (as observed with CoLABs restricted to the automotive sector). Therefore, careful diversification (as resources permit) is definitely also advised as a CoLAB's means for increasing resilience. In short, radical focus (aiming at world leadership, which requires maximal concentrated effort) must be complemented with careful diversification – in early years for instance restricted to just one additional domain.

R.6 Emphasize Tangible Assets

On one hand, many tech-transfer institutions underestimate the fact that tech transfer happens in people's heads, not in artifacts like documents or demonstrators or even code (which is why "human-trans-fer" between organizations

must be facilitated, see R.3 and R.4). On the other hand, this very fact also means that CoLABs will lose people at fast pace. This means that they have to invest in assets which they can keep as manifestations of the expertise trust they built up over time. Moreover, as-sets like testbeds, code libraries, development platforms, simulators etc. represent an invaluable competitive edge: since they can be reused among projects, they drive down the project cost. Even "demonstrators" (or minimum viable products, MVPs) may manifest knowledge and evolve over time. In short, tangible assets are among the most crucial issues in tech-transfer – and in some CoLABs, an underestimated one.

R.7 Speed Up Innovation Even More

Some domains where CoLABs operate progress at such fast pace that reaching a global top position requires innovation speed more than anything else. While virtually all CoLABs aim at fast development already, this issue may be so crucial that even more efforts and creativity are re-quired. Industry has come up with various concepts in this respect (lean development, DevOps, Agility), and some concepts like co-creation and design thinking apply directly to innovation cycles. It must be acknowledged that European culture is not by itself tuned to ultra-fast innovation pace (like the US and some Asian cultures) but rather to "solid engineering". In summary, targeted efforts towards establishing functioning fast-innovation measures are considered absolutely decisive for many CoLABs due to their "high-tech" domains.

FCT/ANI may again consider the "meta-CoLAB structure" mentioned above as a framework for offering continuous education in how to increase innovation speed and agility.

R.8 Assure Competitive Employment

Since many CoLAB operate in "high-tech" domains as just thematized, they operate in a scarce-labour area. The best-qualified potential employees have endless opportunities and the offered wages tend to rise way over-proportionally. The Corona pan-demic has seriously aggravated this situation: many globally operating companies experienced that home-office work can be viable and productive. They tend to go to countries with relatively cheap labour but relatively highly qualified personnel: Portugal ranks very high on the corresponding list of countries. This has created a job shortage which CoLAB experience dramatically in

their daily business. There-fore, they have to offer truly competitive working conditions, which can only come as a package of (i) (semi-)competitive salary, (ii) excellent and transparent, clearly-shaped qualification paths (e.g., with the help of the closely connected local and international research institutions and the highly innovative industry connected), and (iii) acceptable work-life balance.

FCT/ANI will play a decisive role in this respect: they must help the CoLABs in offering better wages, otherwise the entire CoLAB concept will be at stage, at least for the many (!) CoLABs in high-tech domains.

R.9 Mitigate Corona Consequences

The Corona pandemic introduced a whole series of problems to CoLABs, from the employment problem (see R.8) to a general slow-down of public life and – maybe most dramatic – considerable caution of the most potent industry partners regarding innovations. Many prospective industry projects were therefore postponed or even abandoned by the CoLABs' partners. The CoLABs make big efforts to mitigate these problems, but the help of FCT/ANI will be crucial here, too.

FCT/ANI can make a wise move if they offer the CoLABs support in mitigating the consequences of Corona. They could, for instance, offer targeted support upon application, such as prolongation of the phase-1 support, shifting of funds, additional funds for cases of hardship etc.

7. Final Remarks

AlmaScience aims at a unique product category with extremely high potential in both sustainability and innovation, C5LAB and BUILT complement each other in a sector with super high sustainability potential, Cecolab aims at the ultimately pressing need to address the "Limits to Growth" with revolutionary circular economy approaches, and S2UL caters to the need to make our urban environments smart and sustainable. All five CoLABs address the urgent big issues of our society with exciting innovative concepts and energy, and are ideally suited to make the underlying aims of the PRR program come true. They deserve the attention of FCT/ANI to assure their success in turbulent times (Covid etc.) during their "childhood".

Social Services and Tourism

The thematic area Social Services and Tourism integrate 3 CoLABs, answering specific economic and social challenges related with employment, social protection and social exclusion – CoLABOR, ProChild and KIPT are geographically represented in Figure 15. Distributed among North, Lisbon and Algarve regions, these CoLABs are responsible for **7% of the employment created** by CoLABs until September 2021.

Figure 15. Location of 'Social Services and Tourism' CoLABs

Counting with the participation of **40 entities** as associates, **22% of the involved entities are SMEs**, **20% are large enterprises** (Table 11), **38% are R&D institutions, 13% are associations and 7% are other Public Administration entities.**

Table 11. Enterprises CoLABs Shareholders 'Social Services and Tourism'

	CoLAB
Algardata, Sistemas Informáticos, SA	KIPT
Blue Geo LIghthouse, Lda	KIPT
Delta Cafés Sociedade Gestora de Participações Sociais, SA	CoLABOR
Domingos Da Silva Teixeira, S.A.	ProChild
Ensilis, Lda- Universidade Europeia	KIPT
HOTI STAR- Portugal Hotéis, SA	KIPT
Irmãos Rodrigues - Confecções, S.A.	ProChild

Logical Safety S.A	KIPT
Media Invest MITG LDA	KIPT
Mota-Engil, SGPS, S.A.	CoLABOR
Prizmakat	KIPT
Salmor - Sociedade de Investimentos Hoteleiros, SA. – Hotel Pestana Group*	KIPT
Sgs Portugal - Sociedade Geral de Superintendência S.A	KIPT
SONAE Corporate S.A	ProChild
Sonae Mc - Serviços Partilhados, S.A	CoLABOR
UPSTREAM – Valorização do Território, S.A.	KIPT
Vila Galé – Sociedade de Empreendimentos Turísticos, SA	KIPT

CoLABOR and ProChild participated in 21 competitive proposals to funding programs in 2020 with a total requested investment of 31 million€. In 2020, 1 application was approved representing a total approved investment of 40 thousand€ to CoLABs activities.

CoLABOR mobilizes resources from academia, business, public administration and social and solidarity economy organizations in order to deepen knowledge of present and foreseeable problems around three areas of activity: work and employment; social protection; social and solidarity economy. CoLABOR's strategy for the first three years of activity focuses on five axes: i) Evaluation of the impact of technologies on work, employment and labour relations (research line: work and employment); ii) Evaluation of social responses (research lines: social protection and social and solidarity economy); iii) DataLABOR; iv) Evaluation of the adequacy of social security models (research line: social protection); v) Dissemination and internationalization. In terms of its presence in society and the fruit of its research, this CoLAB promotes public participation and cooperation with research and innovation institutions in order to establish and consolidate networks for sharing experience and knowledge.

Areas of Expertise: Labour; Employment; Social Protection; Public Policy Evaluation.

Examples of ongoing activities:

- Assessing the impact of technology on work and labour relations –The Technology Impact Assessment Toolkit (TIAT), currently under development, is a tool to support collective deliberation in processes of technological development and/or change that provides guidance for the selection and application of technology impact assessment methods, with a focus on labour and employment.

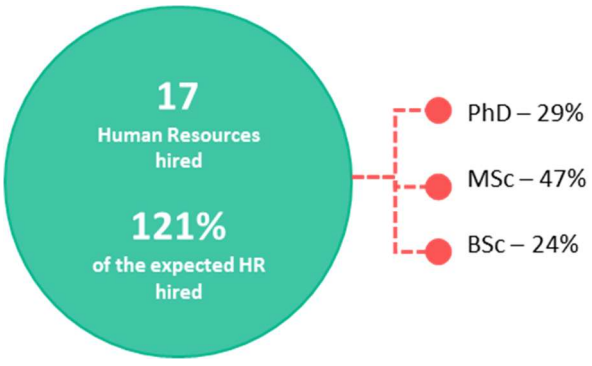
- DATALABOR, specialized statistical and legal information services for the areas of labour, employment and social protection.

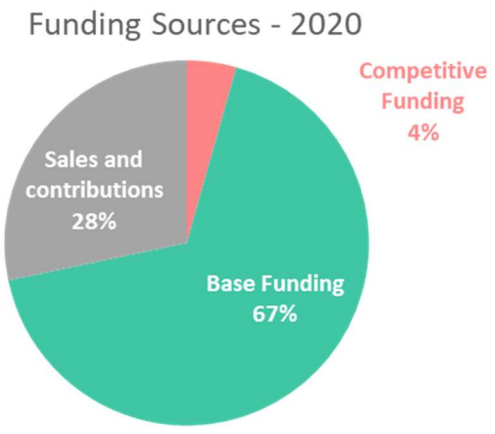
- The Future of Work in the Automotive Sector in Portugal, developed in partnership with the International Labour Organization (ILO), investigates the impacts on work and employment of socio-technical changes underway in the automotive sector.

Associates:

- Centro de Estudos Sociais da Universidade de Coimbra
- Confederação Nacional de Instituições de Solidariedade
- Delta Cafés Sociedade Gestora de Participações Sociais, SA
- Instituto de Direito Económico, Financeiro e Fiscal
- ISCTE - Instituto Universitário de Lisboa
- Mota-Engil, SGPS, S.A.
- Santa Casa da Misericórdia de Lisboa
- Sonae Mc - Serviços Partilhados, S.A

Main Figures:





ProChild

ProChild CoLAB aims to combat childhood poverty and social exclusion, based on a multidisciplinary scientific approach around two major areas: Social Intervention and Technological Development. The Social Intervention area includes four strategic axes, each with specific projects, implemented in specific territories: i) Health and Wellbeing; ii) Development and Education; iii) Social Participation, Citizenship and Gender Equality; iv) Protection from Violence, Exploitation, Abuse and Neglect.

These axes are linked to the transversal strategic area of technological development and innovation, in the fields of Digital Technology and Nanotechnology ProChild CoLAB thus seeks to promote effective social change, in the alliance between social intervention and technological innovation not only in the production of scientific knowledge, but also in the construction and dissemination of intervention programs and technological products that respond to the needs of children, families, professionals and institutions.

Areas of Expertise: Poverty; Social Exclusion; Digital Technology; Nanotechnology.

Examples of ongoing activities:

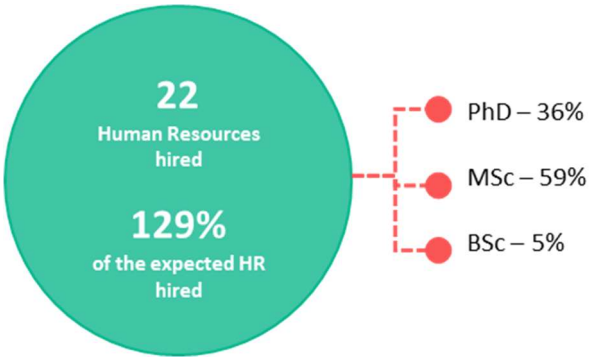
- CoAction Against COVID-19 - Screening, assessment and intervention in children's mental health problems in pandemic context.

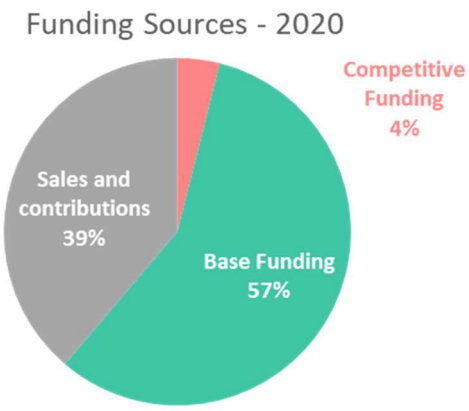
- ProChild kit(e) – Kids Transforming Education - This project started from the need to find answers to the effects of school closures due to the COVID-19 pandemic. The lack of face-to-face contact between teachers of the Curricular Enrichment Activities (AEC) and children made it necessary to develop distance contact strategies that would allow the observation and monitoring of children.

