GRUPO spri TALDEA

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EUSKADI BASQUE COUNTRY

Basque Country

Perspective on Nanotechnologies and Advanced materials for Regional Growth

Workshop "Nanotechnologies and Advanced Materials Pilot Projects
Test-beds for industry and private investments"

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Strategic Initiatives.
SPRI Basque Business Development Agency

San Sebastián – March 8th

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1. History and Background
2. Nanotechnology and advanced materials within the current RIS3 framework
3. Pilot plants in Basque Country and their impact in different industrial sectors
4. Basque participation at SME instrument related to nanotechnology and advanced materials

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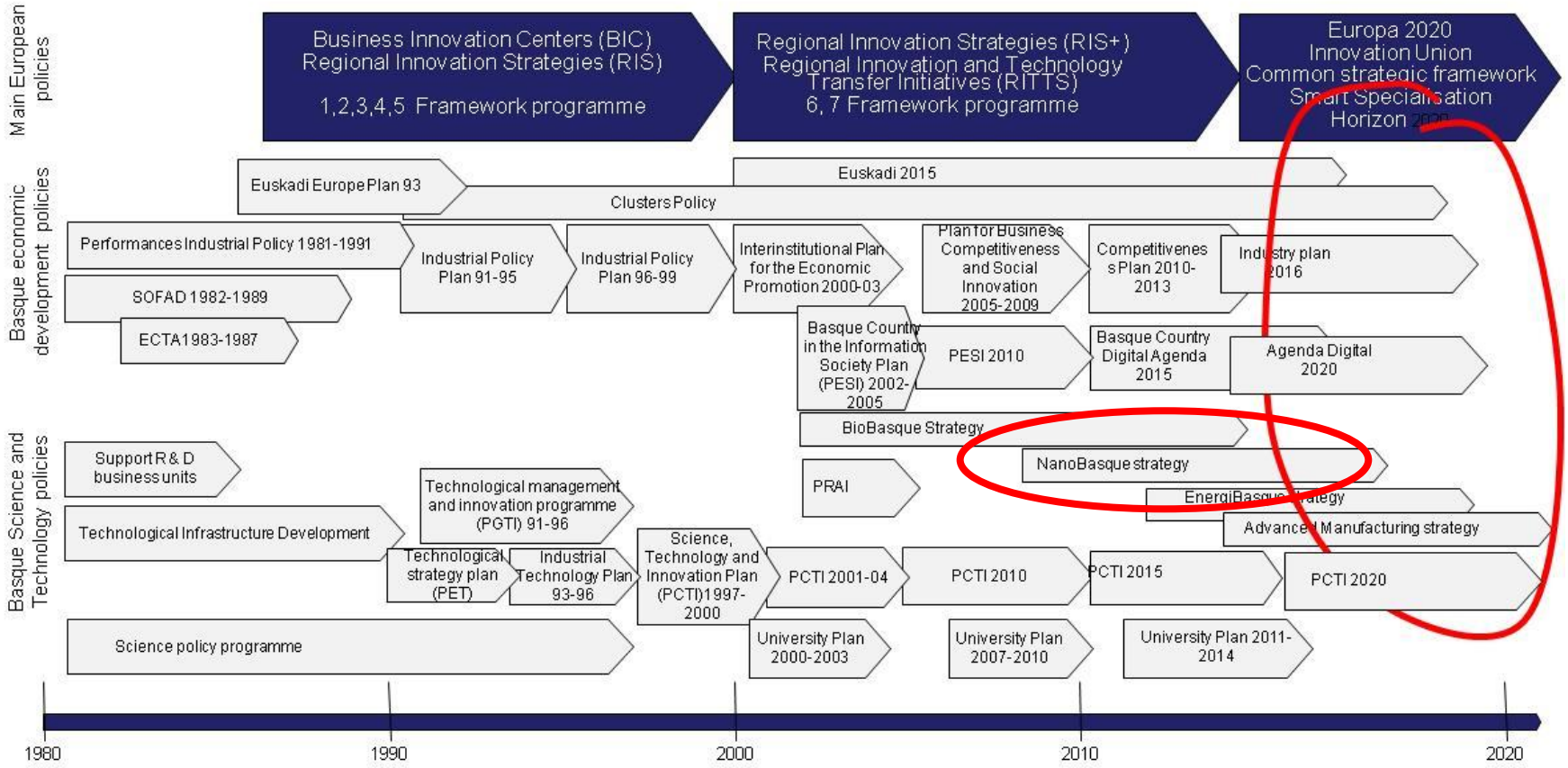
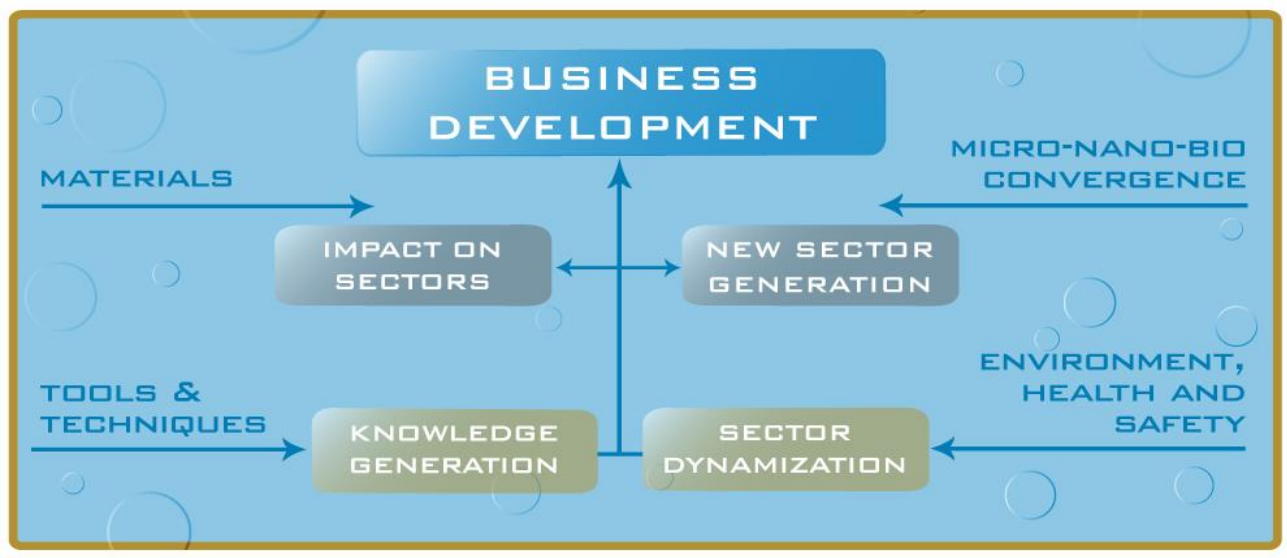
Industrial Policy in Basque Region

