

TECHNOLOGICAL ROADMAP
on Additive Manufacturing and
Advanced Materials
in the **SUDOE** region

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Additive manufacturing is a disruptive technology, which has been adopted by several industrial sectors, such as the aerospace, aeronautics and defence, as well the automotive sector and the medical one. It is also being gradually adopted by many other sectors including textile and sportswear, food and construction. It is a key technology fostering a paradigm shift focusing on the concepts of mass customisation and mass personalisation, allowing for products to be produced closer to the point of use at the time of need, which significantly changed the traditional supply chain, limiting material waste, promoting economies of scale and reducing the lead time. Moreover, additive manufacturing is a core element of the smart connected manufacturing transformation characterising the so-called fourth industrial revolution.

Since its emergence thirty years ago, additive manufacturing was embraced by several companies in Portugal, Spain and France, and I would like to congratulate the consortium responsible for the preparation of this important document. It is a consortium formed by partners with internationally recognized expertise in the field of additive manufacturing, who play an important role in its development, optimization, dissemination and promotion within new industrial sectors. This roadmap is a valuable document presenting the state-of-the-art of additive manufacturing in the SUDOE region. It covers aspects related to the most relevant techniques, materials and applications, and addresses key challenges and future developments. Thus, the document is of undeniable interest for students, researchers, industrialists and policy makers.

Personally, I found it quite relevant and informative and the authors deserve my full recognition.

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ABBREVIATIONS

3DP	3D Printing or 3D Printer
3DP W	3D Printing or 3D Printer Based On Wire Extrusion
AM	Additive Manufacturing
Am	Advanced Materials
BJ	Bind Jetting
EBM	Electron Beam Melting
FDM	Fused Deposition Modelling
KET	Key Enabling Technologies
RTD	Research and Technological Development Institution
R&D	Research and Development
R&D+I	Research and Development and Innovation
IRT	Industrial Research Institute
RIS3	National/Regional Research and Innovation Strategies for Smart Specialisation
SL / SLA	Stereolithography
SLM	Selective Laser Melting
SLS	Selective Laser Sintering

TERMINOLOGY

3D Printing	Refers to AM Desktop Equipments
FDM SL / SLA SLS	Refers to AM Industrial Equipments (Plastics)
EBM SLM	Refers to AM Industrial Equipments (Metals)



INTRODUCTION

This document aims at presenting a guidance map regarding Additive Manufacturing (AM) and Advanced Materials (Am) Key Enabling Technologies (KET) in the SUDOE region, and constitutes an open working document developed in the framework of SAMT SUDOE project “Spread of Additive Manufacturing (AM) and advanced materials Technologies for the promotion of KET industrial technologies in plastic processors and mould industries within SUDOE space”.

This roadmap was designed with the aim to motivate the increase in the use of Additive Manufacturing Technologies and Advanced Materials within the SUDOE region and to facilitate the approach of Moulds and Plastics Industry and R&D entities.

This is an important tool for these sectors in order to identify new opportunities, either from market, innovation or research and to stimulate the participation in R & D projects in this fields.

This document is based on the compilation of the results from the project activities namely, industry and RTDs surveys, trend analysis, interviews and workshops. The views presented here are in accordance to this outputs and do not necessarily represent the views of the entire AM community.

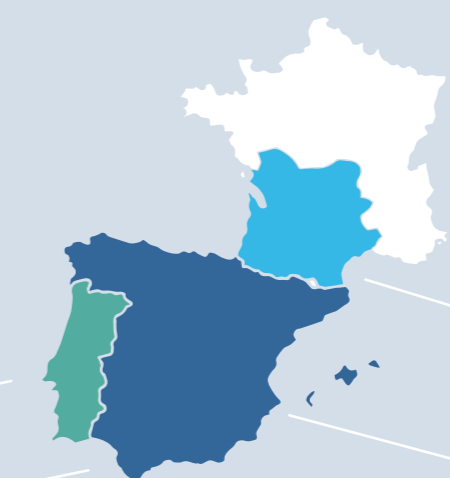
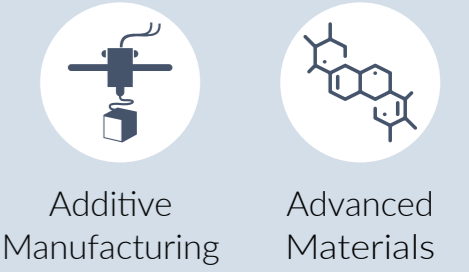


PROJECT AND FRAMEWORK

PROJECT AND FRAMEWORK
SAMT SUDOE PROJECT



PROJECT AND FRAMEWORK
PARTNERSHIP



SPREAD OF ADDITIVE MANUFACTURING AND ADVANCED MATERIALS TECHNOLOGIES IN PLASTIC PROCESSORS AND MOULD INDUSTRIES

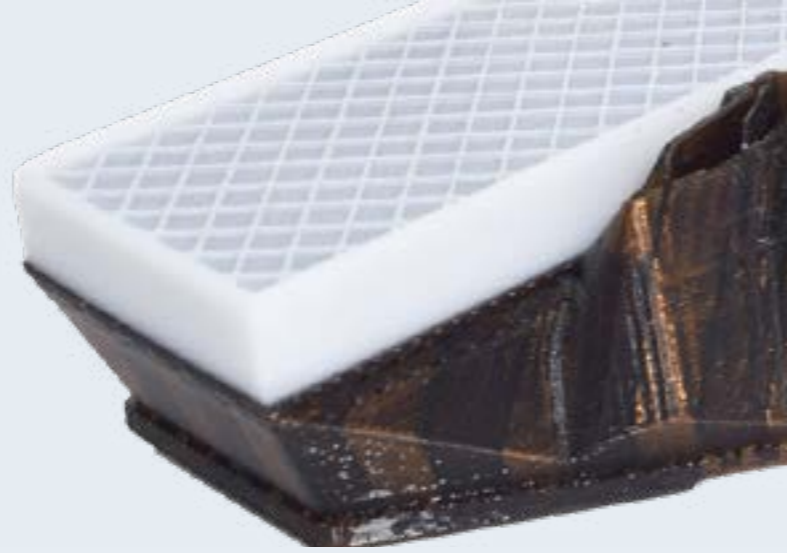
SAMT SUDOE PROJECT aims at developing links and synergies between enterprises, R&D centres, clusters, higher education and R&D+i governmental & regional institutions to promote new KET in SUDOE space.

Particularly, Additive manufacturing technologies (3D printing) and Advanced Materials will be the project focus in order to boost advanced production systems, nanotechnology and advanced materials in industrial sectors present in SUDOE space such as plastic processors and mould industries.



SURVEY DEMOGRAPHICS

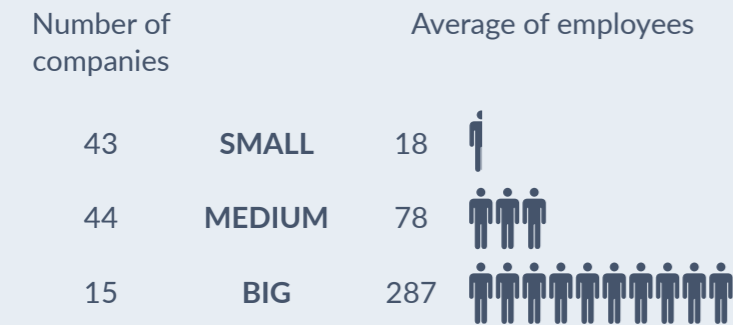
The state of art reflected in this roadmap has been built upon a series of surveys undertaken along France, Spain and Portugal. The main characteristics of the companies and science and technologies centers surveyed are included here. Complete information on this surveys can be seen in www.samtsudoe.com in the specific reports.



102 COMPANIES



SIZE OF THE COMPANIES



36 SCIENCE AND TECHNOLOGY CENTERS



TYPE OF SCIENCE AND TECHNOLOGY CENTERS

RESEARCH CENTER	13
TECHNOLOGY CENTER	9
UNIVERSITY	3
POLYTECHNICAL INSTITUTE	2
LABORATORY	4
OTHER	5

RESPONDENTS



COMPANIES

ACTIVITY SECTOR

	FR	ES	PT
Moulds	1	7	28
Plastics	16	16	17
Moulds & Plastics		11	
Special Tools	9	5	6
Standard parts manufacturing	5	4	4
Press-forming	5		2

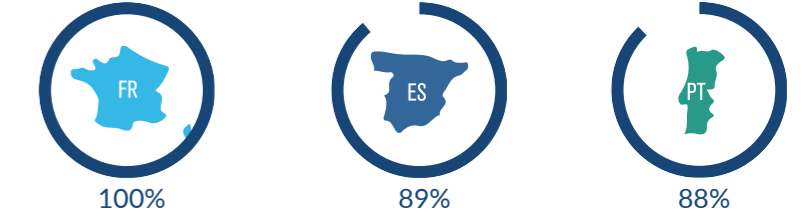
CLIENT SECTOR

	FR	ES	PT
Automotive	33%	65%	85%
Electronics	33%	44%	
Home appliances	33%	49%	56%
Housewares	11%	65%	54%
Packaging	56%	70%	66%
Medical devices	39%	47%	37%
Aeronautics	22%	40%	41%