Associates:

- Associação C. C. G. / Zgdv - Centro de Computação Gráfica
- Centro de Estudos Sociais da Universidade de Coimbra
- Câmara Municipal de Guimarães
- Domingos Da Silva Teixeira, S.A.
- Faculdade de Psicologia da Universidade de Lisboa
- Fundação Vasco Vieira de Almeida
- Irmãos Rodrigues - Confecções, S.A.
- Instituto Superior de Economia e Gestão
- Santa Casa da Misericórdia de Lisboa
- SONAE Corporate S.A
- Universidade de Aveiro
- Universidade de Coimbra
- Universidade Católica Portuguesa
- Universidade do Minho
- Universidade do Porto

Main Figures:





KIP[T] | Knowledge to Innovate Professions in Tourism

The KIPT Collaborative Laboratory - Knowledge to Innovate Professions in Tourism - aims to be a collaborative platform that proposes to bring businesses and academia closer together, through the development of an action plan around three strategic axes: knowledge, employment and sustainable competitiveness. This CoLAB, focusing on the professions as a leading factor in ensuring competitiveness and sustainable development, addresses the sustainability of the Tourism sector in different scenarios (resilience, recovery, and transformation) to overcome the problems facing the sector, with the ultimate goal of contributing to a valued, rewarding, inclusive and conciliatory labour market.

With a social capital that includes 20 entities linked to Science, Technology and Higher Education, tourism governance, information systems, certification, hotel and restaurant management, operations, travel agencies, sustainability, and innovation and entrepreneurship, KIPT brings together knowledge in a large majority of areas of the tourism system and in different geographical areas of the country, focusing particularly on five crucial development areas (information, training and education, career and skills, certification, quality and sustainability, innovation and entrepreneurship) to address the problems of the sector in general, including those related to labour.

Areas of Expertise: Tourism

Associates:

- Ensilis, Lda- Universidade Europeia
- Algardata, Sistemas Informáticos, SA
- ISCTE - Instituto Universitário de Lisboa
- Instituto Politécnico de Leiria
- Associação da Hotelaria, Restauração e Similares de Portugal,
- Universidade de Évora
- COFAC – Cooperativa de Formação e Animação Cultural, CRL
- Sgs Portugal - Sociedade Geral de Superintendência S.A
- Salvor - Sociedade de Investimentos Hoteleiros, SA. – Hotel Pestana Group*
- Universidade do Algarve
- Vila Galé–Sociedade de Empreendimentos Turísticos, SA
- HOTI STAR- Portugal Hotéis, SA
- Advance- ISEG
- Media Invest MITG LDA
- Prizmakat
- Instituto Politécnico de Bragança
- BLue Geo LIghthouse, Lda
- Logical Safety S.A
- ATA- Associação de Turismo do Algarve

Approved in March 2021.

THE COLABS IN THE THEMATIC AREA "SOCIAL SERVICES AND TOURISM": REMARKS ON THE ACTUAL SITUATION, THE LESSONS LEARNED AND SOME RECOMMENDATIONS FOR THE FUTURE

Personal view by J. L. Encarnação

Professor Dr.-Ing., Technische Universität Darmstadt and
Fraunhofer Institute for Computer Graphics (IGD), Darmstadt; Germany

1. Introduction and Overview

This "Personal View Paper" describes, first the need for a new form of cooperative platform to develop the innovations needed for the major transformations that our society is undergoing and explains then why CoLABs are considered to be the right innovation instruments to successfully implement these transformations.

Next, the Portuguese CoLABs innovation Program, with already existing 35 CoLABs, distributed over 8 Thematic Areas (TA), is briefly described. For the TA "Social Services and Tourism" there are 3 CoLABs starting and successfully developing their operation: COLABOR, ProChild and KIPT. These are as of today the only CoLABs addressing, the domain of "Humanities, Social- and Work-Sciences". They are then also very briefly described. The paper closes with a summary and the recommendation to promote and support further CoLABs in this domain.

2. On-going Transformations in our society

Our society, in all its facets and at all levels, is undergoing major transformations bringing fundamental changes in society and having a strong impact in all aspects of life. These transformations are caused by:

- the process of the "digitalization" of the society,
- the increasing need of society to transform itself at all levels, functions, and processes so that in the future it will better respect, stronger consider and take more intensive care of the "environment", and

because of these two transformations

- there will be new forms of (human-human, human-machine, and human-environment) communication and interpersonal interaction, and of the new mobility.

These transformations must be implemented in a way, that guarantees and even aims at increasing wealth and wellbeing for humankind. The processes for these transformations demand therefore for a large diversity of innovations in applications, in the solution of problems, and in the delivering of all kinds of services in the "new society" in this "new digital world".

To achieve and speed up the process of developing the innovations needed for these transformations, there is a need for large and intensive inter-, multi-disciplinary and multi-institutional co-operations with participation of all involved societal players, like users, industry, market players, societal institutions, and academia. To make these co-operations possible and efficient there is a need for new forms of co-operation platforms.

One of the possible ways of implementing these platforms to develop, implement, prototype, test and deploy the innovations needed to achieve these transformations in society, by bringing together all the players involved and by making it possible for them to cooperate, participate are contribute in a multi-, inter-disciplinary and multi-institutional way, are the Cooperative Laboratories, the CoLABs.

3. CoLABs: an instrument to support and facilitate the innovations needed for the on-going transformations in Society

A CoLAB is an independent, private, and non-profit association, or an independent private company, specially created for this purpose, that integrates as associates, several academic and research institutions, different types of companies, business associations, public institutions, and other relevant partners such as social or cultural institutions. They are incorporated as one new, independent legal entity, the CoLAB, that has as its R&I target a specific "thematic area", usually an application domain, a technology area or the solution for a given problem, all needed to make progress and to implement the societal transformations in that domain. A CoLAB is therefore a special form of a "PPP" (public private partnership).

The operation of a CoLAB is based on a business model in which the associates share the costs and the risks of the operation, but also the R&I results achieved in a jointly developed, and for the mission, scope and purpose of each CoLAB dedicated R&I Agenda. CoLABs are not fully public funded R&I units; their funding is typically based on an income with three

components: a base funding, including participations and / or membership fees from the associates, a funding coming from competitive projects and a funding coming from projects with the associates and from services. Usually, these three components are in a certain balance, like ca. 1/3+1/3+1/3.

The CoLABs aim at complementing and reinforcing existing landscapes of R&D units, and at stimulating an active and strong participation of the scientific/academic, business, and public communities in the analysis and solution of large scale and complex problems and applications, typically of multidisciplinary, interdisciplinary, and multi-institutional nature and of big relevance for the transformations our society is undergoing.

The CoLABs are therefore a new, evolutionary concept and instrument to support and facilitate in achieving the innovations needed for the on-going transformations in Society. The CoLABs mobilize the involved players in each domain of society and serve as a platform for them to participate, cooperate and contribute to the implementation of innovative, effective solutions needed for these transformations in the work domain of the CoLAB and there with a strong socio-economic impact in society. An additional role of the CoLABs is to generate a substantial number of new and high-qualified scientific jobs in their domain of work.

4. The network of CoLABs in Portugal

To contribute to the transformations in society described before (digitalization, environmental impact, communication and interpersonal interaction, and new forms and concepts for mobility) a large diversity of application domains, of technology areas or of solution of different problems in society have to be addressed. To support and make this happen in Portugal in an innovative, advanced way, an innovation program was conceptualized in 2016 and initiated in 2017 by the Ministry MCTES, put in place and moderated by the FCT (the Portuguese Science Foundation) and in its operation monitored and attended by ANI (the Portuguese Innovation Agency) in order to develop a network of CoLABs in Portugal having the vision and the scope and purpose described in the previous session of this paper.

Out of many candidate proposals, FCT decided based on four calls for proposals and in four evaluation rounds, supported by an international panel of experts, to assign the label “CoLAB” to 35 of these

proposals. A 5th. evaluation round is now planned for early 2022. The 35 CoLABs are not only doing R&I work in different domains, but also distributed across the country. Within this distribution more than 91 % of todays' CoLABs are working in domains related to Environment (12 CoLABs), to Human Health and Wellbeing (12), to Science, Engineering and Materials (8) and less than 9 % are working in a domain somehow related or close to Humanities, Social- and Work-Sciences (3). The 35 Co LABS address within these innovation domains different "Thematic Areas" (TA), namely Agri-food (5 CoLABs), Biodiversity and Forest (3), Climate, Space and Oceans (4), Digital and Communication (3), Energy and Sustainability (5), Health (7), Material, Circular Economy and Urban Sustainability (5) and finally "Social Services and Tourism" (3). This is a good distribution and diversity of important TA areas for Portugal, its society, and its economy.

5. The innovation domain "Humanities, Social- and Work-Sciences"

The transformations in society (digitization, environmental impact, communication and interpersonal interaction, and new mobility) are also having a fundamental impact in the domain of "Humanities, Social- and Work-Sciences". Domains of our society like:

- Home and living,
- Family and Children,
- Minorities,
- Immigration and Integration
- Education and Training
- Lifelong learning
- World of work,
- Sports and Leisure,
- Culture and Museums,
- Travelling and Tourism,
- Theatre, Music and Festivals,
- and many others,

are also undergoing major changes due to and because of the large impact the societal transformations listed before are having, also in all these domains.

These changes all include many issues needing innovations, that are of strong economic and technological nature, but some of them also strongly relate to the domain "Humanities, Social- and Work-Sciences". Therefore, there is here also a need to see and identify "Thematic Areas" in which CoLABs could work to change and innovate following the societal transformations in cooperation with and with contributions from the several,

diverse disciplines of “Humanities, Social- and Work-Sciences”.

In this context there will two types of impact and related changes. One will be directly on these disciplines themselves; these transformations will generate new ways of working for the disciplines of “Humanities, Social- and Work-Sciences”, with new methods, systems and tools using the new technologies and opening new opportunities for their own way of achieving advanced, innovative results (based on, for example, new data gathering techniques, on new data analysis methods, on new modelling techniques, on new type of computer-based Simulators, Evaluators and Predictors, on experimenting with new forms of Living Labs integrating computer-generated realities, on using AI techniques, etc., etc.). The second type of strong impact and large changes in this domain will be based on using and applying the “innovated” disciplines of “Humanities, Social- and Work-Sciences” to the different domains of our society listed above.

Both types of impact will together generate many innovations, also resulting into many new products, systems, applications and services, these will also generate by themselves new business opportunities, new spin-offs and new jobs that will result into a strong economic impact in these domains of society and, based on that, also in the national economy.

This is one of the reasons why CoLABs make also a lot of sense in these domains of our society, assuming that their market-players come together and join forces to jointly generate further progressive and innovative proposals for CoLABs that work on transforming these domains of our society, based on a sustainable operation and a not exclusively public-funded business model, and with an advanced R&I agenda.

6. The thematic Area (TA) “Social Services and Tourism”

As of today, the only already existing CoLABs addressing somehow directly this domain of “Humanities, Social- and Work-Sciences” are the ones in the Thematic Area “Social Services and Tourism”, with 3 CoLABs, namely COLABOR, ProChild and KIPT.

6.1. COLABOR, the CoLAB for Work, Employment and Social Protection

COLABOR is a CoLAB, that mobilises resources from academia, companies, public administration, and social and

solidarity economy organisations, with a view to gleaning a more in-depth understanding of the present and foreseeable problems in three central areas of activity: work and employment, social protection, and the social and solidarity economy.

CoLABOR's action plan wants to generate outputs that can be appropriated both nationally and internationally by private sector companies, the public administration, and entities from the social and solidarity sector. COLABOR wants to engage companies that are particularly sensitive to the transformations of work and their impacts on social models. From banking to industry, from distribution to agri-food sectors, CoLABOR involves companies which employ a significant workforce nationally, are present throughout the territory and have an international projection.

COLABOR is still in its early bootstrapping phase, but is developing well, with an interesting set of important R&I activities, achieving already some promising results and with developments, especially in their DATALABOR division, that promise to be a good starting basis and a good chance to be able to diversify their income and funding based on some direct market orientation by expanding and reinforcing their SW developments (data bases, simulators, prediction tools for this domain, etc., etc.) and by sharing these with their associates and other interested market players.