- RIS3 strategy is a natural extension of Basque historical policies in this area.
  - Basque Country has a long history defining economic development strategies over the last 35 years.
  - Consecutive plans and strategies, responding to specific needs of each stage, have progressively sought modernization, competitiveness, specialization, diversification and sophistication of Basque economy.



nanoBasque Strategy (2008-2015)

- The incorporation of nanosciences, micro and nanotechnologies as an strategic area of industrial diversification within the Basque science, technology and innovation policies have been done with a twofold objective:
  - To exploit the large potential for application of these technologies in practically all the Basque industrial sectors
  - To promote the creation of new technology based firms (NTBF) specifically born to develop their activity with applications based on these technologies.



nanoBasque Strategy (2008-2015)

Business development

- In 2015 there were 213 firms involved in micro and/or nano activities, 39 start ups
- The horizontal nature of micro and nanotechnologies is reflected in the identification of active companies in more than 15 industrial sectors

http://www.spri.eus/es/actualidad-spri/publicaciones/directorio-de-empresas-nano-y-micro-nanobasque-2015

nanoBasque Strategy (2008-2015)

Knowledge Generation

CIC nanoGUNE
nanoscience cooperative research center

10 Research Groups:
Nanomagnetism, nanooptics, self-assembly, nanobiomechanics, nanodevices, nanomaterials, theory, nanoimage, nanoengineering and electron microscopy.

tecnalia Inspiring Business
nano technology cluster

4 R&D Areas:
Nanomaterials, nano-based products, multi-scale simulation, nanosafety

IK4 Research Alliance

5 R&D areas:
Micro-nanodevices, micro-nanoengineering, nanomaterials, nanosurfaces and nanomedicine.

nanoBasque Strategy (2008-2015)

Dinamization

EHS advance

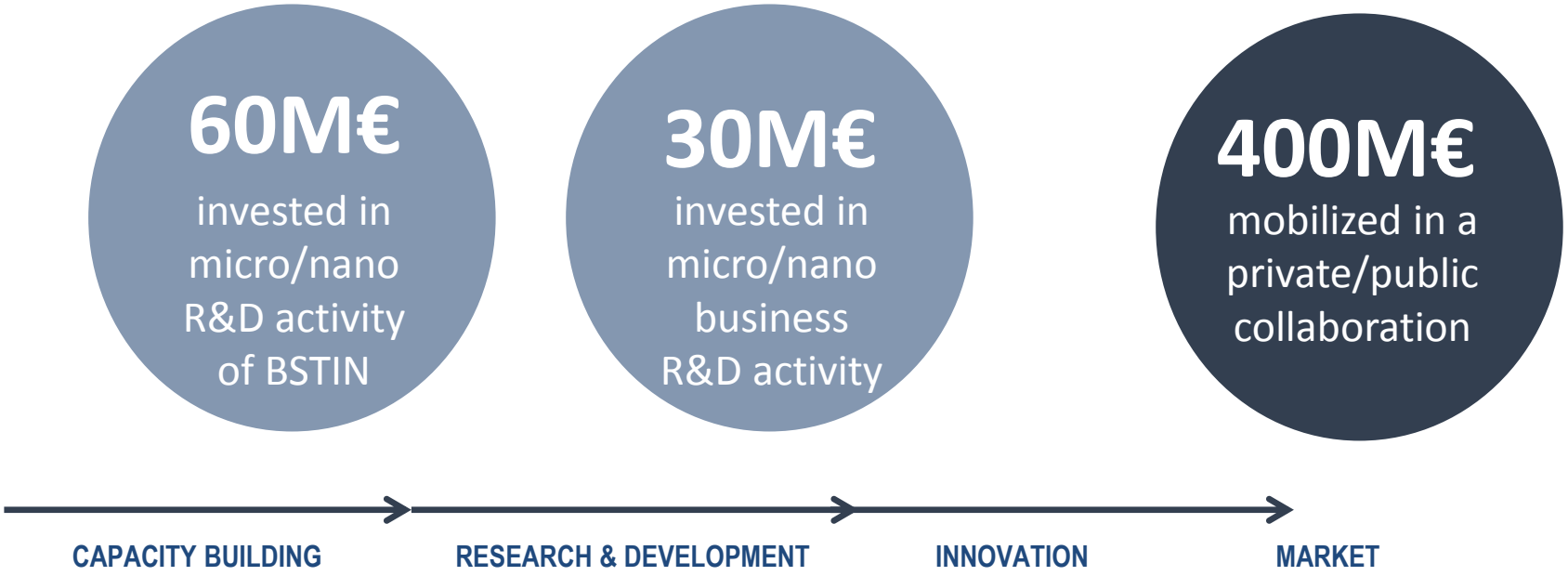
Distributed Competence Centre **based on the Basque Science Technology and Innovation Network**, to serve and answer to all questions related to the **environment, health and safety issues of nanomaterials** from industry, R & D centers and universities, seeking the synergistic effect of making merge our assessment, analysis and testing capabilities and the existence of specific infrastructure in the Basque Country, with a strong interaction with organisms with the same interests at European level

A SINGLE POINT OF CONTACT FOR ALL THE nano EHS ASPECTS

- Studies, analysis and tests on toxicology and ecotoxicology
- EHS Risk Assessment in a given process / operation
- Implementation of methodologies
- Training
- EHS surveillance

nanoBasque Strategy (2008-2015)

Regional Funds invested in nanoBasque Strategy



nanoBasque Strategy (2008-2015)

Nanopublications, patents & products

- ISI nano-publications from the Basque Country accounted for 7.7% of all Spanish ones, in 2014, being its population only 4.7%.