SCIENCE AND TECHNOLOGY CENTERS

USE OF AM BY THE ENTITIES SURVEYED

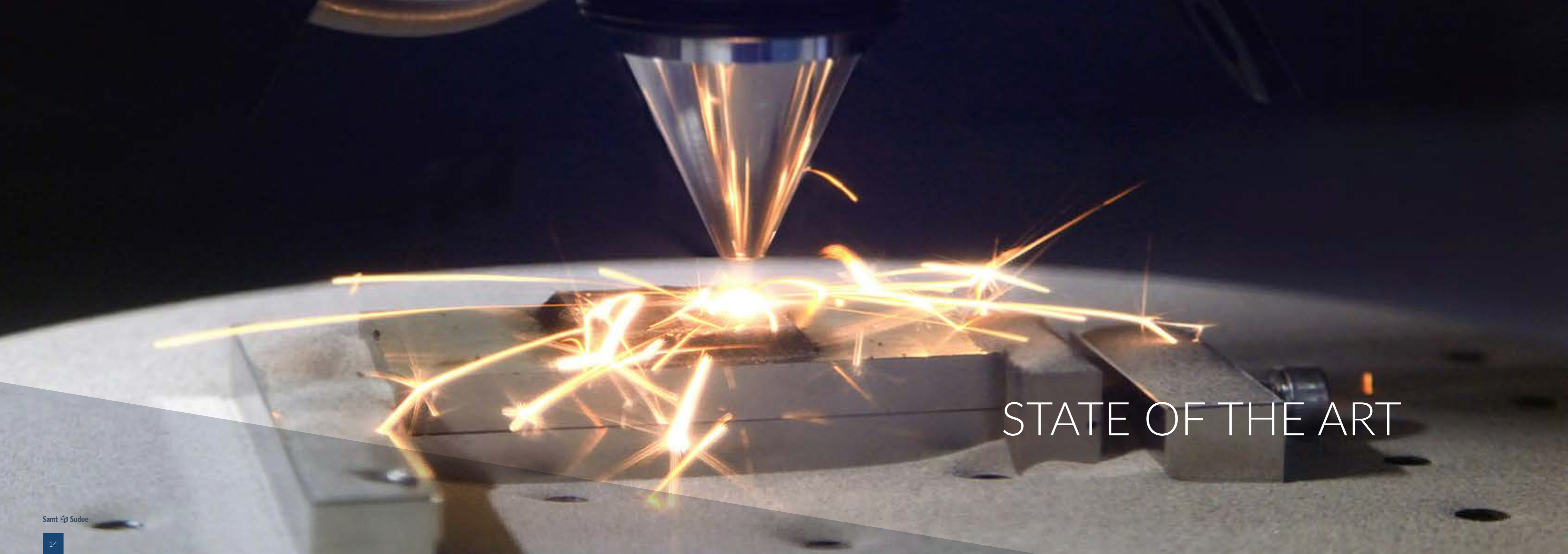


MAIN APPLICATIONS

- Research on technology and materials regarding Additive Manufacturing
- Industrial applications for new materials and non-conventional materials
- Support services for companies (tests, laboratory, pre-series, etc.)

MAIN ACTIVITY SECTOR OF THE ENTITIES

	FR	ES	PT
Moulds	29%	60%	67%
Plastics	43%	40%	78%
Automotive	71%	40%	67%
Medical devices	57%	80%	44%
Aeronautics	100%	40%	22%



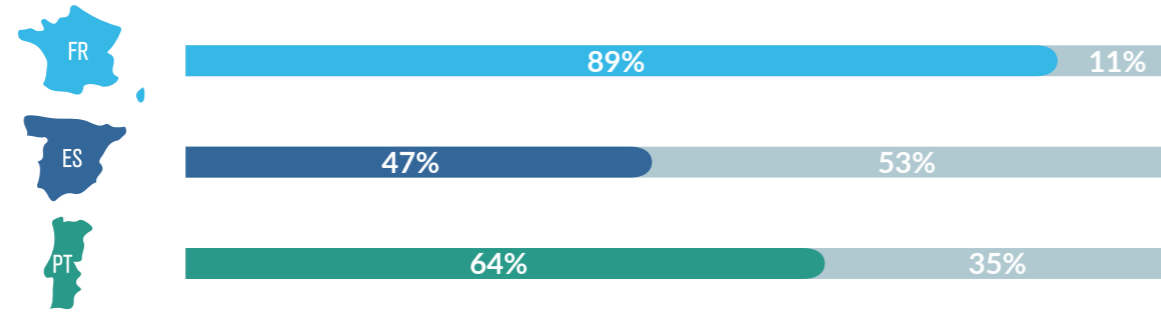
STATE OF THE ART

EXISTING TECHNOLOGIES

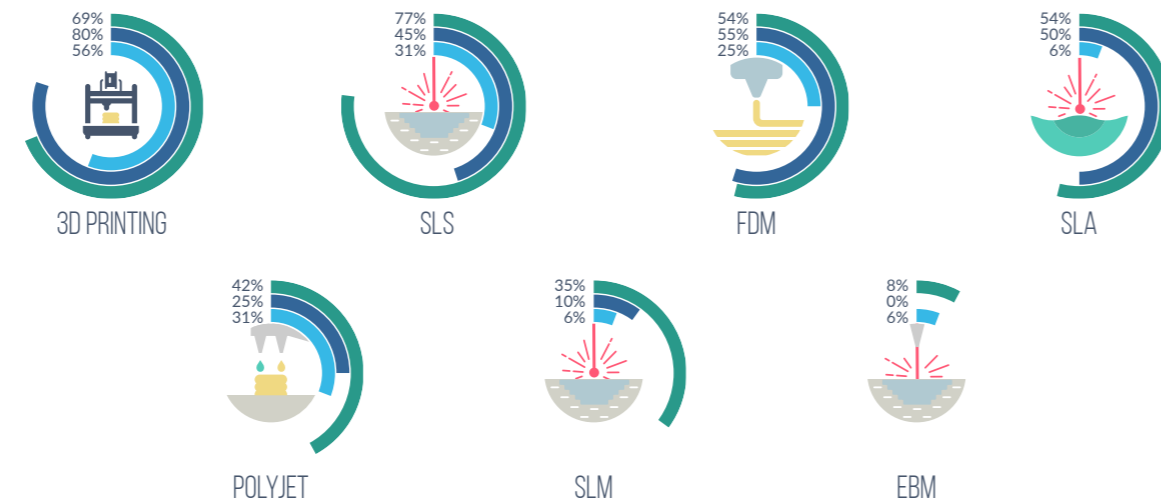
TECHNOLOGIES ALREADY USED BY COMPANIES

The vast majority of companies in the SUDOE region have a reasonable knowledge of Additive Manufacturing technologies, and use these technologies to develop their activities and thus better satisfy their customers.

DO THESE COMPANIES MAKE USE OF ADDITIVE MANUFACTURING?



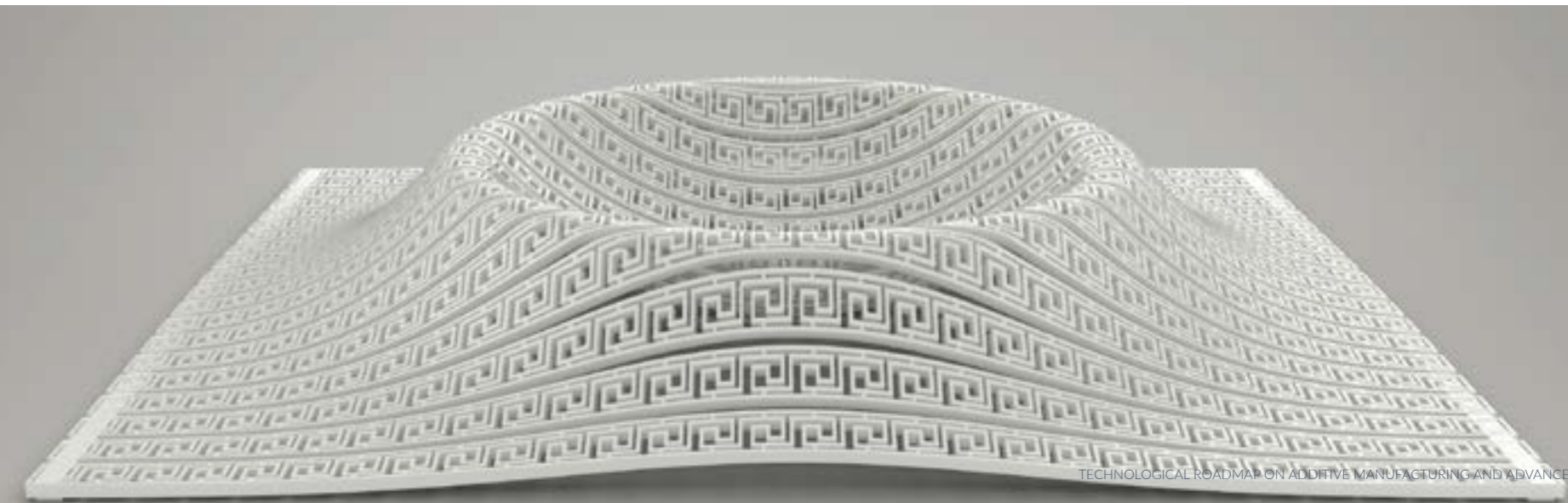
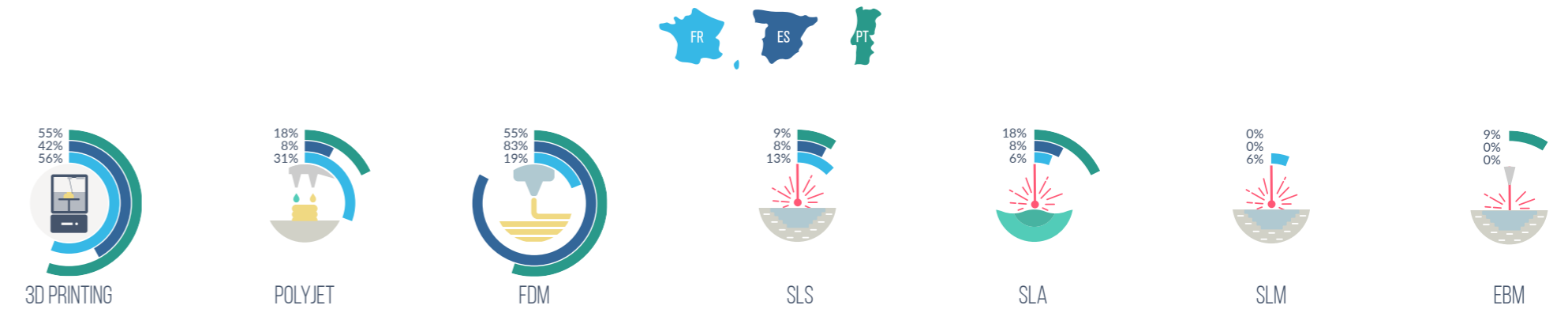
MOST USED TECHNOLOGIES