6.2. ProChild, the CoLAB Against Poverty and Social Exclusion

Poverty and social exclusion prevent more than 200 million children worldwide from attaining their developmental potential. This leads to long-lasting negative developmental consequences that impact adult functioning, care for the future generations and ultimately the wellbeing of societies. The ProChild CoLAB approach will boost an effective social change in the country by placing children - one of the most fragile and vulnerable social groups - at the centre of research and innovation. The ProChild CoLAB will also promote professional scientific training within the public administration and private entities enrolled in the social arena. Additionally, the ProChild CoLAB will promote a change in the Corporate Social Responsibility (CSR) within this collaborative network by offering to the enterprises scientific evidence of good practices that will foster a move from dispersed social-supportive

activities in CSR21 towards integrative and scientific-based action models.

The ProChild CoLAB research and innovation agenda is grounded on 4 strategic interdisciplinary areas: health and wellbeing; development and education; social participation, citizenship, and gender equality; and child protection against violence, exploitation, abuse and negligence.

6.3. KIPT, the CoLAB for Knowledge to innovate professions in tourism

The CoLAB KIPT aims to be a collaborative platform that supports policy makers, industry agents and students/professionals through innovative research and up-to-date information, with strategic activation models that benefit tourism, businesses, people, places, and the world in general. The Vision of KIPT is carried out in three fundamental axes: *Research; Training and Knowledge Dissemination, throughout a management tool of qualified employment organized to respond to the needs of the sector*.

KIPT will focus on research/training/dissemination: The appreciation and development of human resources and their competitiveness in tourism and hospitality. The geographical scope of privileged research is Portugal and Portuguese speaking countries. The Expected results are the production and publication of developed knowledge, the promotion of initiatives to disseminate the knowledge, the creation of research & innovation networks in tourism and hospitality extended to the Portuguese speaking world; and the development of intelligent technological platforms (smarts).

7. Conclusions and recommendation

Our society is undergoing major transformations bringing fundamental changes and having a strong impact in all aspects of our life. These transformations will result into a large and diverse number of innovations, that will have to be developed based on large and intensive inter-, multi-disciplinary and multi-institutional co-operations with participation of all involved societal players. To make these co-operations possible and efficient there is a need for new forms of co-operation platforms.

A possible way of implementing these platforms are the Cooperative Laboratories, the CoLABs. In Portugal an innovation program was conceptualized in 2016 and initiated in 2017 to develop a network of CoLABs having the vision and

the scope and purpose of implementing these societal transformations. There are at the moment 35 CoLABs being bootstrapped or already in full operation, of which less than 9 % are working in a domain somehow related to “Humanities, Social- and Work-Sciences”.

The only already existing CoLABs addressing somehow directly the domain of “Humanities, Social- and Work-Sciences” are in the Thematic Area “Social Services and Tourism”, with 3 CoLABs, namely COLABOR, ProChild and KIPT. These three CoLABs were briefly summarized; they are quite successful on their way, but in different stages of maturity.

It is expected that for future FCT evaluations further proposals for CoLABs in the domain of “Humanities, Social- and Work-Sciences” will be submitted. Assuming that a few of these candidates will have the right set of associates, the proper operation and business models, an innovative, jointly developed, advanced and innovative R&I Agenda, and also a good chance of future sustainability, then it is recommended to welcome and motivate interested groups (consortia) to submit proposals for evaluation. As a result, other CoLABs in this domain may be accepted. This would be very good for the Portuguese society and for the Portuguese economy, and would strongly contribute in innovating this market.

THE INTEGRATION OF COLABS IN REGIONAL INNOVATION AND SPECIALIZATION DYNAMICS

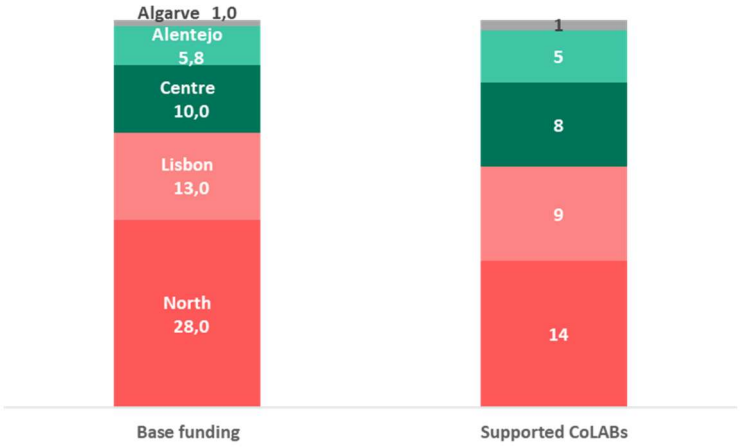
The CoLABs operate in a framework in which it's highlighted the need to expand the group of companies that assume innovation as a strategic priority to increase its competitiveness, directing resources towards knowledge-intensive activities, research and technological development and stimulating the connections with national and international players, through collaborative networks and technology platforms, as well as attracting and retaining high-skilled human resources in technological and technical areas. To this end, the CoLABs network must be understood in its close relation with the territories in which they are inserted. In fact, the CoLABs' installation and consolidation process is being supported by the Regional Operational Programmes with a total investment of 57.6 million euros, meaning that regions are investing in the attraction of talent, highly skilled human resources, to improve the regions' innovation dynamics and to increase the competitiveness of the productive fabric through the development of market-driven solutions and the incorporation of innovation in the productive processes of companies.

By the end of 2020, public funding made available through national and community funds for the creation and implementation of Collaborative Laboratories reached 69 million euros, of which 57.6 million euros through a specific measure to support the hiring of highly qualified human resources made available by the Regional Operational Programs and 11.4 million euros through the Foundation for Science and Technology.

As shown in

Figure 16, the North is the region with the highest amount of base funding approved to support CoLABs (28 million euros) and with the highest number of CoLABs operating in the region (14 CoLABs), followed by Lisbon region with 13 million euros available for 9 CoLABs.

Figure 16. Distribution of base funding by Regional Operational Program, 2020



The Centre region represent more than 10 million euros to support the 8 CoLABs with headquarters or branch operating in the region and Alentejo and Algarve represent, respectively, 5.7 and 1.07 million euros to support 6 CoLABs. By the end of 2020, 22% of the total amount committed by the Regional Operational Programmes to the implementation of CoLABs human resources hiring plans for 3 years had been executed, as expressed in Table 12.

Table 12. CoLABs Base funding – Execution 2020

	Base funding committed for 3 years (M€)	Additional Contribution FCT (M€)	Executed Base Funding 2020 (%)	Executed Base Funding - total (%)
AlmaScience	2.9	0.58	32%	12%
Atlantic	4.4	0.88	39%	14%
B2E	0.96	0.19	52%	51%
BIOREF	2.3	0.41	59%	15%
BUILT CoLAB	2.0	0.40	41%	4%
C5LAB	4.3	0.86	55%	18%
CECOLAB	2.8	0.54	67%	22%
CEiiA - S2uL	4.1	0.83	33%	11%
CoLAB Vines&Wines	0.8	0.16	96%	51%
CoLab4Food	1.5	0.29	67%	22%
CoLABOR	1.3	0.27	96%	52%
DTx	4.4	0.88	62%	35%
FeedInov	0.93	0.17	29%	3%
Food4Sustainability	1.4	0.27	10%	1%
ForestWISE	2.6	0.52	63%	18%
GreenCoLAB	1.0	0.21	89%	30%
InnovPlantProtect	2.8	0.57	80%	22%

MORE	2.6	0.53	99%	51%
NET4CO2	0.99	0.19	95%	38%
ProChild	1.9	0.38	80%	27%
SFCoLAB	1.4	0.29	26%	7%
Smart Energy LAB	2.0	0.41	19%	3%
VectorB2B	2.5	0.50	116%	46%
VG CoLAB	2.5	0.50	5%	1%
VOH.CoLAB	0.89	0.18	97%	42%
VORTEX	1.5	0.31	33%	16%
	57.6M €	**11.5M€**	61%	22%

Deviations in the execution of the contracting plans and in the financial execution were duly pointed out, corresponding mainly to delays in the installation of CoLABs (many of them only started their activities in 2020) and due to difficulties in recruiting some technical and scientific profiles. As some of the difficulties mentioned have been overcome, no reasons were identified for the planned contracts and financing not to be fully implemented by the end of the operations in progress. In fact, the year 2020 revealed progress in the execution of the funding considering that during this year, 61% of the contracted amount for the year was executed.

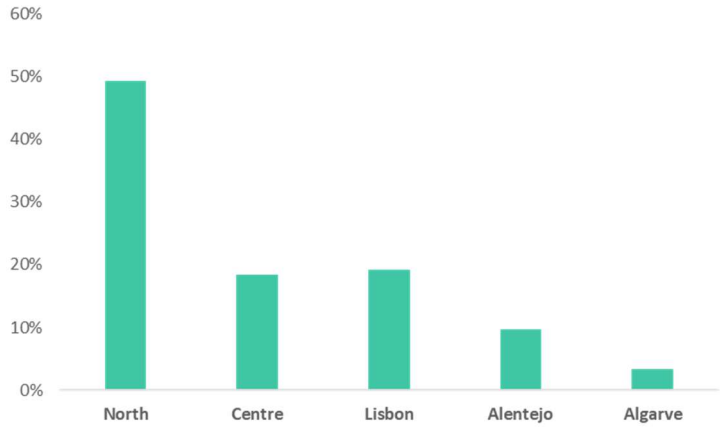
Impact on jobs creation and talent attraction

The CoLABs represent the opportunity for scientific and academic institutions, in close collaboration with economic, social and cultural sectors, to contribute to the development, in Portugal, of international relevance projects, with an effective impact on territories and society, stimulating in particular the creation of qualified employment in the country. Based on this premise, it is important to map the impacts of CoLABs (and, consequently, the public funding invested) in the regions where they are inserted. Thus, the most direct impact related to knowledge-based activities developed by CoLABs is on employment creation and talent attraction.

As a result of the base funding available for the 26 CoLABs approved until 2020, a total of **562 direct employments** were created by September 2021. The region with greater employment creation is the North region which represents almost half of the total employment created by CoLABs (49%), followed by Lisbon and Centre regions (Figure 17). With only 3% of the direct jobs created, the Algarve is the region less impacted. These

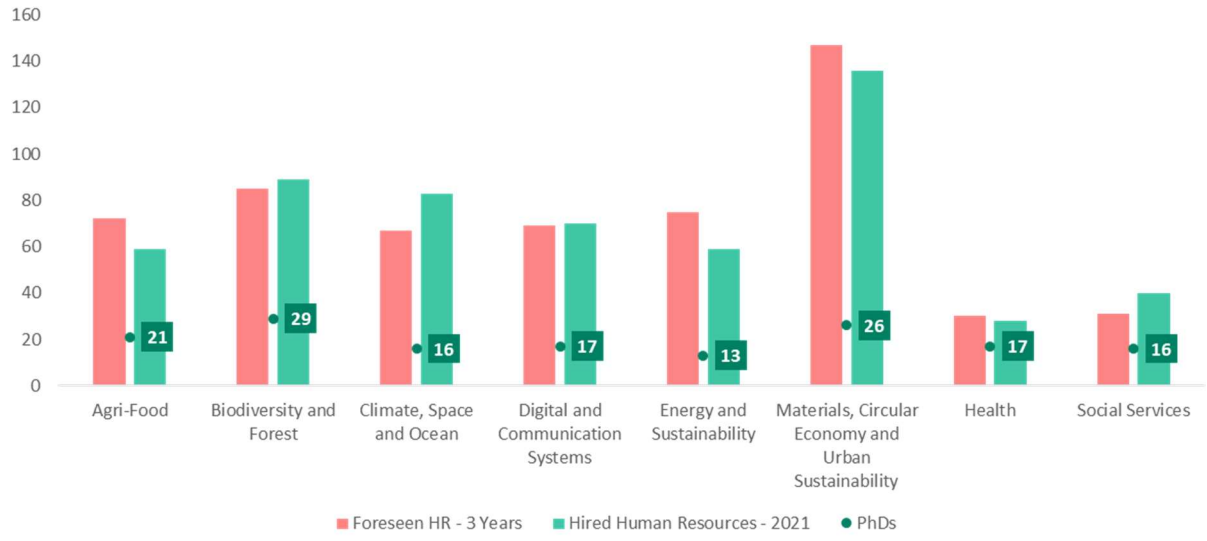
numbers must be also understood in relation to the number of CoLABs operating in each region.