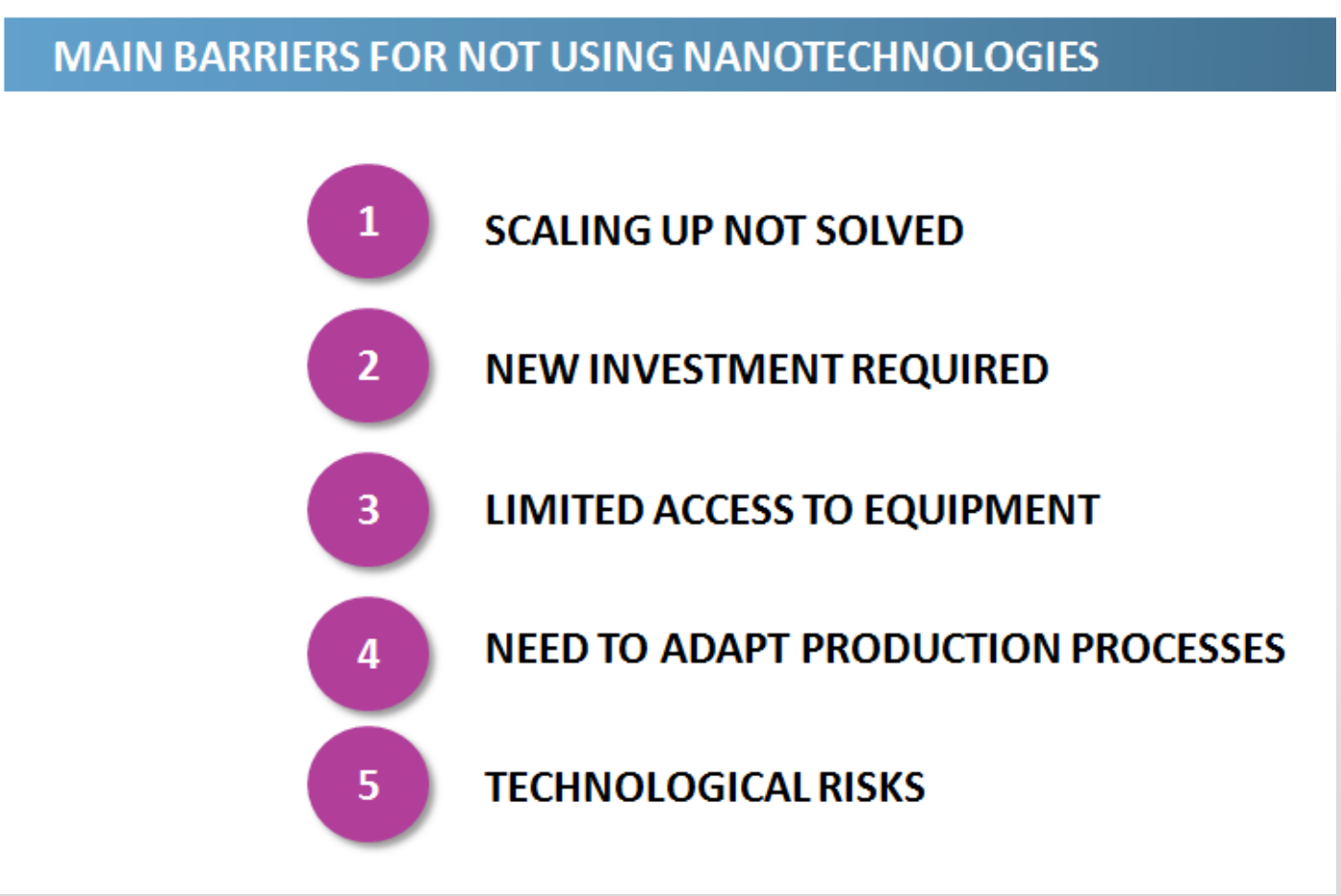
	Number of PCT nano-patents (2008-2012)	PCT nano-patents/million inhab. (2008-2012)	% over all PCT patents (2008-2012)	Specialisation index in nano-patents (UE28 = 100)	% of change between 2003-2007 & 2008-2012
Araba	0,0	0,0	0,0	0	0,0
Gipuzkoa	4,0	1,2	1,6	187	298,6
Bizkaia	4,8	0,9	1,9	223	*
Basque Country	8,8	0,8	1,4	165	781,7
Spain	146,0	0,6	1,6	189	153,3
Germany	611,9	1,5	0,7	79	-28,4
EU-28	2.146,8	0,9	0,9	100	-7,0
USA	3.346,3	2,2	1,4	164	-19,4
Japan	2.153,5	3,4	1,2	136	1,5

[Source: NANOTRANSFER PROJECT. Authors' elaboration, based on OECD.Stat]

- Only 20% of Basque Companies active in nanotechnologies are commercializing nanoproducts and 20% more intend to do so over the next three years.

nanoBasque Strategy (2008-2015)

Main challenges identified by Basque companies



[Source: EHS ADVANCE PROJECT]

Nanotransfer recommendations

- Knowledge transfer barriers are mainly related to the nature of nanosciences and nanotechnologies. Scaling up problems seem to be the key issue for knowledge transfer, which is not being solved by knowledge infrastructures (related with the knowledge base).
- It should be necessary to combine the scientific knowledge base in nanosciences and nanotechnologies which relies on scientific agents with the market and engineering knowledge base predominant in the firms and technology agents. These could be achieved by improving actors collaboration.
- Despite the organisational incentives play an important role for knowledge transfer, lack of market knowledge is the key factor in this process.