TECHNOLOGIES AVAILABLES IN COMPANIES

The vast majority of Additive Manufacturing equipments that companies hold internally at their facilities are less expensive ones (3D Printers) and with lower operating, maintenance and materials costs (FDM).

Companies mostly use these technologies for production of prototypes and functional models for advanced applications involving product evaluation and functional testing which demonstrates a good knowledge and confidence in the application of these technologies.



STATE OF THE ART
EXISTING TECHNOLOGIES

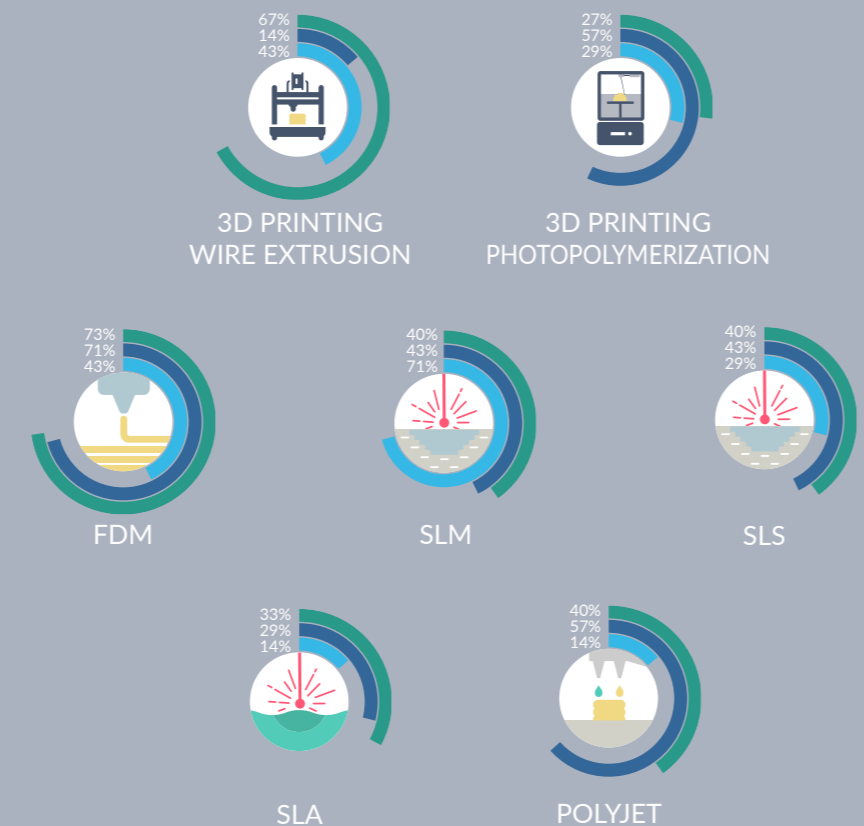
IN HOUSE TECHNOLOGIES IN RTDs

The most common Additive Manufacturing Technologies are available and widely used in the R&D entities of the SUDOE region.

The areas of expertise and research domains are focused on activities directed to the Automotive industry, Healthcare, Electronics and Plastics.

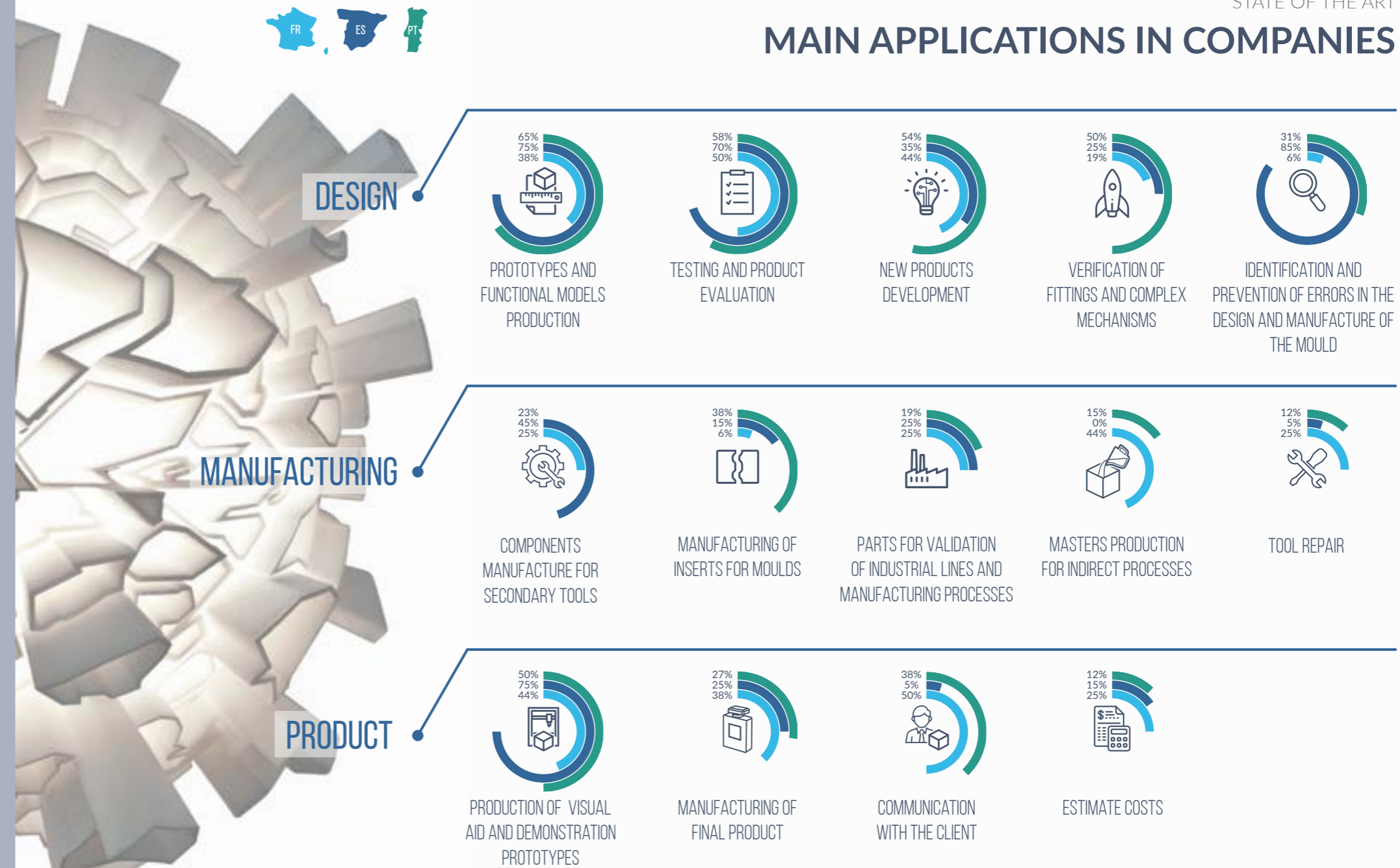
The vast majority of R&D entities provides services in the field of Additive Manufacturing directly to companies.

Effectively, companies are incorporating the Additive Manufacturing Technologies into their Manufacturing processes, often relying on the services of the R&D entities.



STATE OF THE ART

MAIN APPLICATIONS IN COMPANIES

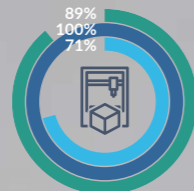


MAIN APPLICATIONS IN RESEARCH AND TECHNOLOGY CENTERS

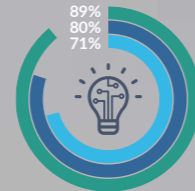


The main AM Technologies are used in multiple activities as a response to current market needs and research projects for future challenges..