Figure 17. Employment created, by region, 2021



When analysing, by thematic area, the distribution of highly qualified human resources hired until September 2021, it is possible to verify that the thematic areas ‘Biodiversity and Forest’, 'Climate, Space and Oceans', and 'Social Services' exceeded the number of human resources foreseen (Figure 18).

Figure 18. Foreseen vs. Hired Human Resources, by Thematic Area, 2021



It what concerns the recruitment of doctorates, it is possible to verify that the thematic area 'Biodiversity and Forests' achieved the highest number of doctorates hired (29), followed by the area 'Materials, Circular Economy and Urban Sustainability' with 26 PhDs and by the area 'Agri-food' with 21. As previously highlighted, the thematic area ‘Biodiversity and

Forest' is the field that attracted the highest share of foreigners (10% of the human resources hired in this area are foreigners).

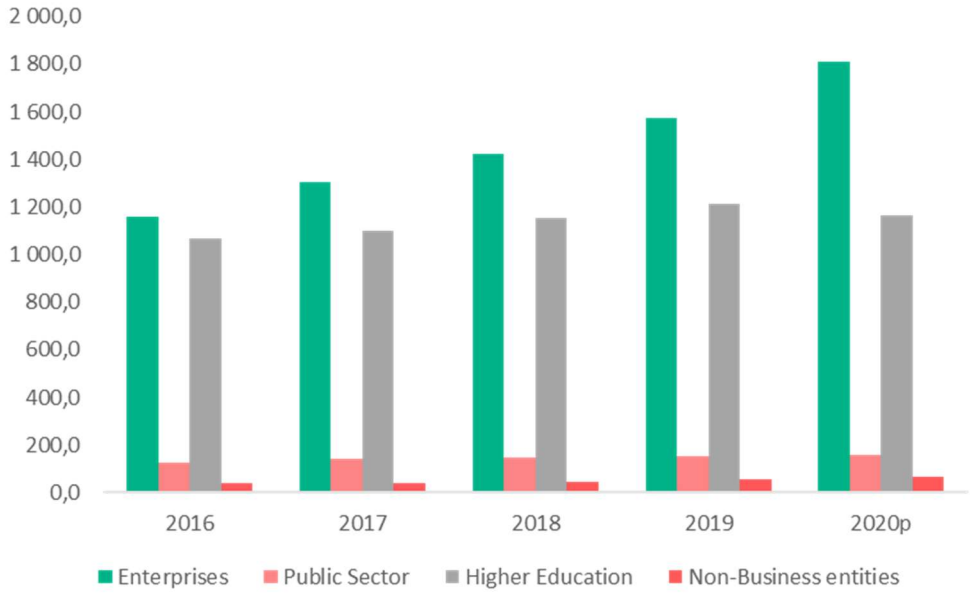
Contribution to increase business R&D investment

The main challenge that CoLABs must address is the effective densification of the national territory in terms of knowledge-based activities, through a growing institutionalisation of new forms of collaboration between science, technology and higher education institutions and economic and social stakeholders. In this process, the promotion of connections between different stakeholders and entities with different competences assume fundamental importance to increase enterprises R&D investment.

Provisional data from the R&D Survey 2021 reports that enterprises represented 0.89% of GDP R&D expenditure in 2020, followed by Higher Education sector with 0.58%. this is equivalent to an increase from 1 156.5 million € in 2016 in firms' R&D expenditure to 1 811.3 million euros (

Figure 19).

Figure 19. R&D Expenditure in Portugal (million €), by sector (2016-2020p)



Source: IPCTN, DGEEC (2021)

The impact of the CoLABs activities and their contribution to private investment in R&D is not yet possible to determine. However, when analysing the top 100 enterprises/groups with the highest investment in R&D in 2020, it is possible to find 13 of the associates/shareholders of CoLABs in the list (Table 13), illustrating its commitment to research and development.

Table 13. Companies/groups with more expenditure on R&D activities in 2020

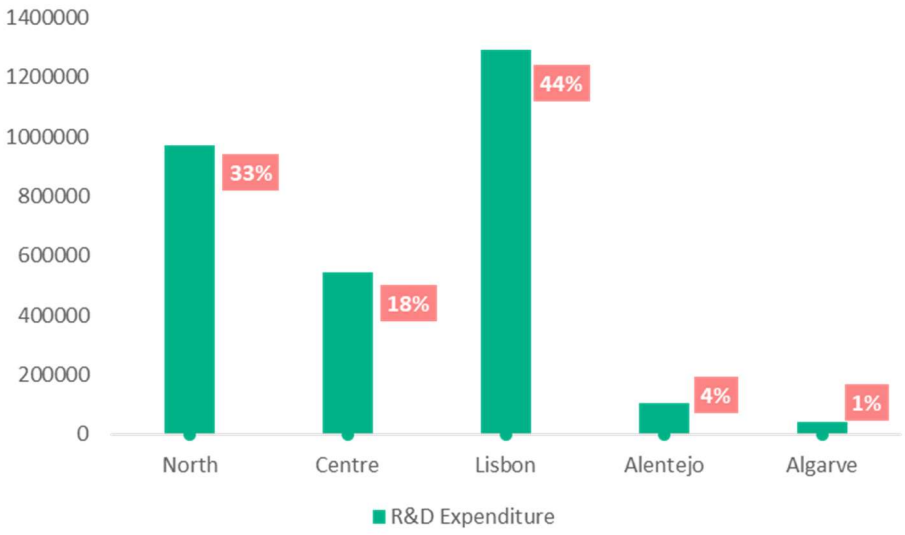
Position	Entity	R&D Expenditure (thousands €)	R&D Human Resources (nr)		CoLABS in which the company/group participate
			Total	PhDs	
1	**NOS, SGPS, S.A.**	67 251	226	12	**DTx Healthy Ageing@CoLAB**
8	**Empresas Sonae**	24 095	373	8	**CoLABOR ProCHild B2E**
10	**Grupo Galp Energia**	20 630	159	4	**BIOREF NET4CO2 HyLAB CEiiA-S2uL**
13	**Grupo Secil**	16 478	159	4	**BUILT CoLAB C5LAB**
23	**Grupo Simoldes**	10 162	206	2	**CEiiA-S2uL DTx**
27	**Grupo Super Bock Group, SGPS, S.A.**	8 482	48	4	**Colab4Food**
31	**Grupo Corticeira Amorim, SGPS, S.A**	n.a.	n.a.	n.a.	**ForestWISE**
35	**Altranportugal, S.A.**	n.a.	n.a.	n.a.	**VORTEX**
40	**Grupo Efacec Power Solutions, S.A.**	5 856	101	5	**4LifeLAB CEiiA-S2uL VG CoLAB**
45	**Deimos Engenharia, S.A.**	5 242	62	8	**+Atlantic**
59	**Cimpor - Indústria de Cimentos, S.A.**	n.a.	36	0	**C5LAB**
83	**Imprensa Nacional - Casa da Moeda, S.A. (INCM)**	2 916	30	5	**AlmaScience**
100	**Grupo Soja de Portugal, SGPS, S.A.**	2 256	59	3	**B2E FeedInov**

Source: DGEEC, 2021

In terms of the CoLABs regional context, data indicates that Lisbon is the region with the higher investment in R&D expenditure, representing 44% of the total R&D expenditures in the country. The North region, which concentrate more than 50% of the manufacturing industry in Portugal, represent 33% of R&D expenditures, followed by Centre region with 18% and Alentejo with 4%. The Algarve is the region with the lowest share of R&D expenditure,

accounting with 1% to the national total (Figure 20). Regarding the regional R&D expenditures by thematic area of the National Research and Innovation Strategy for Smart Specialisation, it is possible to verify that, in the last year available (2019), the thematic area with the highest volume of **R&D expenditure in the North** region was 'Health', followed by 'Information and communication technologies' (ICT), and 'Industry and production technologies'. For the **Centre and Lisbon regions**, 'Health' and ICT are also highlighted as the main R&D areas of expenditure. **Alentejo** region present the Agri-food sector as the main source of R&D expenditure, while in **Algarve region**, Sea-based Economy constitutes the most expressive sector regarding R&D expenditure in the region.