Promoting knowledge transfer mechanisms in knowledge infrastructures in N&N should be oriented towards a real collaboration **(with private investment) among different agents and towards the shared used of equipment, personnel mobility and training and dissemination of research.**

CONCLUSIONES Y RECOMENDACIONES 38

[Source: NANOTRANSFER PROJECT]

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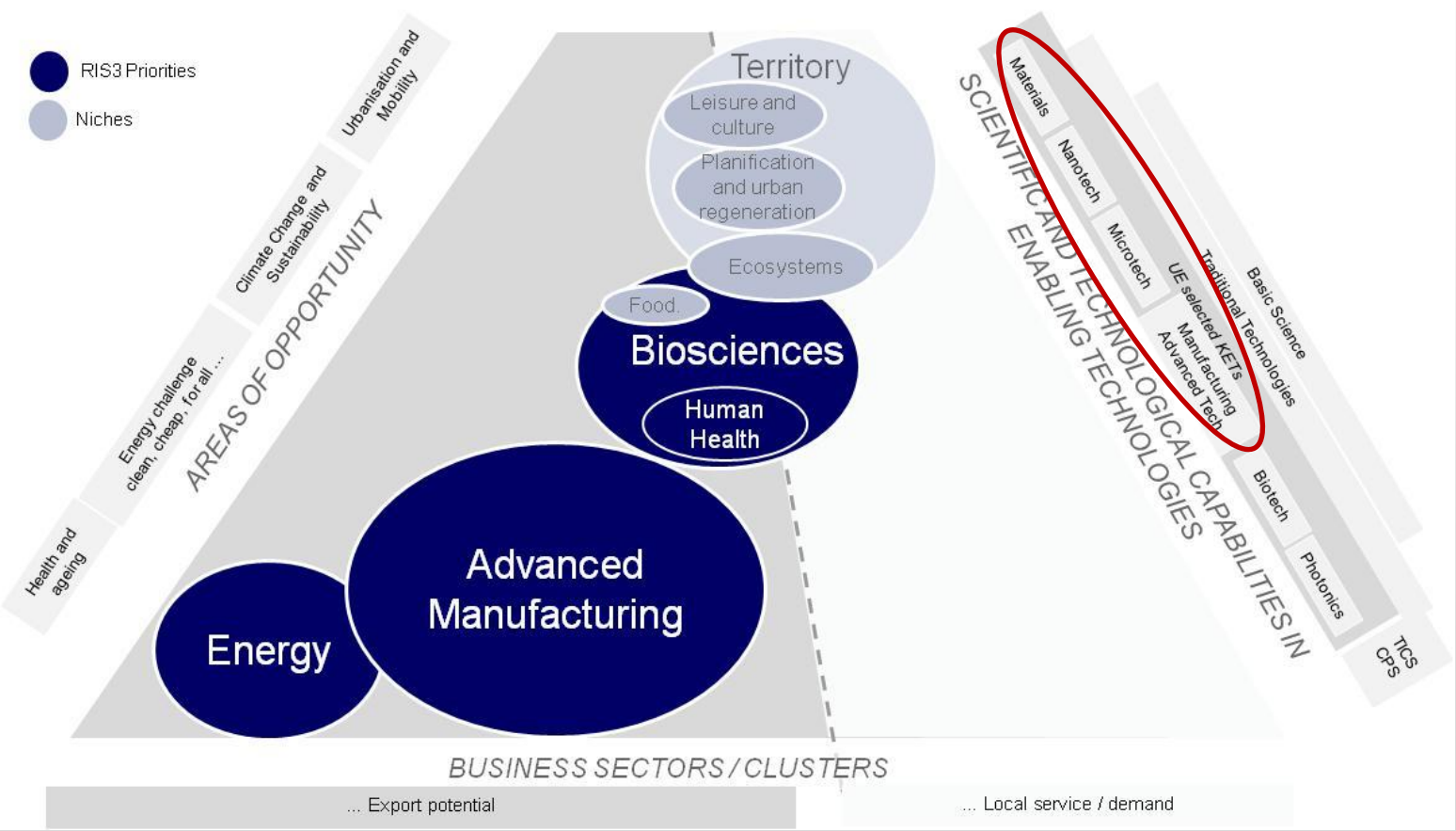
RIS3 Euskadi

- Three smart specialization priorities have been selected: Advanced Manufacturing, Energy and Biosciences (mainly human health). Additionally, some niches related with the Territory have been identified



Advanced Manufacturing Strategy.

- A commitment to technological development in Advanced Manufacturing as being crucial to maintain competiveness in industry and to secure positioning in market niches with greater added value

Mission

To strengthen the position of the Basque Country as an economy with an industrial base through the promotion of knowledge intensive manufacturing

Vision

A country in optimum conditions for manufacturing due to the existence of an industrial network backed by know-how, due to the capacity of its scientific-technological agents and due to the presence of highly qualified labour market.