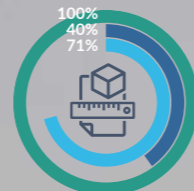
The application of AM Technologies in the manufacturing of metallic components and inserts for moulds is still very low revealing the need for greater interaction, promotion of applications and knowledge sharing between the R&D institutions and companies through demonstration actions and the promotion of advantages and opportunities in this type of applications.



PRODUCTION OF VISUAL AID AND DEMONSTRATION PROTOTYPES



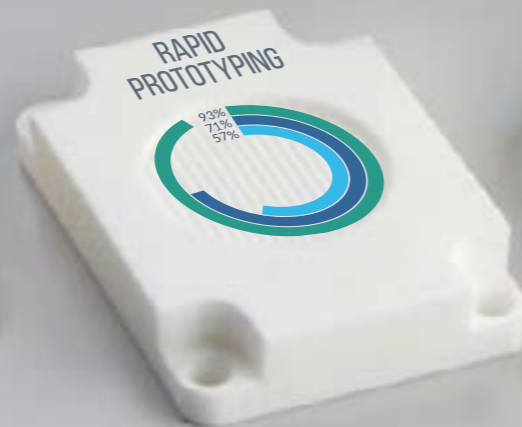
SUPPORT TO NEW PRODUCTS DEVELOPMENT



PROTOTYPES AND FUNCTIONAL MODELS PRODUCTION



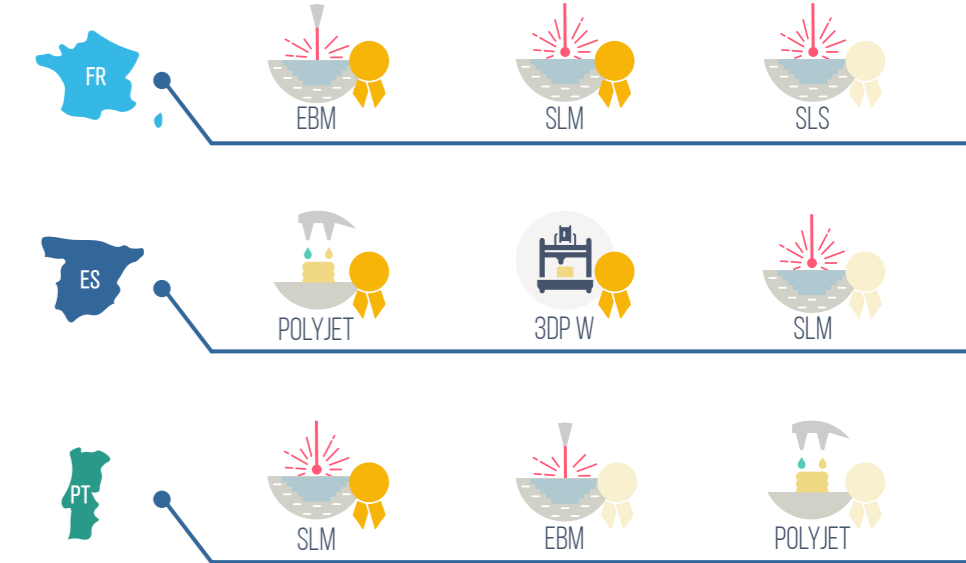
TESTING AND PRODUCT EVALUATION



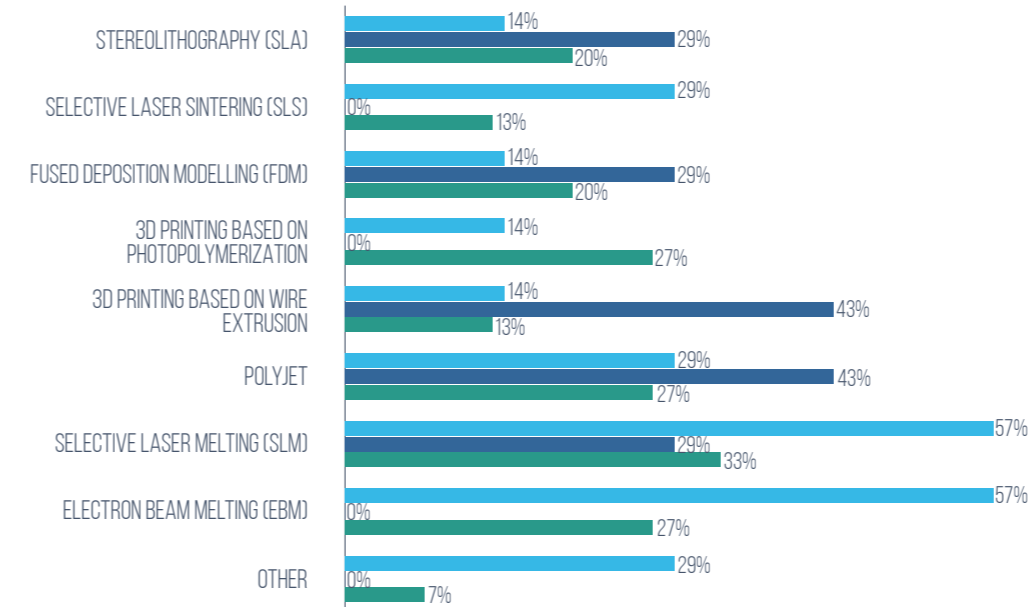
FUTURE ACQUISITIONS - NEXT 5 YEARS

The R&D entities were questioned about the future prospect in terms of capacity increase in Additive Manufacturing Technologies and, in this sense, it was possible to identify the Technologies that the entities of each country plan to invest in the next 5 years.

It can be foreseen a strong investment bet on Additive Manufacturing Technologies for metallic materials as well as in 3D Printers and on the use of noble materials like titanium for more advanced applications .



EXPANSION OF THE ORGANIZATION CAPACITY FOR ADDITIVE MANUFACTURING TECHNOLOGIES (5 YEARS)





TECHNOLOGY GOALS AND BARRIERS

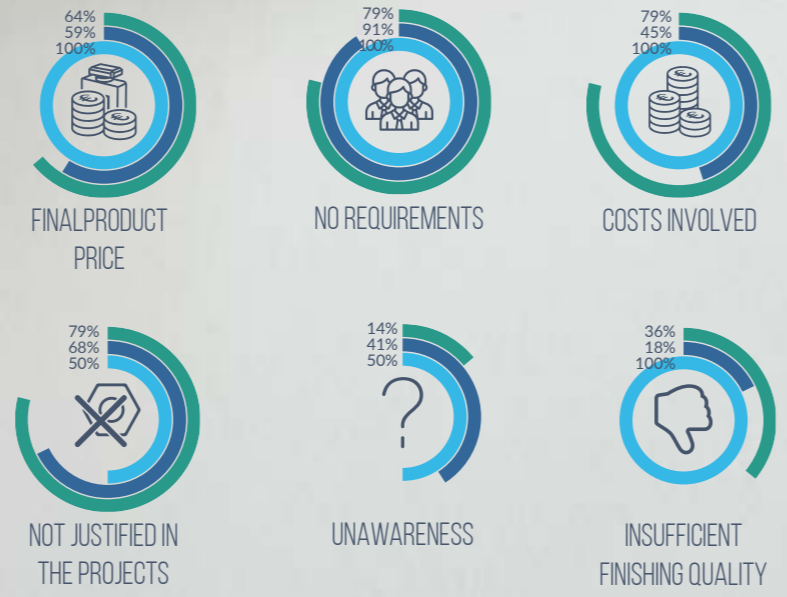
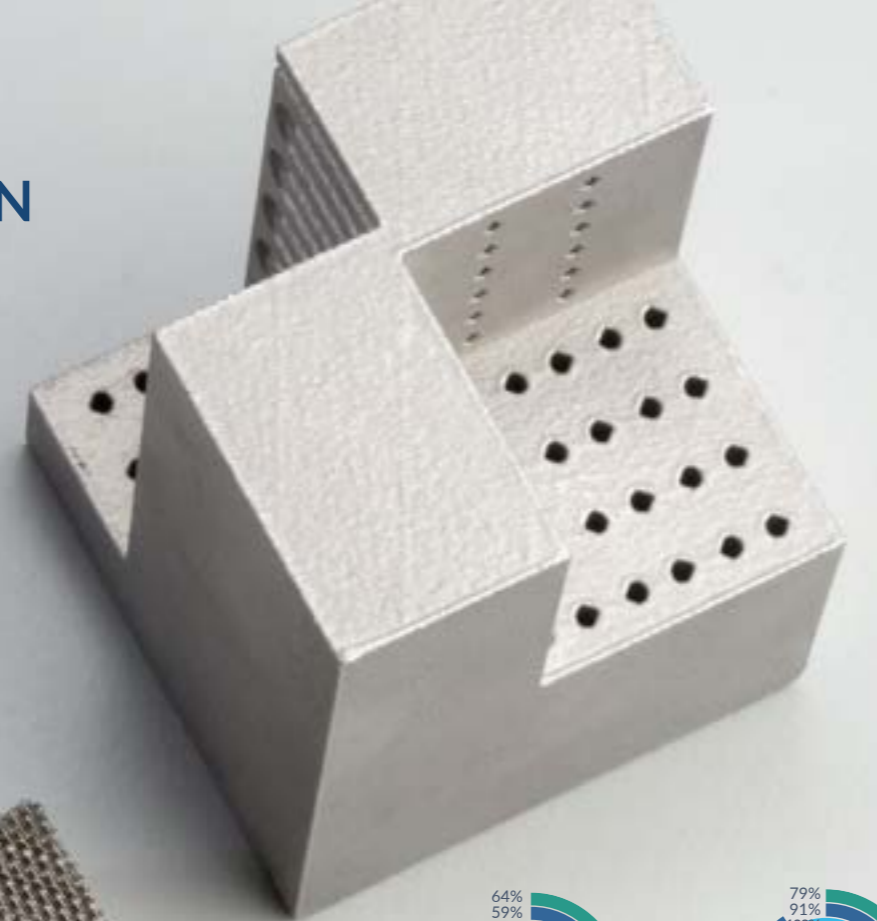
MAIN BARRIERS FOR DECISION

WHY COMPANIES DO NOT USE AM?