Figure 20. R&D Expenditure in Portugal (%), by region - 2019

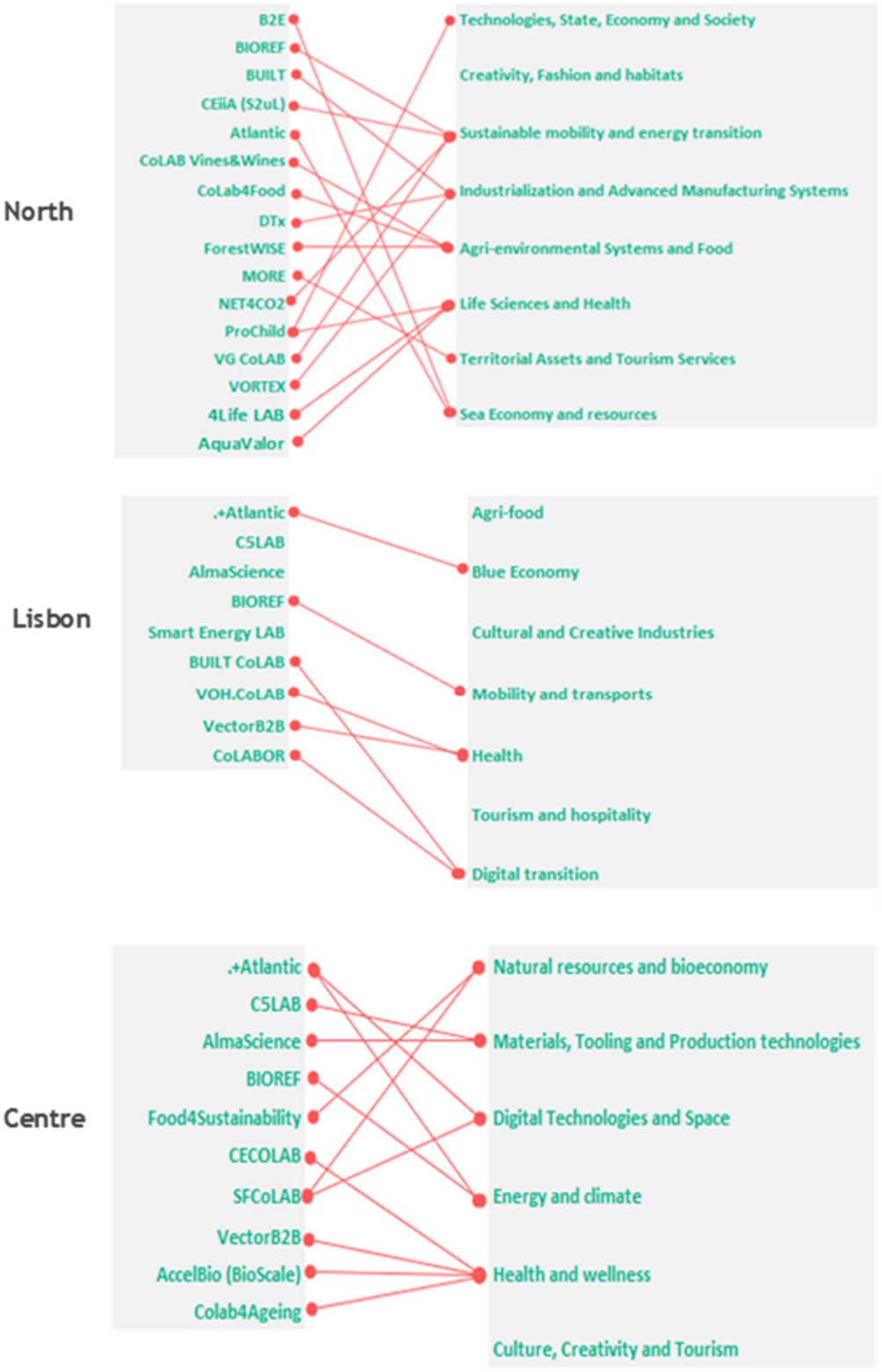


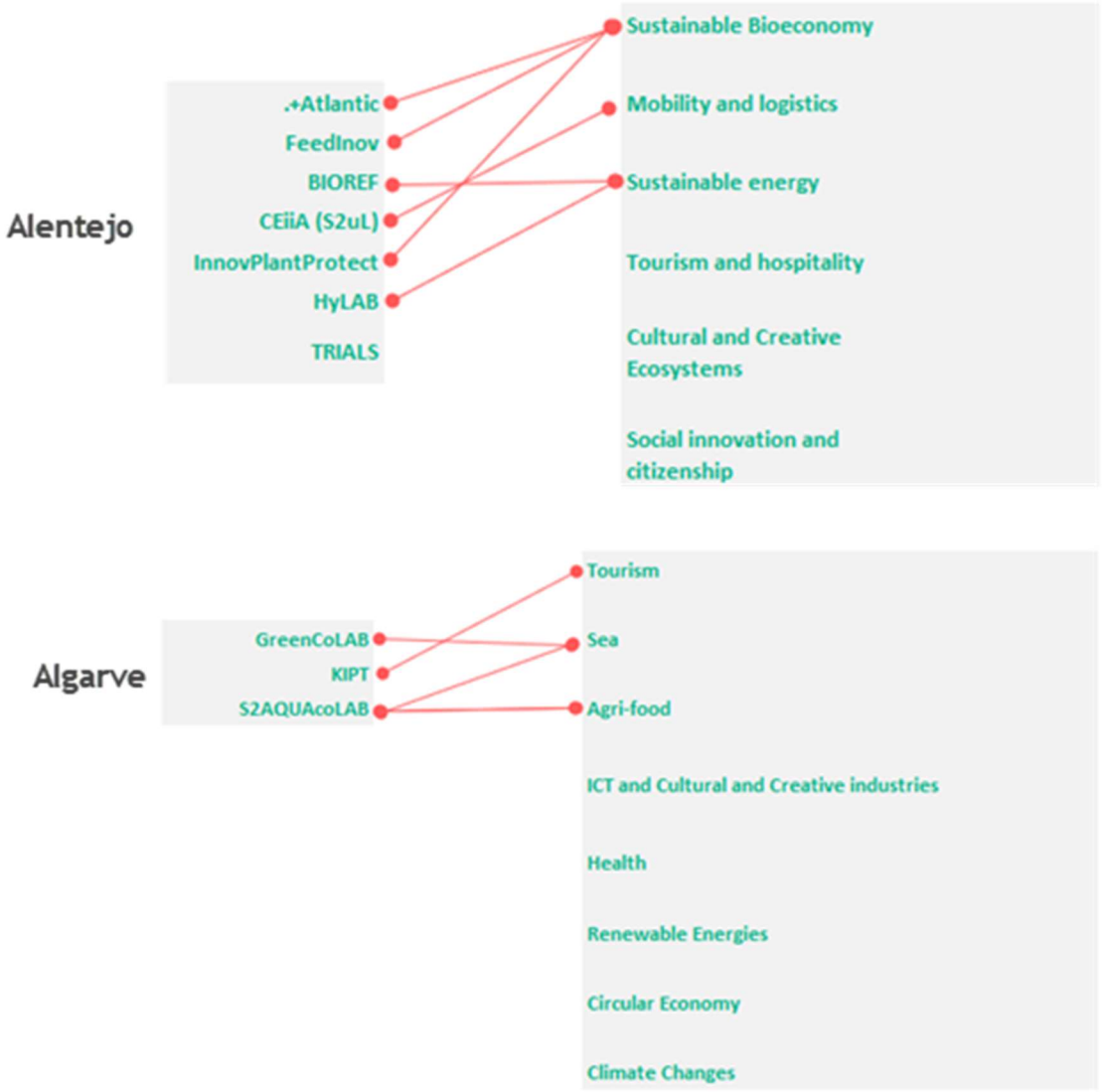
Source: IPCTN, 2020

The agenda of each CoLAB should be the result of a joint effort between public and private sectors, adopting a matrix that crosses specialisation priorities with technologies and scientific knowledge. Additionally, the regional Smart and Specialisation Strategies (RIS3) to the period 2021-2027 highlights the extreme importance of knowledge production and technology development to generate economic and social value and the need to promote the incorporation of innovation in traditional and emergent sectors. Thus, considering the thematic specialization of CoLABs and its integration in regional dynamics, it is also important to analyse the connection between the regional priority domains and the areas in which

CoLABs can provide solutions to concrete problems. With this purpose, a simple matrix that connects each CoLAB to the specialization domains in each region is provided in **Figure 21.**

Figure 21. Connection of CoLABs to region's RIS3 domains





From this analysis, North and Centre are the regions with more correspondences between the thematic area of the CoLABs and the region's priority domains, demonstrating that the CoLABs are connected with regional specialization priorities. In the Lisbon region, CoLABs attend to four of the 7 specialization domains – Health, Digital transition, blue economy and mobility and transports. As regards to Alentejo region, CoLABs mainly operate in three specialization areas: sustainable bioeconomy, sustainable energy and mobility and logistics. Finally, the CoLABs located in the Algarve relate to three priority domains, two of them considered structural for the region (Tourism and sea).

FINAL REMARKS

This report provides an overview of the evolution of the CoLABs network in the past year, analysing their integration in the Portuguese ecosystem. Analysing the data provided in the report, it is possible to verify that the network of 35 CoLABs is evolving in different dimensions which can be summarized on three main axes.

The first correspond to the mobilisation of the productive, social and cultural sectors in the creation and consolidation of CoLABs. Integrating 300 entities in their associative structure, CoLABs are demonstrating their capacity to integrate different types of entities in this process of co-responsibility and risk sharing between public and private sectors in the development of market-oriented research and innovation. As shown in the report, companies assume a greater predominance in CoLABs, representing 46% of its associates.

The second relate to the thematic specialization of CoLABs. Corresponding to initiatives in various areas of knowledge, the implementation of the CoLABs' research and innovation agendas is contributing to the creation of new competencies and synergies, resulting also in the diversification of CoLABs funding sources. Considering in particular the effort to attract competitive funding, the data shows that, in 2020, CoLABs were engaged in more than 250 competitive applications, from which 53 were approved, resulting in the attraction of 30.5 million € of investment to the development of CoLABs activities.

Finally, having contributed to the direct creation of 562 highly qualified jobs, CoLABs are demonstrating their potential to attract and retain talent, contributing to answer regional innovation and specialization challenges and to the densification of national territories in terms of knowledge-based activities with economic and social impact.

ANNEX I – (PT)

TORNAR A ECONOMIA MAIS COMPLEXA POR VIA DA INOVAÇÃO

A industrialização inovadora do país é encarada como uma das vias prioritárias para alcançar a *convergência* europeia até 2030 e, por conseguinte, alavancar o potencial de crescimento da economia portuguesa e garantir uma melhoria sustentável do nível de vida da população.

A concretização deste desígnio passa pela consolidação de empresas competitivas à escala global, potenciando uma transformação estrutural da economia portuguesa. Em particular, o próximo quadro de financiamento plurianual 2021-2027, em articulação com o Programa de Recuperação e Resiliência (2021-2026), deverá permitir tornar a economia mais complexa por via de inovação empresarial e do desenvolvimento do conhecimento científico e tecnológico, através de novas combinações de capacidades e competências, associada a uma diversificação produtiva baseada no princípio das atividades relacionadas, tal como proposto no "Atlas da Complexidade Económica" (ver em https://atlas.cid.harvard.edu/; e Hausmann e Hidalgo, 2009).

Neste sentido, a evolução recente do tecido empresarial é brevemente analisada neste anexo por forma a identificar fileiras industriais que revelem massa crítica em termos de capacidades e competências exigidas para liderar as agendas de industrialização. Mais concretamente, o desafio passa, por reconhecer as fileiras industriais inseridas de forma consolidada nos mercados internacionais, que demonstrem capacidade de gerar empregos qualificados a partir da introdução de processos e produtos inovadores.

Assim, é em primeiro lugar analisada de forma breve a inserção de Portugal nos mercados globais e o nível de complexidade dos produtos exportados, a partir dos dados disponibilizados pelo observatório de complexidade económica. A segunda etapa deste processo de identificação passa por complementar a análise com a caracterização dos setores no que diz respeito à inovação empresarial, ao nível de produtividade e à geração de emprego, permitindo assim identificar.

Este processo de identificação preliminar é suportado por um exercício analítico que consiste na classificação das principais fileiras industriais a partir de um Índice Compósito de Competitividade Industrial. Este índice é calculado a partir de indicadores macroeconómicos que permitem ilustrar o desempenho de cada fileira nas dimensões acima referidas, nomeadamente Intensidade em I&D, Orientação Exportadora, Produtividade e Emprego. São considerados tanto indicadores numa perspetiva estática, considerando a sua posição em 2018, o ano mais recente para o qual existe informação disponível, como indicadores numa perspetiva dinâmica, avaliando a sua trajetória ao longo da última década.

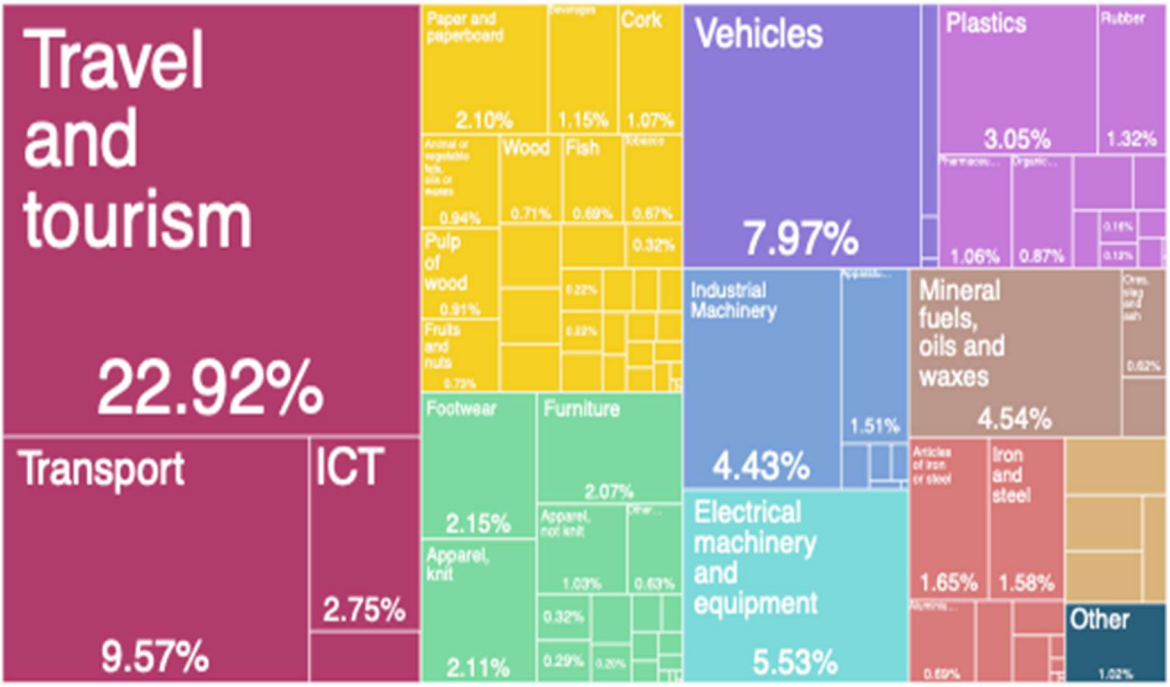
De seguida, são analisadas de forma crítica as oportunidades concretas de diversificação produtiva associadas a cada fileira.