Strategic Objectives

SO1. To help and guide Basque companies towards more knowledge intensive manufacturing activities which have greater added value

Added Value

Integration of KETs

SO2. To promote multi-disciplinary and technological convergence in a structured fashion so as to develop *best-in-class* manufacturing capacities and solutions while optimizing existing resources

Global value chains– Cluster 2.0

SO3. To integrate local and international value chains to meet the challenges of Advanced Manufacturing using the sum of the particular capacities of each sector and its companies

Scaling Up

SO4. To foster collaboration and support as a catalyst for the industrialization of the results of R+D+i in Advanced Manufacturing

SO5. To support education and on the job training in technologies and management systems related to Advanced Manufacturing

Talent

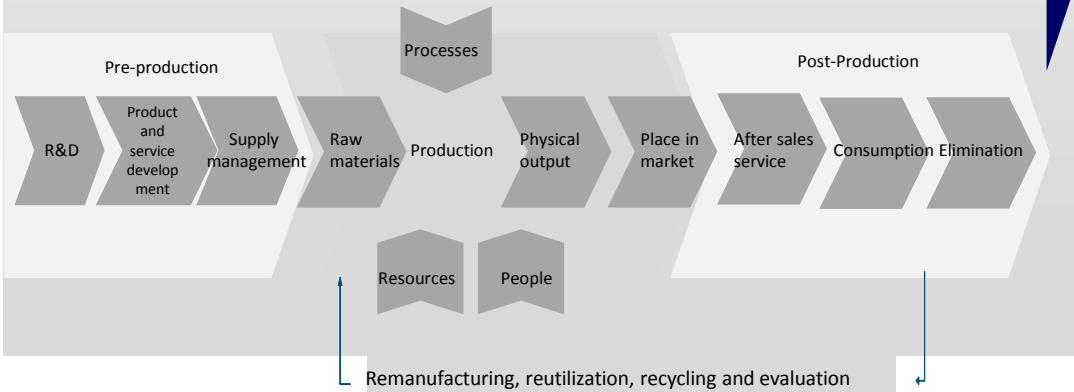
Advanced Manufacturing Strategy.

- A definition of Advanced Manufacturing which includes materials, processes, means and systems and which encompasses the production phase as well as the phases of pre and post-production

The Scope of Advanced Manufacturing

Materials	Processes	Means	Systems
Materials and their transformation processes	Manufacturing processes	Products and production tools	ITC support equipment to optimize the manufacturing resources
Transformation of raw materials into materials suitable for use in manufacturing processes	Set of phases necessary for the transformation of raw materials	The means utilized for carrying out the various manufacturing processes	Intelligent support tools for design, development, production and integrated manufacturing management