Additive Manufacturing Technologies are recognized by some companies in Spain and Portugal to bring significant benefits in terms of reduced moulds and product potential design, reduced product developments, reduced manufacturing errors, and for mould making sector more specially in terms of capacity of using conformal cooling channels and reduced design time.

Despite such recognized advantages, companies still hesitate to invest in AM mainly for cost reasons.

As regards to companies which have no relation with these technologies, this is due to the lack of knowledge about them and because they are not convinced about the quality of finishing (especially in France).



ADVANTAGES AND NEEDED KNOWLEDGE

RECOGNIZED ADVANTAGES



KNOWING NEEDS IN COMPANIES

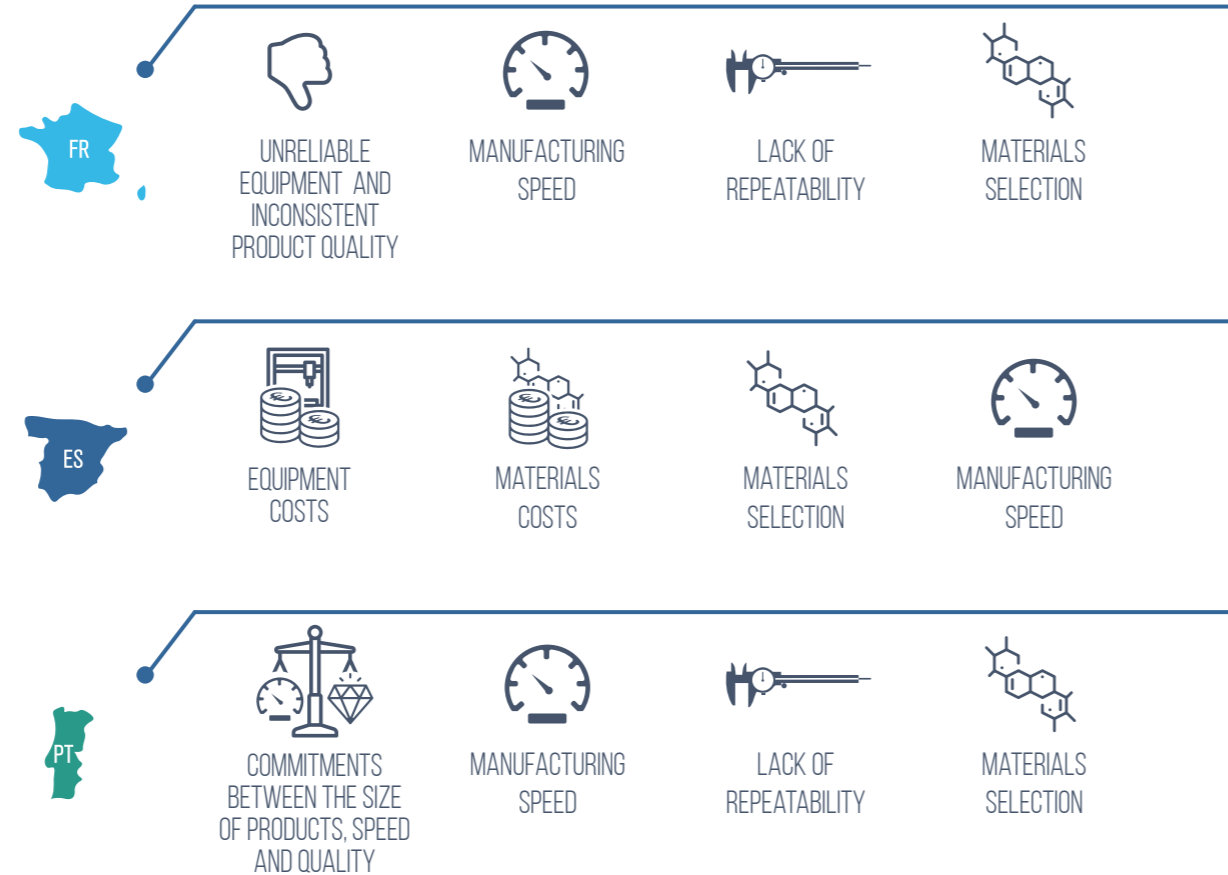
Companies that are not yet using these technologies shown a strong interest at increasing knowledge in the field of additive manufacturing, namely in:

- Knowing types of equipment and technologies
- Gathering deep knowledge on the technologies
- Attending demonstrations and places where the technology is available
- Getting in contact with scientific and technological centers which work in this field.

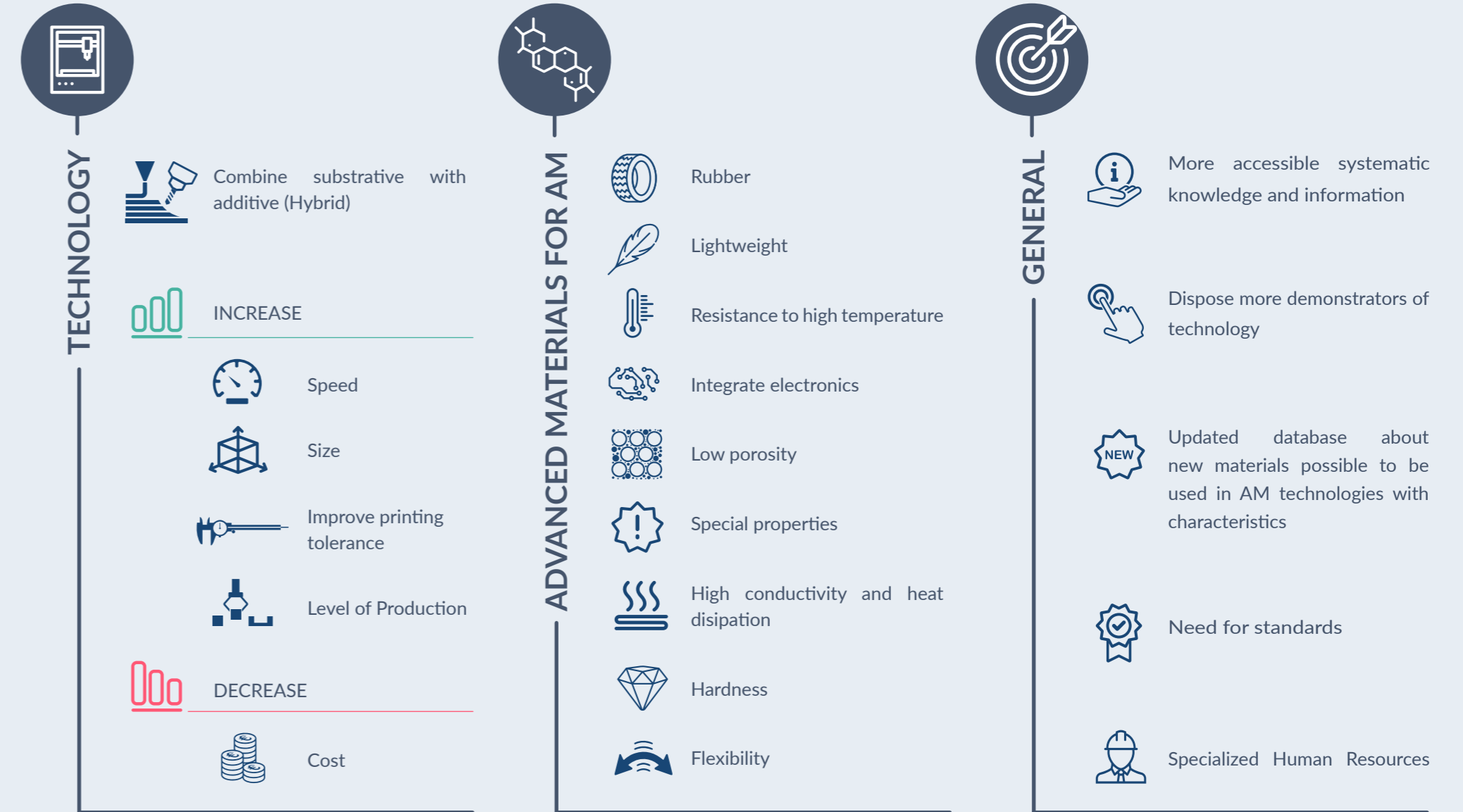
CHALLENGES TO ADOPTION BY RESEARCH CENTRES

The R&D entities were questioned about the challenges they face in market regards in terms of Additive Manufacturing Technologies and Advanced Materials, as well as their strategic perspective to face these challenges.

There is still a long way to go in the development of KET-Key Enabling Technologies, regarding the various challenges and barriers considered most important that entities will face in the next 5 years.