A. **Inserção nos mercados internacionais**

Em 2018, Portugal exportou um total de 106 mil milhões de dólares, tendo registado um crescimento de 3,2% nos últimos 5 anos, tendência positiva que permitiu a subida do peso das exportações no PIB de 30% em 2010 para 44% em 2018

Os serviços mais representativos são o turismo, os transportes e as telecomunicações e os produtos com maior peso nas exportações são os veículos, o equipamento e maquinaria, o calçado e os têxteis. Esta distribuição está representada na figura 1.

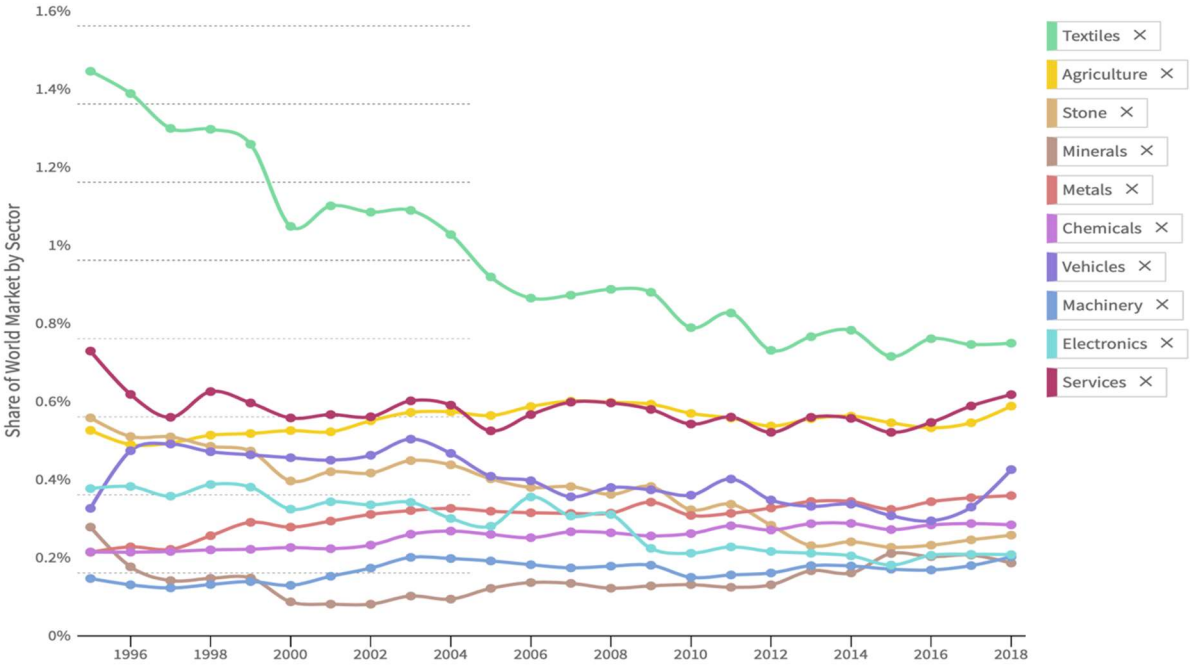
Figura 1- Distribuição das exportações por produtos (2018)



Fonte: https://atlas.cid.harvard.edu/

A análise da quota das exportações nacionais por setor no total mundial de exportações permite avaliar a performance competitiva das fileiras nacionais nos mercados globais. A sua análise permite destacar o têxtil enquanto setor com maior quota, mas também aquele que tem registado um desempenho mais negativo. Em sentido contrário, a evolução deste perfil destaca o recente aumento da relevância dos veículos nacionais.

Figura 2- Evolução das peso nas exportações mundial por setor



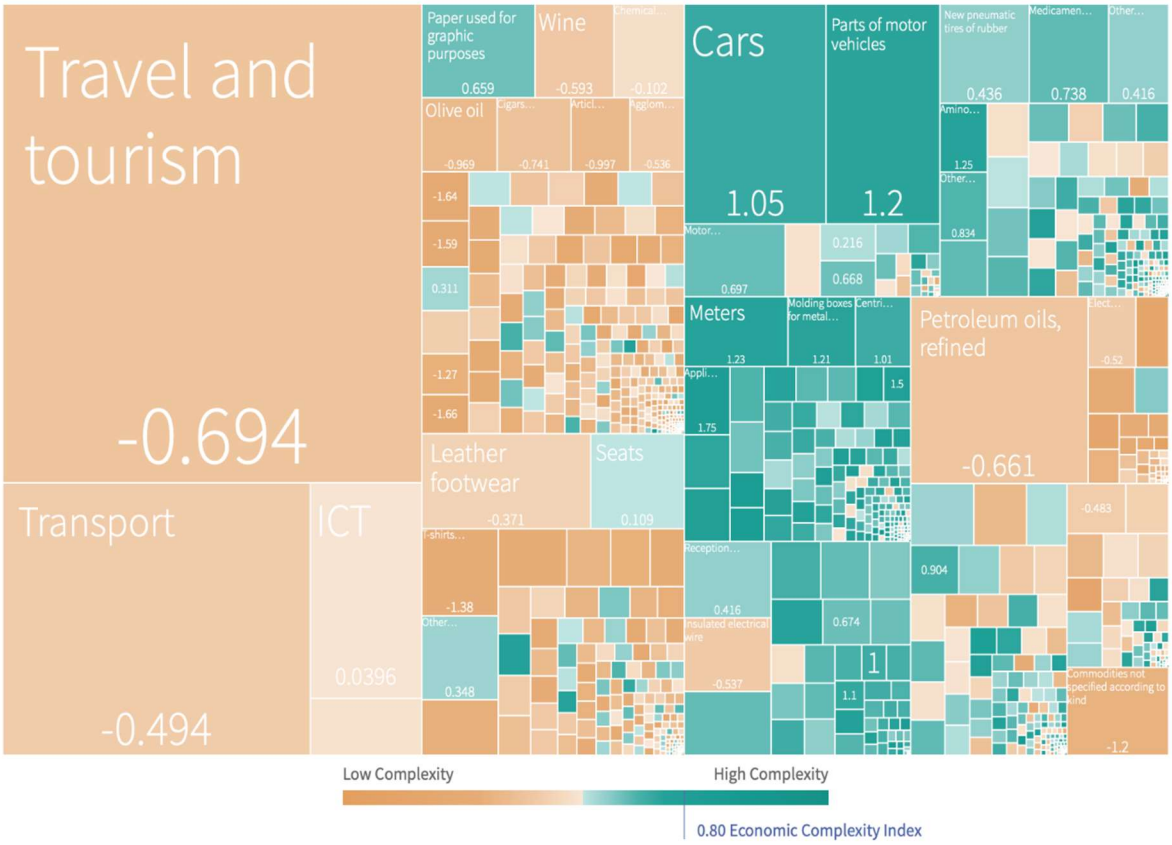
Fonte: https://atlas.cid.harvard.edu/

B. **Complexidade**

O trabalho do observatório de complexidade económica tem ilustrado uma relação entre o nível de complexidade dos produtos exportados pelos países e o seu crescimento económico. Para além disso, argumenta que o crescimento pode ser feito por um processo de diversificação de produção para produtos mais complexos.

Na figura seguinte apresenta-se o perfil de exportações de Portugal de acordo com a complexidade para o ano de 2018. De acordo com a figura pode observar-se que os produtos de baixa ou moderada complexidade ainda representam uma importante proporção das exportações nacionais.

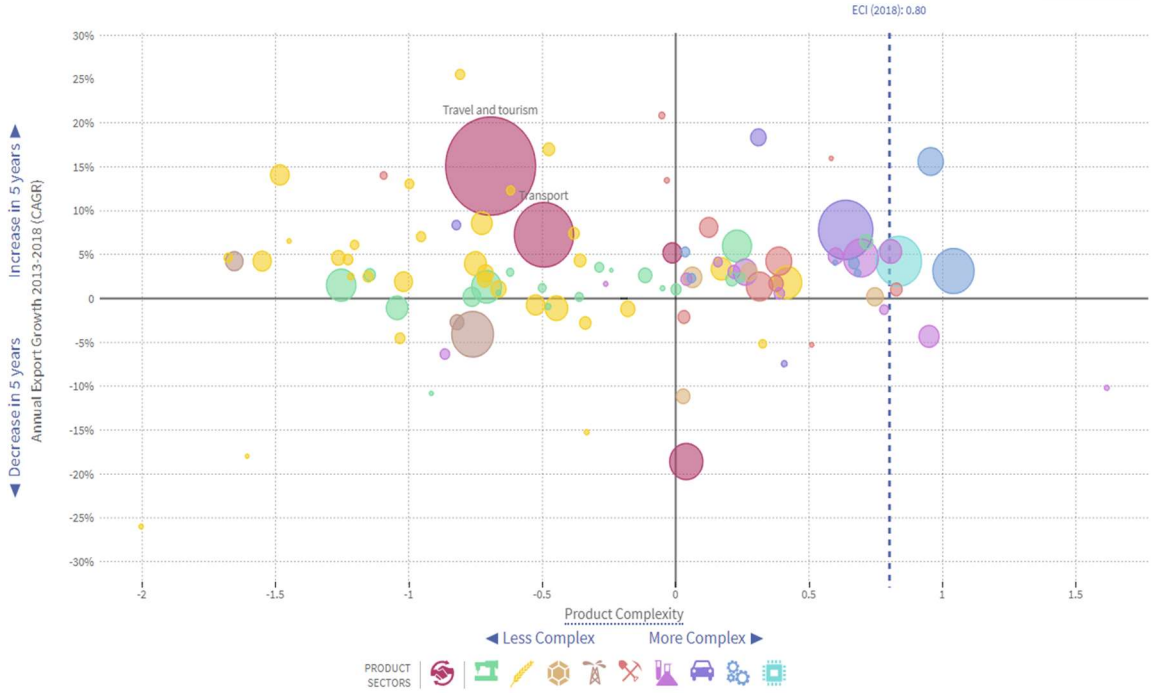
Figura 3- Perfil de complexidade de exportações em Portugal - 2018



Fonte: https://atlas.cid.harvard.edu/

No entanto, quando analisamos a evolução deste perfil nos últimos 5 anos, podemos observar que tem havido um aumento significativo em setores de maior complexidade, nomeadamente o aeronáutico, o farmacêutico e a eletrónica.

Figura 4- Crescimento das exportações por níveis de complexidade



Fonte: https://atlas.cid.harvard.edu/

C. **Competitividade Industrial**

O processo de identificação preliminar das fileiras industriais com capacidade para liderar agendas de industrialização é complementado com a proposta de um Índice Compósito de Competitividade Industrial. Este índice é calculado a partir de indicadores macroeconómicos que permitem ilustrar o desempenho de cada fileira nas dimensões acima referidas, nomeadamente Intensidade em I&D, Orientação Exportadora, Produtividade e Emprego. São considerados três indicadores numa perspetiva estática, considerando a sua posição em 2018, o ano mais recente para o qual existe informação disponível, e três indicadores numa perspetiva dinâmica, avaliando a sua trajetória ao longo da última década.

A sua análise permite concluir que a indústria farmacêutica é a fileira que consegue articular de forma mais virtuosa as dimensões preconizadas. É a fileira com maior nível de produtividade, aquela que investe mais em I&D e a segunda em que os mercados internacionais mais pesam nas vendas (76%), fruto do maior aumento percentual de exportações verificado entre as várias fileiras desde 2010 (15% ao ano). Embora tenha conseguido gerar emprego a um nível significativo, importa notar que, face a 2010, esta fileira não tem conseguido aumentar de forma consistente a produtividade.

Adicionalmente, as fileiras mais bem colocadas são o equipamento de transporte, impulsionada sobretudo pela elevada orientação exportadora e geração de emprego, e a produção de equipamentos informáticos e eletrónicos, fileira que regista a segunda maior intensidade em I&D.

O "top 5" é completado pela fileira da produção de máquinas e equipamentos e a fileira química, indústrias que conseguem traduzir a elevada intensidade em I&D num desempenho positivo quer em termos de orientação exportadora, quer em termos de produtividade.