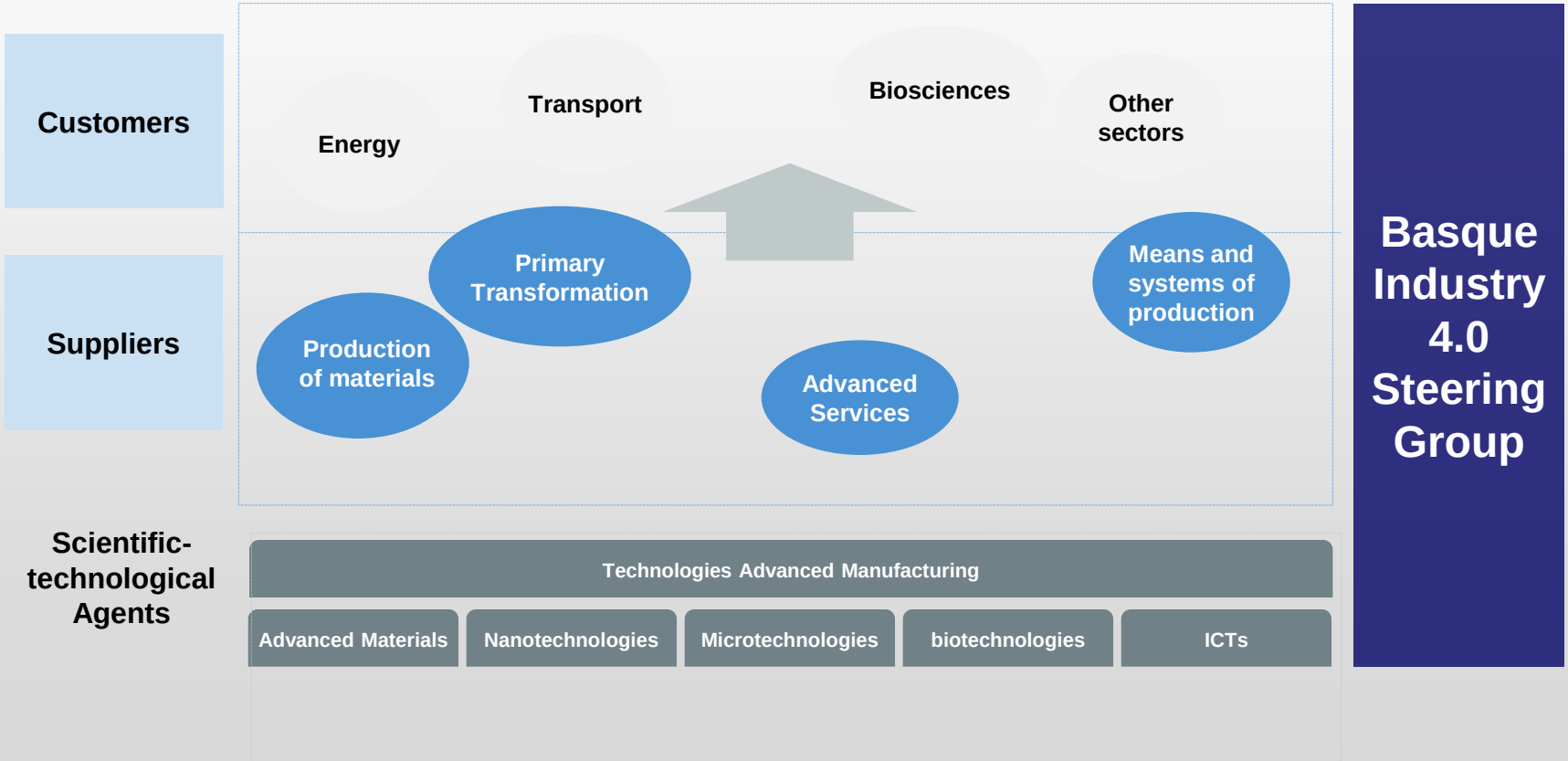
Phases of Advanced Manufacturing



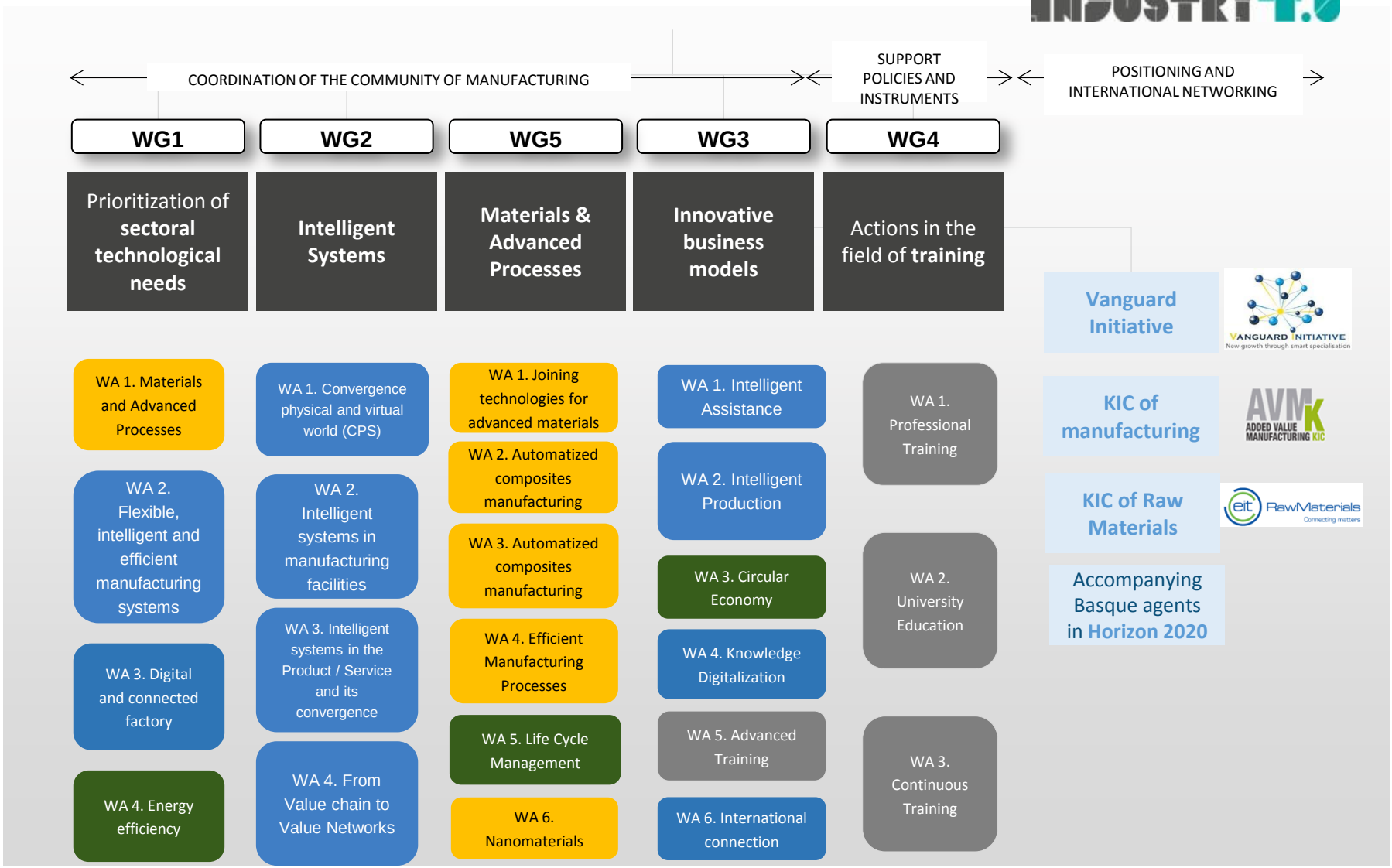
Advanced Manufacturing is the generation and application of knowledge, experience and cutting edge technology for the creation of high added value products, production processes and associated services, with significant potential to generate wealth and employment.
It includes the materials, the processes, the means and the systems, and encompasses the production phases as well as the phases of pre and post-production

BASQUE INDUSTRY 4.0 STEERING GROUP.

- Coordination of a Manufacturing Community made up of clusters, scientific-technological agents and institutions around a public-private collaboration scheme: BASQUE INDUSTRY 4.0 STEERING GROUP



RIS3 Euskadi
Advanced Manufacturing



RIS3 Euskadi
Advanced Manufacturing

- The WG5 “Advanced Materials & Processes” has defined an Action Plan that is responsive to the needs outcropping by industrial sectors (WT1)

WG1 Needs

ACICAE Cluster de Automoción de Euskadi

Advanced Manufacturing Technologies

GAIA

Cluster Energía BASQUE ENERGY CLUSTER

hegan basque aerospace cluster

WG Coordinator

IK4 Research Alliance

Action Lines defined	
AL1. **Joining** technologies for advanced materials	MONDRAGON UNIBERTSITATEA
AL2. Automatized **composites** manufacturing	tecnalia
AL3. **Advanced Surface** technologies	IK4 Research Alliance
AL4. **Efficient processes** for materials	Universidad del País Vasco / Euskal Herriko Unibertsitatea
AL5. Life Cycle Management	ihobe
AL6. **Nanomaterials**	CIC nanoGUNE

Points to note

1. Incorporation of a line of "Nanomaterials" coordinated by CIC nanoGUNE with two areas:
   - Cross: contributions in each of the other lines
   - Specific: long-term analysis
2. Identification of **non-technological gaps:**
   - **Providers** with expertise in certain materials and technologies
   - **Experts** in modeling techniques and calculation of the structural behavior of the material
   - Specific **training** of future demanding sectors of advanced materials