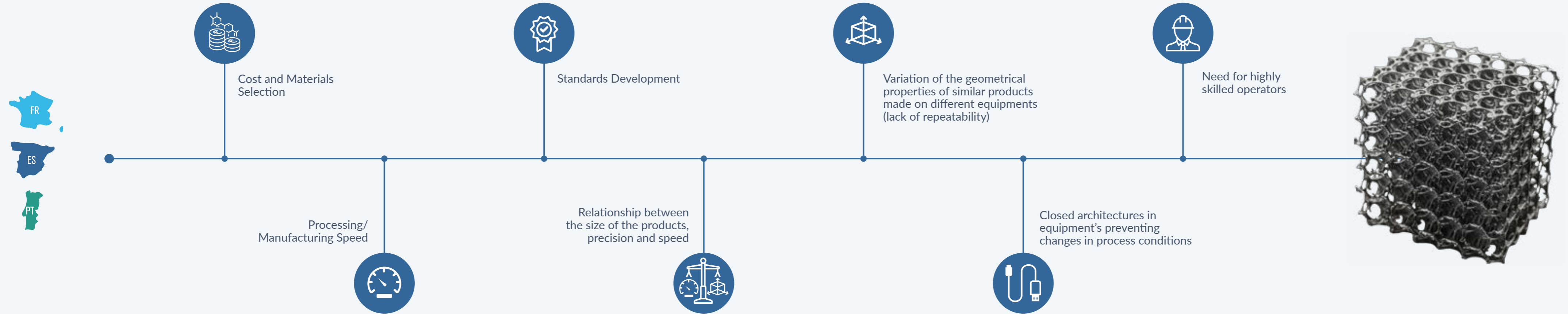


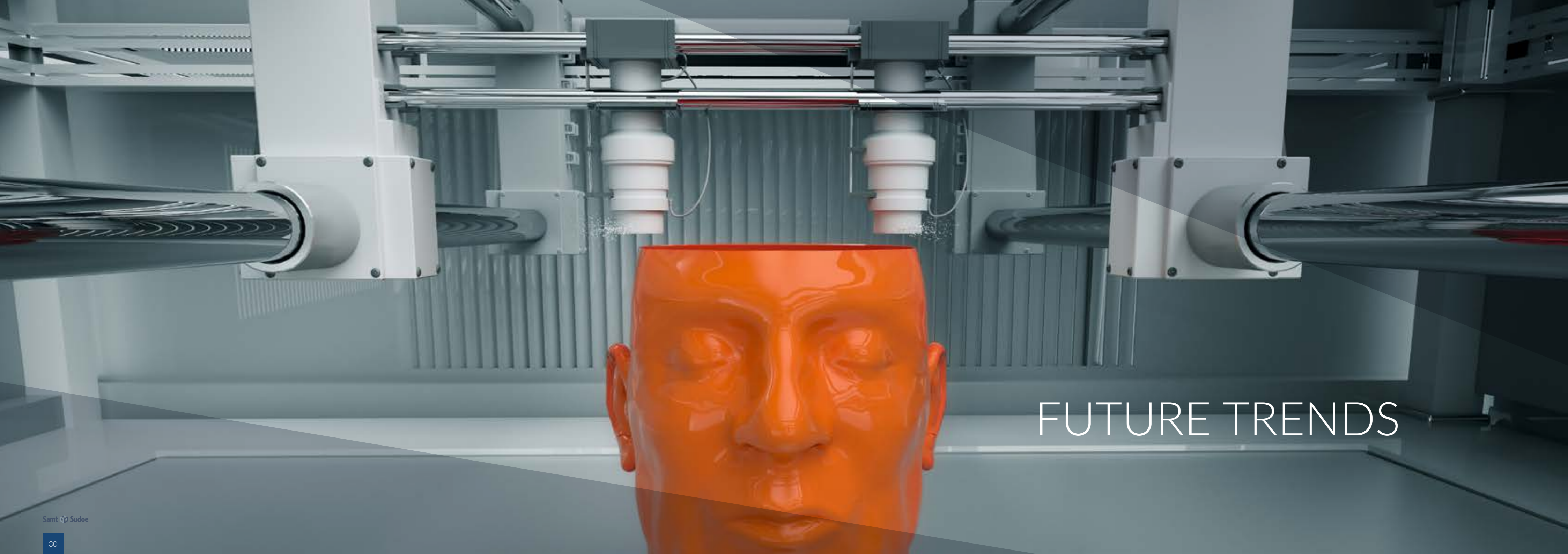
TECHNOLOGY GOALS



CHALLENGES - NEXT 5 YEARS

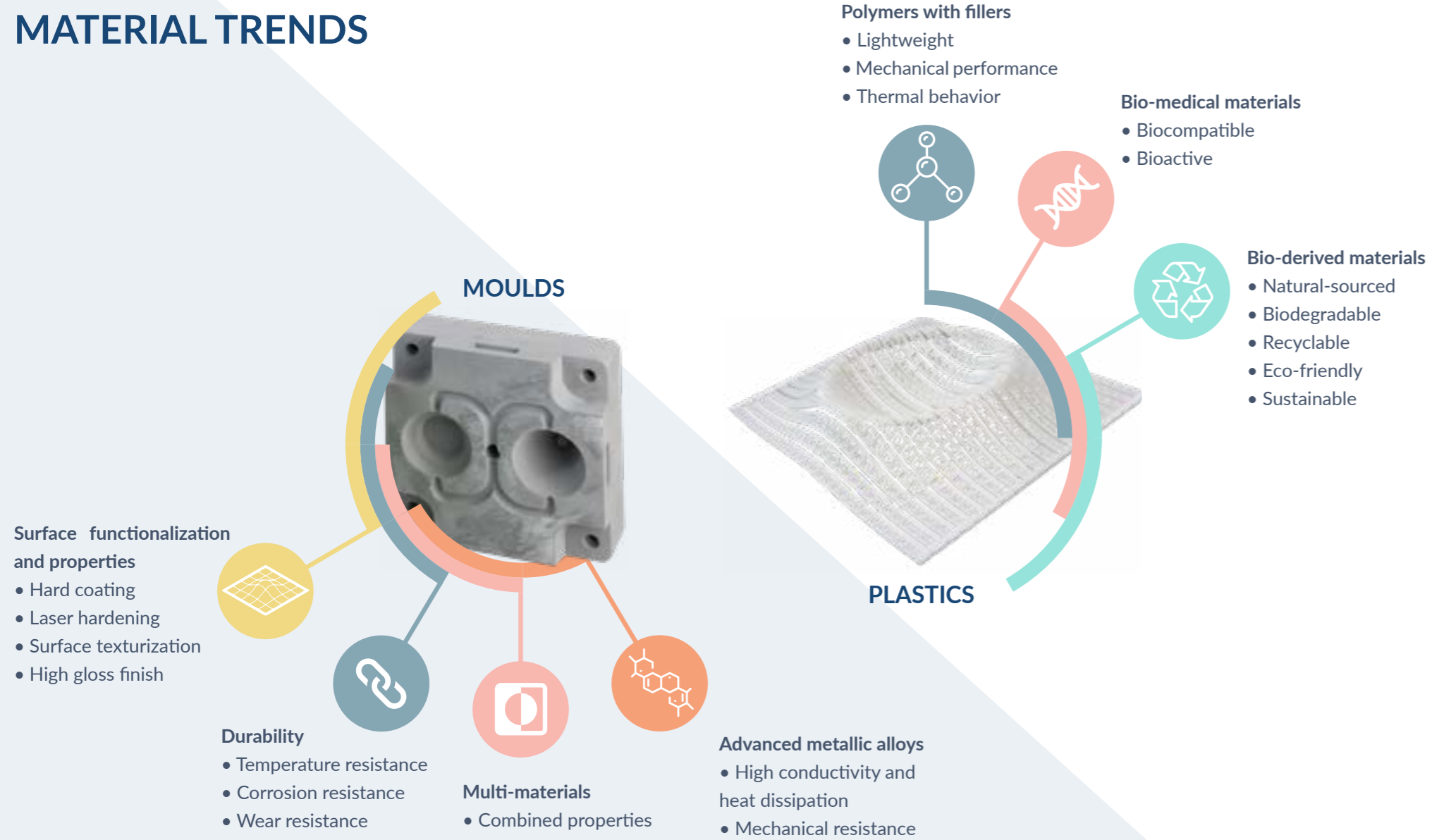
The main challenges and barriers faced by entities within 5 years are transversal to the three countries.