Tabela 1 - Competitividade da Indústria transformadora em Portugal

	2018			**Dinâmica recente (2010 – 2018)**			**Indicador Compósito de competitividade Industrial [2]**
	Produtividade Aparente do Trabalho *(VAB/EMP)*[1]	Intensidade em I&D *(I&D/VAB)*	Orientação Exportadora *(EXP/VNEG)*	Emprego *(CAGR)*	Exportações *(CAGR)*	Produtividade *(CAGR)*	
Farmacêutica	206	23,8%	76,0%	3%	15%	0%	**85**
Equipamento de transporte	122	2,3%	80,4%	5%	9%	1%	**60**
Informática e eletrónica	122	8,5%	65,6%	3%	7%	1%	**55**
Máquinas e equipamento	120	3,4%	53,6%	2%	9%	1%	**46**
Produtos Químicos	183	4,6%	47,5%	1%	4%	0%	**40**
Borracha e Plásticos	130	2,7%	48,1%	0%	5%	2%	**38**
Metalomecânica	100	1,4%	41,6%	1%	7%	3%	**38**
Moda	58	1,0%	58,7%	1%	4%	3%	**37**
Madeira e Papel	137	2,2%	46,1%	-1%	4%	3%	**36**
Outras indústrias	66	1,2%	44,4%	0%	6%	3%	**32**
Agroalimentar	96	2,0%	20,1%	1%	5%	1%	**25**
Equipamento elétrico	113	5,4%	49,3%	0%	1%	-2%	**21**

Fonte de dados: INE; DGEEC

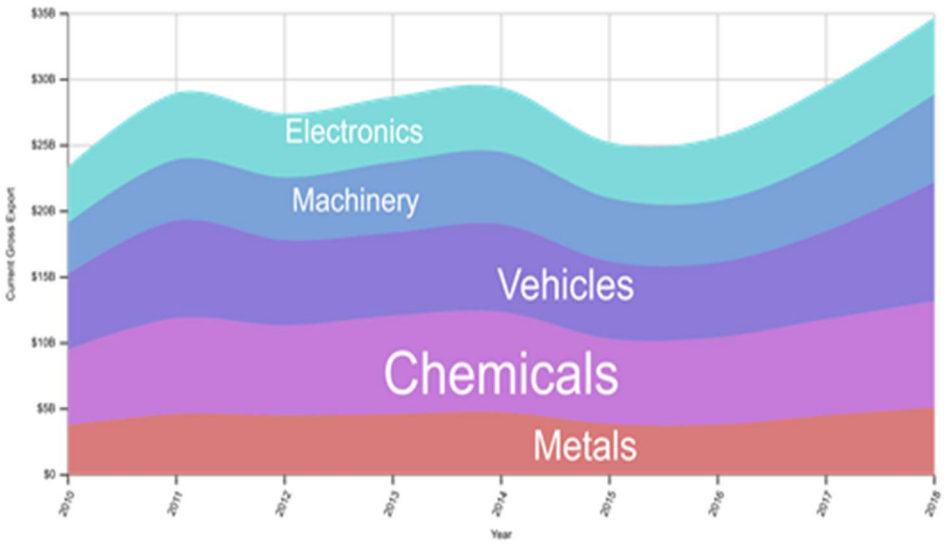
[1] Índice base 100=Produtividade média das Indústrias Transformadoras
[2] O indicador compósito de competitividade é calculado a partir da média dos indicadores, normalizados numa escala de 0 a 100 utilizando uma transformação Min-Max

D. **Análise setorial detalhada**

A partir da análise global apresentada de exportações dos diferentes setores da indústria transformadora, apresenta-se de seguida uma análise mais detalhada para os setores que se destacam pelo conjunto da sua performance nos indicadores apresentados: produtividade, exportações e intensidade de I&D.

A figura 5 apresenta a evolução das exportações para os 5 setores identificados, onde se verifica um crescimento sobretudo na eletrónica, equipamento e nos transportes.

Figura 5- Evolução das exportações por setores



Fonte: https://atlas.cid.harvard.edu/

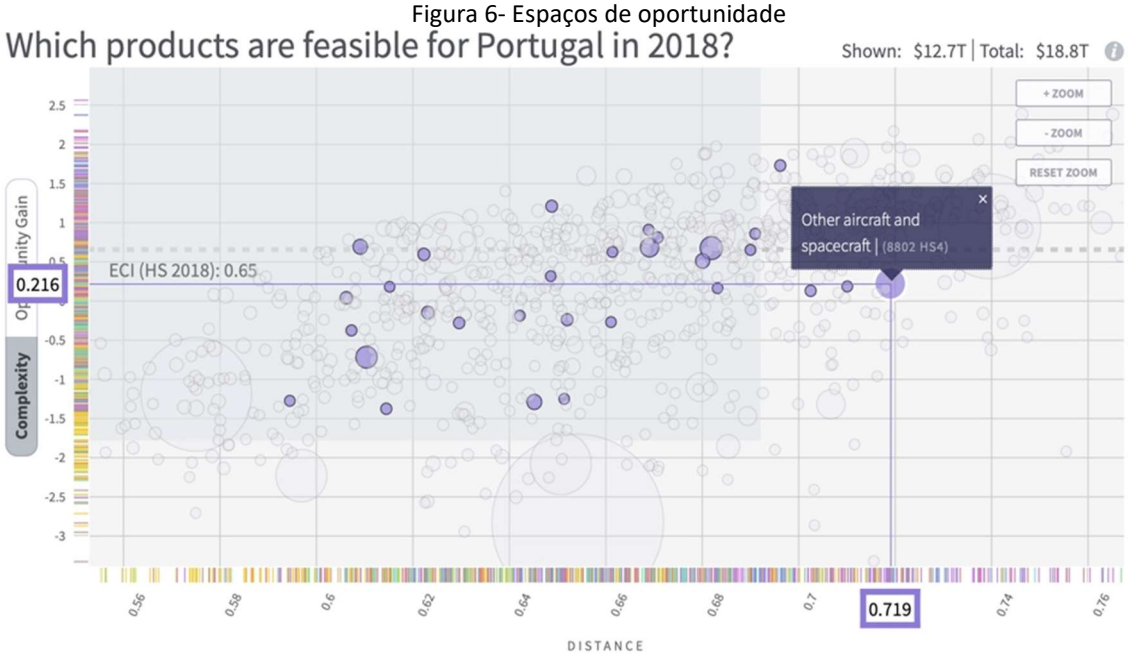
Nota: O setor farmacêutico está integrado nos produtos químicos

E. Oportunidades de diversificação

Com base na capacidade exportadora instalada e na matriz de exportações existentes, é possível identificar produtos nos quais há uma oportunidade de aumentar as exportações. Em anexo apresentamos a lista dos produtos para os quais está identificada maior oportunidade de diversificação e maior complexidade.

Por exemplo, no setor dos transportes, há uma oportunidade identificada na aeronáutica e espaço, produtos de maior complexidade e consequentemente, com um potencial impacto elevado no crescimento económico.

Figura 6- Espaços de oportunidade



Fonte: https://atlas.cid.harvard.edu/

Tabela 2. Espaço de oportunidade de diversificação de exportações- lista de produtos

Product	Distance	Product Complexity Index (PCI)	Opportunity Gain	Sector
Photographic film, developed	0,779	2,56	0,961	Chemicals
Machining centers for working metal	0,746	2,38	1,02	Machinery
Articles for utensils, of cermet	0,744	2,02	1,25	Metals
Chemical elements for electronics	0,765	2,37	0,899	Chemicals
Ion-exchangers based on polymers	0,719	1,96	1,29	Chemicals
Machines n.e.c.	0,712	1,88	1,34	Machinery
Measuring instruments	0,724	1,82	1,27	Machinery
Silicones in primary forms	0,755	1,72	1,22	Chemicals
Interchangeable tools for hand tools	0,692	1,73	1,34	Metals
Phosporic esters	0,754	1,97	0,997	Chemicals
Flat-rolled products of other alloy steel, width > 600 mm	0,711	1,83	1,18	Metals
Electric soldering machines	0,681	1,88	1,2	Electronics
Industrial electric furnaces	0,68	1,87	1,21	Electronics
Calendering or other rolling machines, other than for metals or glass	0,683	1,97	1,1	Machinery
Photographic plates	0,752	1,95	0,928	Chemicals
Instruments for physical or chemical analysis	0,73	1,62	1,24	Machinery

Cermets	0,72	2,16	0,812	Metals
Lathes for removing metal	0,691	1,79	1,15	Machinery
Chemical preparations for photographic uses	0,771	2,18	0,662	Chemicals
Bars of stainless steel, hot-rolled	0,707	1,9	1,02	Metals
Esters of other inorganic acids of nonmetals	0,731	1,57	1,21	Chemicals
Laboratory, hygienic or pharmaceutical glassware	0,707	1,69	1,16	Stone
Self-propelled railway coaches	0,696	1,72	1,15	Vehicles
Photographic film in rolls	0,783	2,08	0,663	Chemicals
Machines with grinding stones for finishing metal	0,681	1,87	1,05	Machinery
Machines for testing the mechanical properties of materials	0,705	1,78	1,06	Machinery
Carboxyimide-function compounds	0,717	1,62	1,16	Chemicals
Inorganic compounds, liquid or compressed air	0,737	2,06	0,749	Chemicals
Other machine tools for planing and cutting metals	0,699	1,86	0,984	Machinery
Screws and similar articles of iron or steel	0,679	1,53	1,29	Metals
Halides of nonmetals	0,764	2,09	0,65	Chemicals
Other salts of acids	0,737	1,61	1,07	Chemicals
Machinery for working rubber or plastics	0,685	1,66	1,14	Machinery
Fork-lift trucks	0,72	1,56	1,14	Machinery

Nickel plates	0,738	1,57	1,09	Metals
Musical instruments	0,719	1,68	1,04	Machinery
Other organo-inorganic compounds	0,75	1,8	0,837	Chemicals
Microscopes, other than optical	0,753	1,62	0,974	Machinery
Electromagnets	0,709	1,54	1,13	Electronics
Machine tools for molding and forging metals	0,683	1,63	1,11	Machinery
X-ray machines	0,77	1,25	1,22	Machinery
Instruments for measuring properties of liquids or gases	0,699	1,54	1,13	Machinery
Transparent paper	0,703	1,87	0,857	Agriculture
Transmission shafts	0,656	1,59	1,18	Machinery
Drafting tables and machines	0,731	1,38	1,17	Machinery
Tungsten (wolfram)	0,72	1,37	1,2	Metals
Acrylic polymers	0,717	1,52	1,07	Chemicals
Epoxides	0,756	1,53	0,97	Chemicals
Machinery for making paper	0,675	1,74	0,978	Machinery
Worked glass	0,721	1,95	0,696	Stone

ANNEX II - (PT)

EVOLUÇÃO DA DESPESA EM I&D: ANÁLISE E PERSPETIVA DE EVOLUÇÃO

(executada e quantificada em termos comparados internacionalmente)

A despesa total em I&D em Portugal atingiu um novo máximo histórico de 3.203 MEuros em 2020, representando agora 1,6% do PIB, superior ao valor de 2.992 MEuros atingido em 2019. Estes dados revelam um aumento pelo quinto ano consecutivo, num total acumulado de 969 milhões de euros face a 2015 (quando era de 2.234 MEuros).