RIS3 Euskadi
Advanced Manufacturing

AL1. **Joining** technologies for advanced materials

- Improve methods of design engineering and manufacturing process of assembly / unions of small-medium and large dimensions (consider distortions). Characterization of behavior of permanent and non-permanent connections. Behavior in use / life (reliability): servicing thinking.
- Develop predictive capacity through modeling, simulation for design and manufacture of joints of dissimilar materials and high quality welds, including the assembly of components ... Behavior in use / life (reliability): servicing thinking.
- Technologies for process optimization. **Industrial scaling-up.**
- Develop capacity of disassembly, recycling ... especially for dissimilar materials and with permanent connections.
- Knowledge development for pieces, products finished treatments: machining, surface treatment
- Search and attraction of key agents for the development of joining technologies for hybrid components.
- Grasping knowledge: training of personnel in international reference centers or companies
- Motivate high school students to study related careers in Manufacturing

RIS3 Euskadi
Advanced Manufacturing

AL2. Automatized **composites** manufacturing

- Materials and manufacturing technologies, automation and fast curing / processing for composites.
- Develop simulation and control tools for composites production processes.
- Technologies and / or equipment for rapid heating and cooling and / or alternative.
- Cutting, handling, preforming, inspection process automation, etc.
- Monitoring technologies and process steps and final piece NDT inspection.
- Joining technologies (multimaterial bonds, in-situ process, hybrid unions, etc.)
- Eco-design and high recyclability of materials.
- Development of multifunctional composite materials and new functionalities (such as fire resistance, improved electrical and thermal properties for anti-lightning, de-icing, erosion resistance, etc.) based on nanotechnology and other materials and processes technologies, " smart "composites materials, bio-composites
- Search and attraction of manufacturers / suppliers of raw materials composites.

RIS3 Euskadi
Advanced Manufacturing

AL3. **Advanced Surface** technologies

3.1 **Development of improved durability surfaces (antiwear, friction reduction, corrosion, self-cleaning ...)**
Reduction of maintenance and repair of components in different sectors. Increased service life.

- Manufacture of required features map and requirements for the target sectors.
- Search multi-sectorial needs (obtained from the analysis of objective functionality and system requirements).
- Pilot or industrial scaling up of technologies that provide these multisector solutions
- Accelerated tests definition and lifetime in use modeling for each sector (versatile test bench). Validation of test methods and modeling based on own material variables and solicitations, validated by tests that allow faster scaling-up
- **Identification of emerging technologies with maturity and applicable to industry.**
- Sustainability analysis of new technologies and their scaling-up

3.2. **Development of aesthetic surfaces (visual, touch ...)**

Access to new markets with design-driven philosophy. Integration of aesthetics in some sectors such as automotive, habitat ...

- Map of Design-driven products sought by companies (definition of customizable features)
- Scaling up, flexibility and adaptation of technologies to manufacture customized products
- **Scale up of production processes**
- Sustainability Analysis

3.3. **Smart surfaces**

Surfaces adaptable to the environment: multi-functional and / or sensorial (active surfaces against external stimulus) allow access to high added- value products emerging markets

- Experimental development of smart surfaces according to sectoral requirements
- Study the compatibility of combining solutions to different needs and create a multiple solution with it
- Manufacture of representative demonstrator (from existing experimental activity) at industrial level in order to perform a technical and economic evaluation of each solution
- Identification of emerging technologies with maturity to be applicable to industry
- **Scale up of production processes**
- Environmental impact analysis

RIS3 Euskadi
Advanced Manufacturing

AL4. **Efficient processes** for materials

4.1. Application of traditional processes in components of very high added value

Improvement in traditional processes with high implantation in Euskadi and in which there is a domain and know-how in their application in conventional components, but are intended to apply to higher added-value components or seeking greater efficiency.

- Development of advanced casting processes, looking for a Near-net shape process and greater efficiency
- Development of machining and grinding technologies with advanced tools including superabrassive
- New methods of unconventional forming: casting, sheet metal forming, forging, ...
- Non-conventional machining processes such as EDM
- Automation of grinding and deburring processes
- Application of modeling and simulation to design new higher added-value components

4.2. Advanced Manufacturing Processes

It also identifies actions in emerging processes and less implementation in the industry:

- Development of more efficient, productive and less polluting additive manufacturing processes
- Monitoring and control process of additive manufacturing
- Development of new casting technologies: new materials and / or process innovation.
- New sheet metal forming processes, billet, slab, ...
- Efficient use of materials in Near-Net Shapeprocesses.
- Development of CAM systems for hybrid processes: machining + Additive, machining + shaping, machining+ treatment ...
- Development of new means of manufacture and / or components
- Process development and manufacture of superabrassive tools

4.3. Development and characterization of materials and components

Knowing the behavior of the material and component both before and after applying the manufacturing process:

- Characterization of parts manufactured by additive manufacturing.
- Identification of useful material/ component cycle and subsequent recovery.
- Generation of structured data repositories where data from different materials and processes can be found.
- Development and characterization of new materials for industrial processes.
- Development of new destructive and nondestructive characterization controls

RIS3 Euskadi
Advanced Manufacturing

AL5. Life Cycle Management

- Development of methodologies and standards for Design for Manufacturing and Modularity, including supply chain
- Development of simulation and validation tools for components made in advanced and not advanced materials.
- Early development of technologies for recovery, reuse and recycling for advanced materials.
- Development of monitoring technologies embedded in components.
- Development of communication components between component and machinery / equipment.
- Design methodologies for remanufacturing: eco-design, end of life, etc.
- Development of procedures and standards for the use of secondary raw materials
- Technologies for remanufacturing of components and products (cleaning, testing, f. Additive, ...)
- Recovery technologies for composites, metal key and critical materials
- Development of equipment and processes for verification of materials
- Substitution of critical materials (function, materials and technologies)
- New business models for service delivery based on own product with life cycle approach
- Interoperability Platforms between PP and SS for circular economy
- Usage and unit traceability