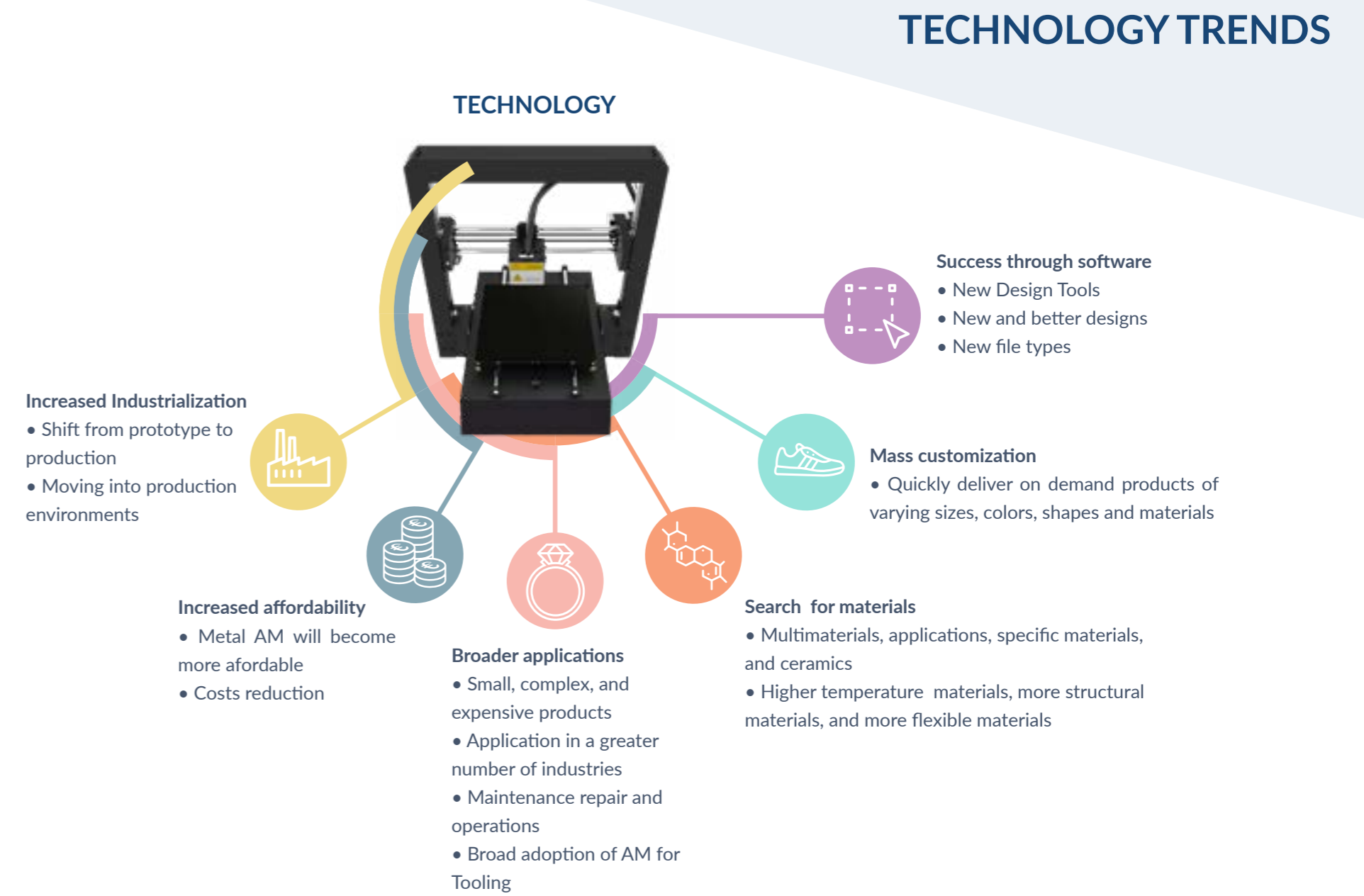


FUTURE TRENDS

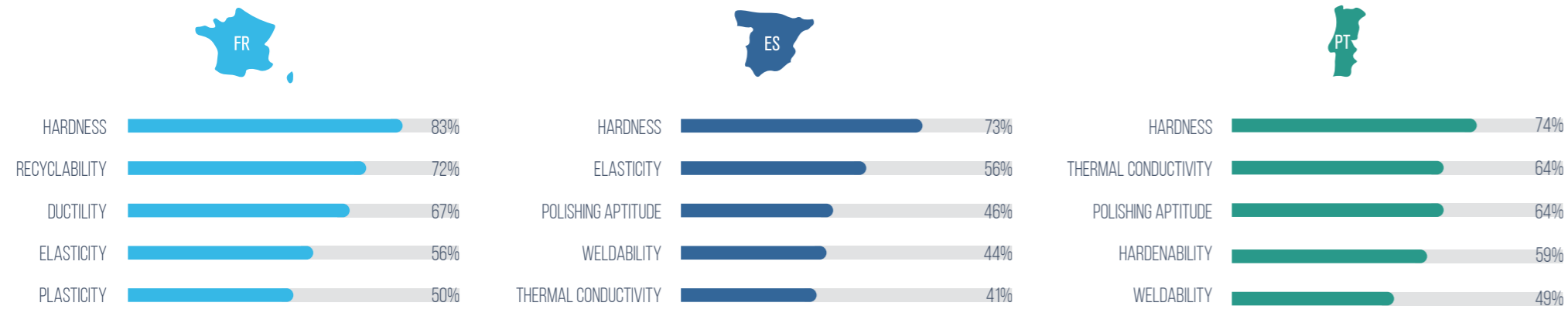
MATERIAL TRENDS



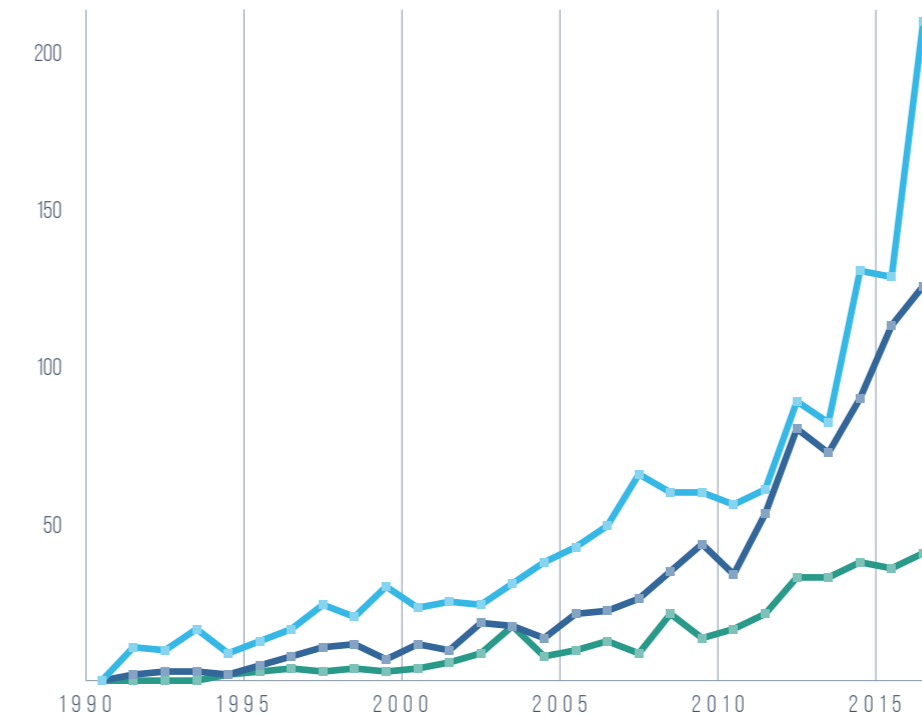
TECHNOLOGY TRENDS



FUTURE TRENDS
MATERIAL PROPERTIES



FUTURE TRENDS
RESEARCH PRIORITIES



The bibliographic analysis of publications in the fields of AM and Am, reveals a strong increase of research activity in these fields in the last 5 years. The graphic shows number of publications in the field according the database used. In last 5 years, papers in the field have greatly increased. For more information on the results and sources you can consult the KET Trends report.



TECHNOLOGIES WITH MORE RESEARCH PROJECTS IN THE REGIONS



MATERIALS WITH MORE RESEARCH PROJECTS IN THE REGIONS



Exploring the regional, national and european projects developed by Spanish, French or Portuguese members (whether they were members or leaders of the project) in last years, the main technologies addressed in research are SLA, SLS and SLM in that order of relevance. Regarding to materials, the main focus of research is metals and biomaterials. There is in general a clear trend in the research of additive manufacturing technologies related with metals as well as developing advanced materials in the field of metals. For deeper information on the results and sources you can consult the KET Trends report.



SUDOE
REGION STRATEGY

NATIONAL STRATEGIES AND ACTIONS

Additive Manufacturing and Advanced Materials are addressed in several strategic documents and actions from the French, Spanish and Portuguese national governments.



INDUSTRY 4.0

Industry 4.0 refers to the fourth industrial revolution after the mechanization, the industrialization, the automation. It's an initiative fostered by the all three countries governments (and UE in general) for shaping a series of acting plans to promote industry digitalisation. Among these measures are specific actions in the field of Additive Manufacturing and Advanced Materials.



TECHNOLOGICAL PLATFORMS

These technological platforms provide companies with means and competences to improve their competitiveness and establish a relationship between scientific research and industry and some of them, develop its main activities deeply related to Additive Manufacturing and Advanced Materials.



RESEARCH

All three countries have a wide range of active research centers covering the entire value chain of additive manufacturing both at public and private levels. A large number of organizations in this countries have been and are currently working in research and development projects in regional, national and EU framework programs.