Figura A.1. Evolução da despesa pública e privada em I&D, com valores executados até 2020

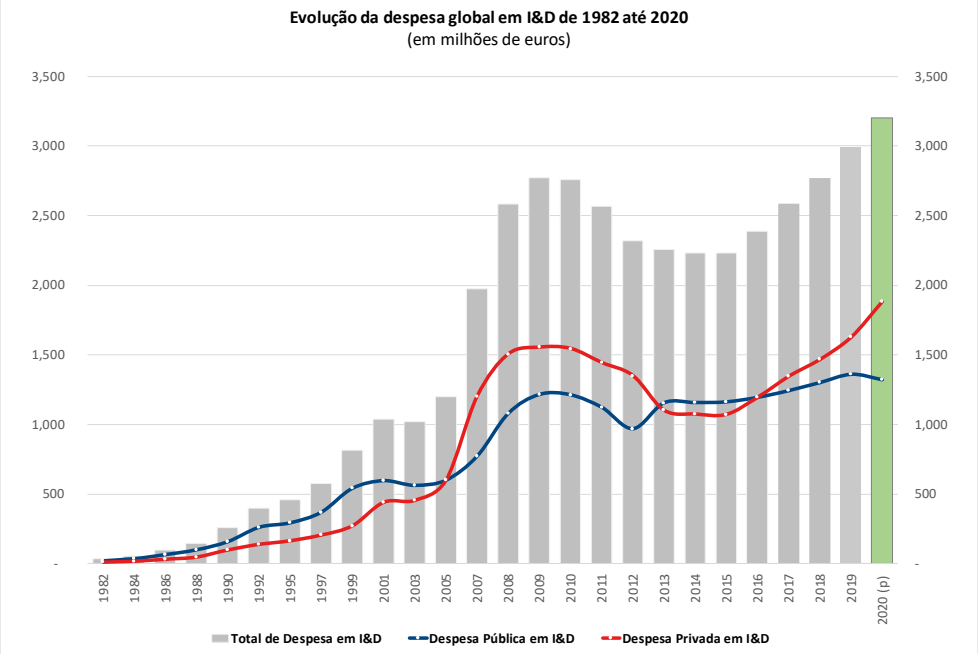
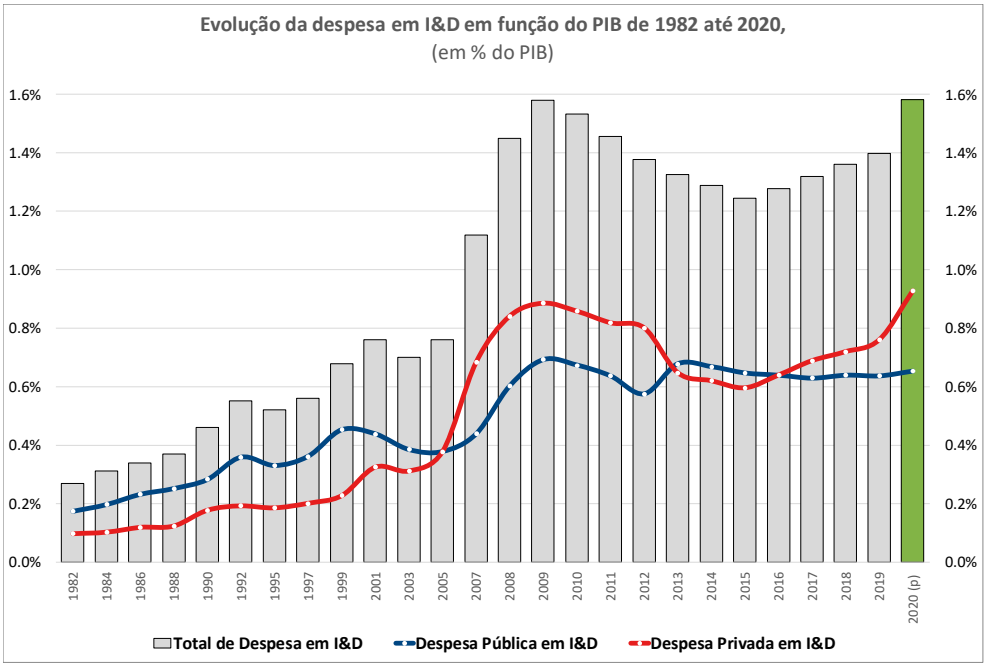


Figura A.2. Evolução da despesa pública e privada em I&D em % do PIB, com valores executados até 2020



O crescimento da despesa em I&D é particularmente expressivo no sector das empresas, crescendo 15% em 2020 (i.e., 241 MEuros) e cerca de 75% desde 2015 (quando era 1.037 MEuros em 2015). Este crescimento está associado a uma despesa em I&D pelas empresas, que representa agora 0,89% do PIB (enquanto era 0,58% em 2015). A despesa em I&D das empresas passa a representar 57% da despesa total em I&D (era 46% em 2015 e cerca de 44% em 2009), superando a despesa pública pelo quarto ano consecutivo.

Os dados reforçam a tendência de crescimento verificada desde 2016, confirmando o processo de convergência com a Europa. O valor da despesa total em I&D corresponde a um aumento de 7% face a 2019 e de 43% desde 2015, quando representava cerca 1,2% do PIB.

Tabela A.1: Evolução da despesa pública e privada em I&D, com valores executados até 2020

Ano	**Despesa Pública em I&D** (inclui ens. superior e Estado) (M€)	**Despesa Privada em I&D** (inclui empresas e IPSFL) (M€)	**Total de Despesa em I&D** (M€)	**Total de Despesa em I&D** (% do PIB)
2015	1 163	1 072	2 234	1,24%
2016	1 194	1 195	2 388	1,28%
2017	1 241	1 344	2 585	1,32%
2018	1 300	1 469	2 769	1,36%
2019	1 361	1 626	2 987	1,41%
2020	1 323	1 680	3 203	1,58%

Fonte: Ministério da Ciência, Tecnologia e Ensino Superior com base em IPCTN;
(e) estimativa

A despesa em I&D no ensino superior reduz de cerca 4% face a 2019 (i.e, cerca de 45 MEuros), em associação com o impacto causado pela pandemia COVID-19 e a diminuição da maioria das atividades presenciais das instituições de Ensino Superior e, consequentemente, a redução das suas despesas de funcionamento, incluindo deslocações.

Pelo contrário, o aumento da despesa em I&D pelas empresas e instituições privadas reflete o crescimento do emprego qualificado e o esforço do sector privado em acompanhar o desenvolvimento científico e a capacidade tecnológica instalada em Portugal.

O número de investigadores na população ativa cresce para um máximo também histórico de cerca de 10,2 investigadores por mil ativos em 2020 (i.e., quando medidos em tempo integral, enquanto era 9,6‰ em 2019 e 7,4 ‰ em 2015).

Foram registados 52.535 investigadores em equivalente a tempo integral (ETI), mais cerca de 2.369 do que em 2019 (i.e., crescimento global de 5%), mostrando um crescimento de 13.863 investigadores ETI desde 2015, ou seja, um aumento de 36% nos últimos 5 anos. O Ensino Superior inclui 28.732 investigadores em ETI (eram 25.043 em 2015), representando cerca de 55% do total, enquanto as empresas incluem 21.389 investigadores em ETI (eram 11.785 em 2015), representando agora 41% do total.

O número de investigadores nas empresas aumenta em 2.169 ETIs, representado um aumento de 11% em 2020 e de 81% desde 2015 (quando eram 11.785 ETIs). O número de investigadores no Estado continua a representar cerca de 3% do total, com 1.601 ETIs em 2020 (eram 1.351 investigadores ETI em 2015, incluindo sobretudo os Laboratórios do Estado).

O total de recursos humanos em atividades de I&D (i.e., total de investigadores, técnicos e outros profissionais) atinge 12,7 pessoas (ETI) por cada mil habitantes ativos, atingindo 65.356 ETIs em 2020 (enquanto eram 47.999 ETIs em 2015). O total de recursos humanos em atividades de I&D nas Empresas também aumenta, totalizando 30.206 ETI em 2020, ou seja, mais de 3.400 do que em 2019 (crescimento de 13%).

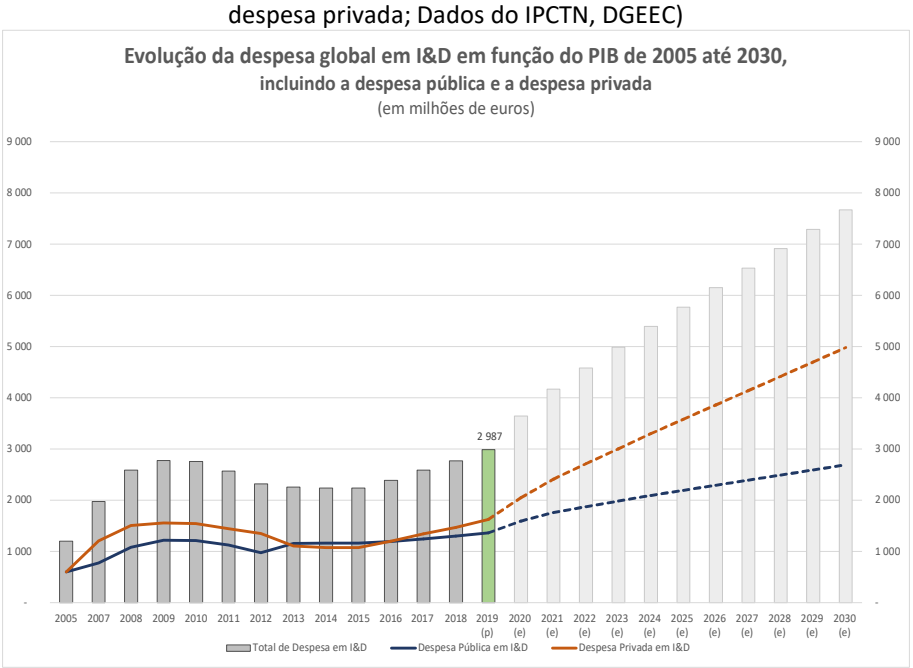
O aumento da despesa privada em I&D reflete o crescimento do emprego qualificado nas empresas e o esforço do sector privado em acompanhar o desenvolvimento científico e a capacidade tecnológica instalada em Portugal. Mas o aumento global do investimento em I&D reflete também a prioridade política dada ao desenvolvimento científico e tecnológico e ao "Compromisso com a Ciência e o Conhecimento", assim como a "Estratégia de Inovação Tecnológica" do Governo (ver resolução do Conselho Ministros 25/2018, de 8 de março), verificando a tendência expressa no Programa Nacional de Reformas quanto à retoma do processo de convergência com a Europa.

A implementação da estratégia de inovação tecnológica e empresarial para Portugal 2018-2030 prioriza o reforço da trajetória de aumento da despesa em I&D, por forma a **alcançar um investimento global em I&D de 3% do PIB até 2030**, com uma parcela de cerca de 1/3 de despesa pública e de cerca de 2/3 de despesa privada. Este objetivo implica o esforço coletivo de **duplicar o investimento privado anual em I&D**, juntamente com a criação de cerca de 20 mil novos empregos qualificados no setor privado, assim como **duplicar o investimento público em I&D até 2030**.

A concretização destes objetivos exigirá uma articulação virtuosa das diferentes fontes de financiamento disponíveis nos próximos anos, designadamente:

1. **Fundos nacionais**, provenientes de receitas de impostos, como identificado na proposta do Orçamento de Estado para 2021;
2. **Fundos comunitários** de gestão descentralizada através do ***Plano de Recuperação e Resiliência*** (PRR) para 2021-26;
3. **Fundos comunitários** de gestão descentralizada através do **Quadro de Financiamento Plurianual 2021-27**, nomeadamente pelo ***Programa Portugal 2030***;
4. **Fundos comunitários de gestão centralizada** através do novo **quadro europeu de investigação e inovação** para 2021-27, incluindo o Programa "Horizonte Europa", o futuro do Programa ERASMUS+ e o futuro programa europeu para o Espaço, entre outros;
5. **Outros fundos privados e públicos**, designadamente o investimento das empresas e da administração pública em formação avançada de recursos humanos e em atividades de I&D.

Figura A.2. Previsão da evolução desejável da despesa global em I&D até 2030 (incluindo a despesa pública e a despesa privada; Dados do IPCTN, DGEEC)



Esta maior alocação de recursos humanos e financeiros em atividades de I&D deverá alavancar o crescimento acelerado das empresas com base na inovação e na diversificação produtiva da estrutura da economia, apoiando em simultâneo a transição rumo a uma economia e uma sociedade mais ecológica, digital e resiliente para prevenir e resistir a eventuais futuros choques.

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