FABLABs

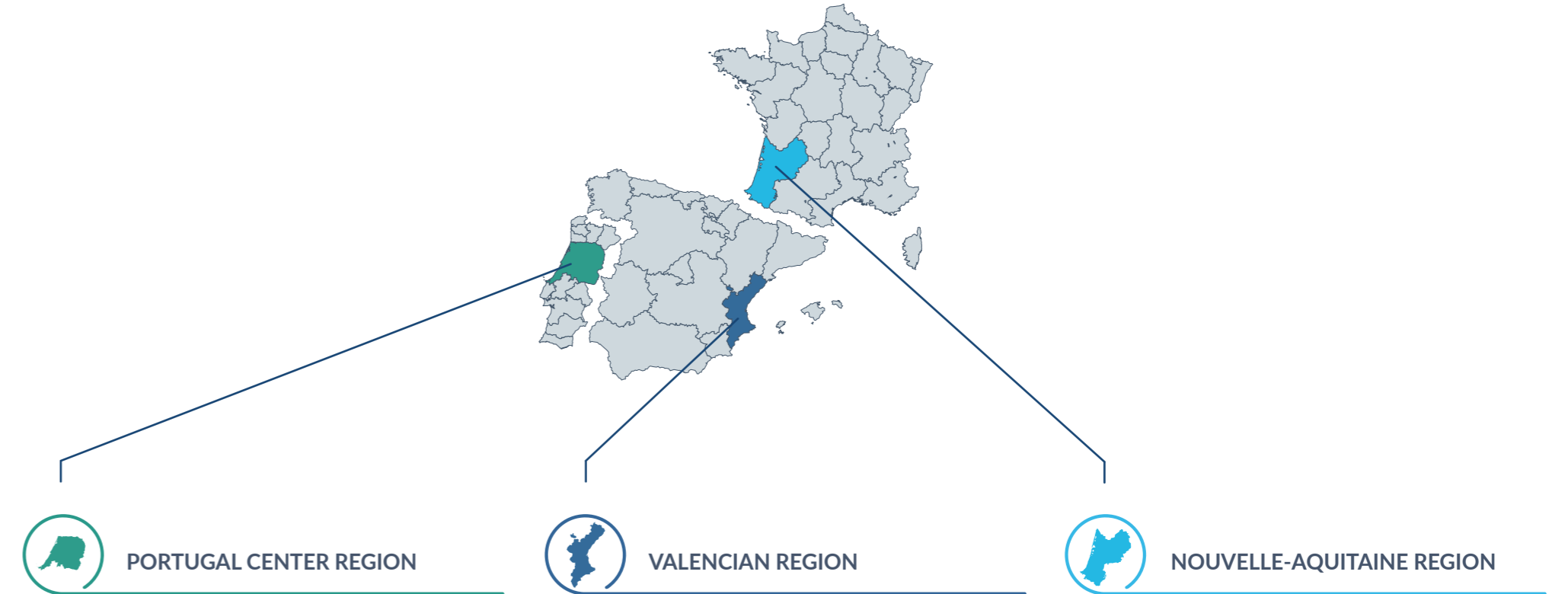
Technical prototyping platforms for innovation and invention, providing stimulus for local entrepreneurship. These labs usually include 3D printers as a tool for users and spread their use. They became an increasing trend in these three countries.



COMPETITIVENESS CLUSTERS

A partnership based around a specific theme or region which brings together large and small firms, research laboratories and educational establishments, all working together to develop synergies and cooperative efforts. Clusters are foresting the transition to I4.0 of its associates.

REGIONAL STRATEGIES AND ACTIONS



PORTUGAL CENTER REGION

RIS3-CP deeply contemplates Additive Manufacturing and Advanced Materials. Both are involved in the Sustainable Industrial Solutions Innovation Platform, at the area "Innovation platform 1. "Sustainable Industrial Solutions" and more specifically at Indicative bets 1.1. Sustained optimization of industrial productivity and 1.2. Development and use of materials.



VALENCIAN REGION

RIS3-CV deeply contemplates in its strategy, mission and field of action Advanced Materials and Additive Manufacturing. These are considered as two of the areas of technology specialization considered relevant to work in. These are defined as: Advanced Manufacturing (where Additive Manufacturing is included) and Advanced Materials and nanotechnology, being the second point devoted specifically to it.



NOUVELLE-AQUITAINE REGION

The *Nouvelle-Aquitaine* region is concentrating its efforts in the field of advanced materials and related innovative technologies such as Additive Manufacturing (AM) dedicated to aerospace industries. The main actions of the *Nouvelle-Aquitaine* region are thus to support technological scanning structure, academic institutions for research and teaching, technology platforms and competitiveness clusters, and to bring them together to interact.





KEY FINDINGS AND RECOMMENDATIONS

KEY FINDINGS

KNOWLEDGE ACCESS

There is a huge deficit in available compiled and organized information about Additive Manufacturing and Advanced Materials in the SUDOE Region, which is demanded by companies.

In all involved countries (France, Spain and Portugal) is extremely difficult to find documents like reports regarding state of the art, trends, technology availability and use, R&D in these fields. On top of that technology and materials evolve fast and constant updates are needed.

Notwithstanding, such organized information exists and it's easily accessible in regard to European and International levels but in a broader perspective and doesn't provide enough insight about the involved countries and the SUDOE region.

BARRIERS FOR ADOPTION

In the sector addressed (Mould making and plastic processors), the level of quality of the parts produced is one of the main barrier of adoption in the sector.



TECHNOLOGY TRENDS

The technologies making use of metals are a clear trend in the sector. As the technology evolves, more possibilities open for these sectors.

APPLICATIONS OF TECHNOLOGY

Understanding the possibilities and right applications for technology is key for the successful uptake of them. One good example is related with design. When working with complicated designs, AM technologies have clear advantage and work better than subtractive technologies.

RESEARCH ON MATERIALS

There's a clear demand on progressing in the amount of materials and characteristics for Additive Manufacturing, which represents an opportunity for research centers and universities that can work together to develop materials according to companies needs.

RECOMMENDATIONS



Create an "AM and Am Observatory" that could keep up with the technological evolution in the field of Additive Manufacturing and Advanced Materials providing easy access to centralised information in these fields in the SUDOE region.



Stimulate the knowledge about AM and Am, through the promotion of Seminars and Workshops, as well as of reciprocal visits: RTD-Company and Company-RTD.



Develop and make available a Cost-Benefit Analysis Methodology for the use and application of AM technologies, which transmits information to support management, decision making and about the advantages of using AM technologies and Advanced Materials.



Participate in national and international research projects and in collaborative Networks to develop, train and share knowledge with companies about AM and Am.



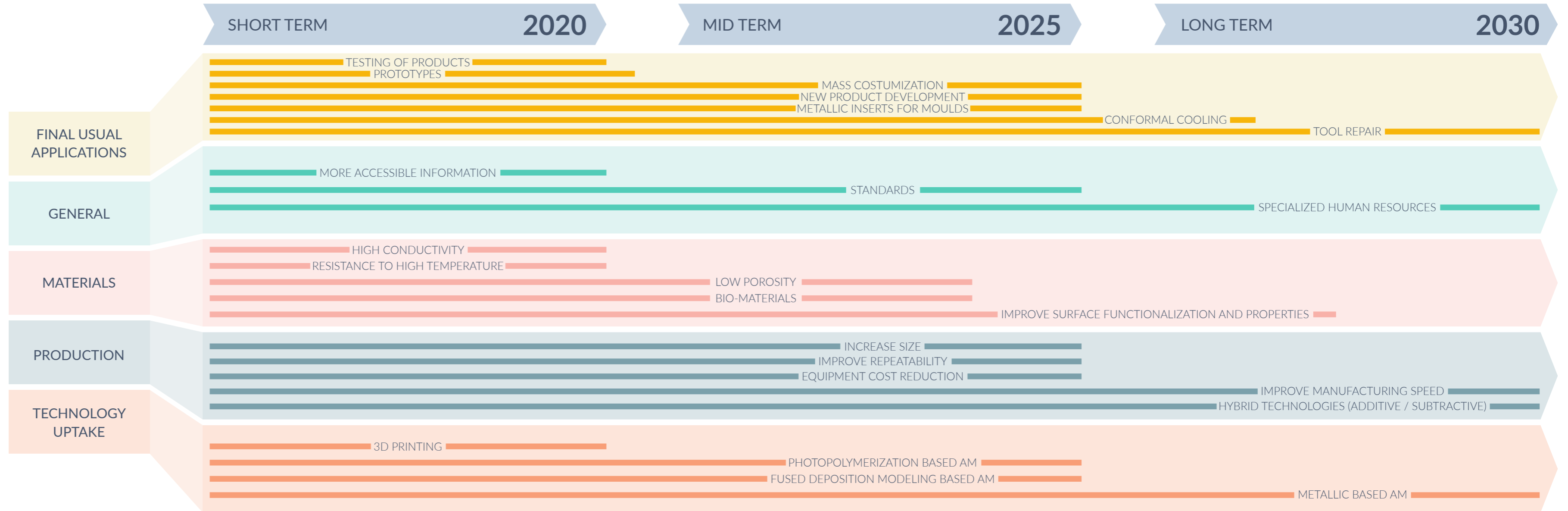
Develop demonstrators that show the capabilities and application of the technologies and materials in the addressed sectors.



Explore with the companies and with the market in general, the detection of new development opportunities for Additive Manufacturing and for Advanced Materials.



PRIORITIES IN THE SECTOR



SAMT SUDOE is developed in the framework of the Interreg Sudoe Programme funded by the European Regional Development Fund (ERDF).

The Interreg Sudoe Programme supports regional development in Southwest Europe financing transnational projects.

The Programme promotes transnational cooperation to solve common problems in Southwest Europe, such as low investment in research and development, weak competitiveness of the small and medium-sized enterprises and exposure to climate change and environmental risks.



Samt  Sudoe

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