RIS3 Euskadi
Advanced Manufacturing

AL6. **Nanomaterials**

- Identified actions for mainstreaming on previous 5 lines of action:
  - LA1 Unions for advanced materials: analysis and characterization by dissimilar bonding simulation; dissimilar joining (eg .: by deposition techniques); Functionality validation.
  - LA2 Automated Composites Manufacturing: adding new functionality to composite materials (ex .: fire resistance, electrical properties and thermal) and the definition of demonstrator equipments.
  - LA3 Advanced surface technologies: based on thin film coating and prolong the useful life based on specific functionality and its characterization; aesthetic design and material definitions (eg .: color, gloss, transparency, interaction with light) and manufacture of equipment for multifunctional solutions demonstrator.
  - LA4 efficient manufacturing processes for materials: material characterization platform before and after manufacturing (electron microscopy).
  - LA5 Lifecycle Management: characterization of advanced and non-advanced materials; "Large-scale electronic" for smart components; new technologies for the use and utilization of waste

Identified specific actions:

Implementation of a specific working group to integrate competitive capabilities in nanotechnology and nanomaterials not present in the above actions to give additional value to advanced manufacturing. For example:

- Production and application of graphene for different industrial sectors, including not only those who have already started their use (electronic, ...) but also others that its application is not contemplated (construction, ...).
- Nanobiomaterials development using nanoscale manufacturing techniques for new features and offer new advanced materials including prototyping industrial scale.

  The aim is to get a diverse portfolio of materials in addition to those traditionally used, with the possibility of customizing its features industrial use, including biodegradability and sustainability characteristics required by current legislation
- Materials and functionalities prototyping using atomic modeling and simulation: definition of parameters / key roles in the nanoscale transposable to the macro scale for obtaining new advanced materials.

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Pilot Plants

Advanced manufacturing Strategy. Instruments to support R&D&i

1. Support for scientific-technological Agents within the Manufacturing Community
2. Support for Excellence in Basic Directed Research

3. Support for R+D projects: Strategic industrial research; Business product development R+D; Company start-up R+D
4. Help and support for the introduction of TEICs (Electronics, IT and Telecommunications Clusters)

5. Design and support for Advanced Manufacturing Centres (CFAs)
6. Setting up a network of pilot plants

Generating Know-How KET (GC)

Technological Development (DT)

Industrial Scaling up (EI)

Non technological Innovation (INT)

7. Help and support for design
8. Setting up Models of Advanced Management in companies

Training and enablement (FC)

9. Training of high-level researchers
10. Training and enablement in design
11. Training and enablement in business models and manufacturing management (postgraduate in manufacturing)
12. Dual FP- (professional training)
13. Teaching and Learning Factories- CFAs

Dinamisation and Boosting(DI)

14. Clusters policy
15. Coordination with and participation in European R+D+I programs: *Basque Contact Points*
16. Advanced Manufacturing Steering Group

Pilot Plants

PILOT PLANTS IN BASQUE COUNTRY

- 300 companies
- 15 Billion €
- 75.000 people (36.000 Basque Region)

- 65 companies
- 1585 M €
- 12.000 people
- 266 M€ R&D

- AEROSPACE, AUTOMOTIVE
  - PLATFORM (TECNALIA) Open access pilot lines for the industrial production of buckypapers, CNT treated prepreg and CNT doped non-woven veils for composite applications
- AUTOMOTIVE
  - IZADI (MAIER) Injection moulding pilot line for the production of master-batches for thermoplastics with anti-scratch and aesthetic properties applied in B-pillar pieces

Pilot Plants

PILOT PLANTS IN BASQUE COUNTRY

- 436 companies
- 4.000 M €
- 20.000 people

- 75 companies
- 380 M €
- 2.300 people
- 27.80 M € R&D

- ENVIRONMENT
  - NANOREM (TECNALIA) Taking nanotechnological remediation processes from lab scale to end user applications for the restoration of a clean environment
- HEALTH
  - NANOPILOT (CIDETEC-IK4) Production of Polymer-based Nanopharmaceuticals in Compliance with GMP
  - NANOFACTURING (MIDATECH) Pilot and large scale manufacturing lines for the production of glycan-coated gold nanoparticles
  - NOCANTHER (BIOPRAXIS) magnetic iron oxide nanoparticles (MNP) multifuntionalised with a target peptide and an anticancer chemical drug scale up from milligram-scale laboratory synthesis up to multigram-scale production to generate sufficient material for clinical and regulatory assays

OTHER PILOT PLANTS with Basque participants

- HEALTH
  - FAST, Functionally graded Additive Manufacturing scaffolds by hybrid manufacturing. Demonstrator of hybrid AM technology to achieve a small production of scaffolds for bone regeneration. Universiteit Maastricht, Netherlands
  - PEPTICAPS, Design of polyPEPTIdes diblock copolymers as emulsifiers to produce safe, controlled and reliable novel stimuli-responsive nanoCAPSules for skin care applications
  - R2R BIOFLUIDICS, Large scale micro-and nanofabrication technologies for bioanalytical devices based of R2R imprinting
- ELECTRONICS
  - INSPIRED, Synthesis and functionalisation of NMs for printing applications with high process throughput. M-Solv Ltd., UK
- ENVIRONMENT
  - REGROUND, restoring contaminated groundwater aquifers. Demonstrating the capabilities and efficiency of the REGROUND technology under real scale conditions in two different contaminated sites, one in Tecnalia, with the aim of a full and complete remediation. The pilot projects will be market-like case studies for further commercialization.
- AERO, SPACE, MOBILITY & Equipment SECTORS
  - NANOTUN3D, Additive Manufacturing (AM) together with the development of a specially tailored Ti- based nano-additived material to achieve dramatic improvements in structural parts. Powder integration, consolidation and validation done by CEIT-IK4

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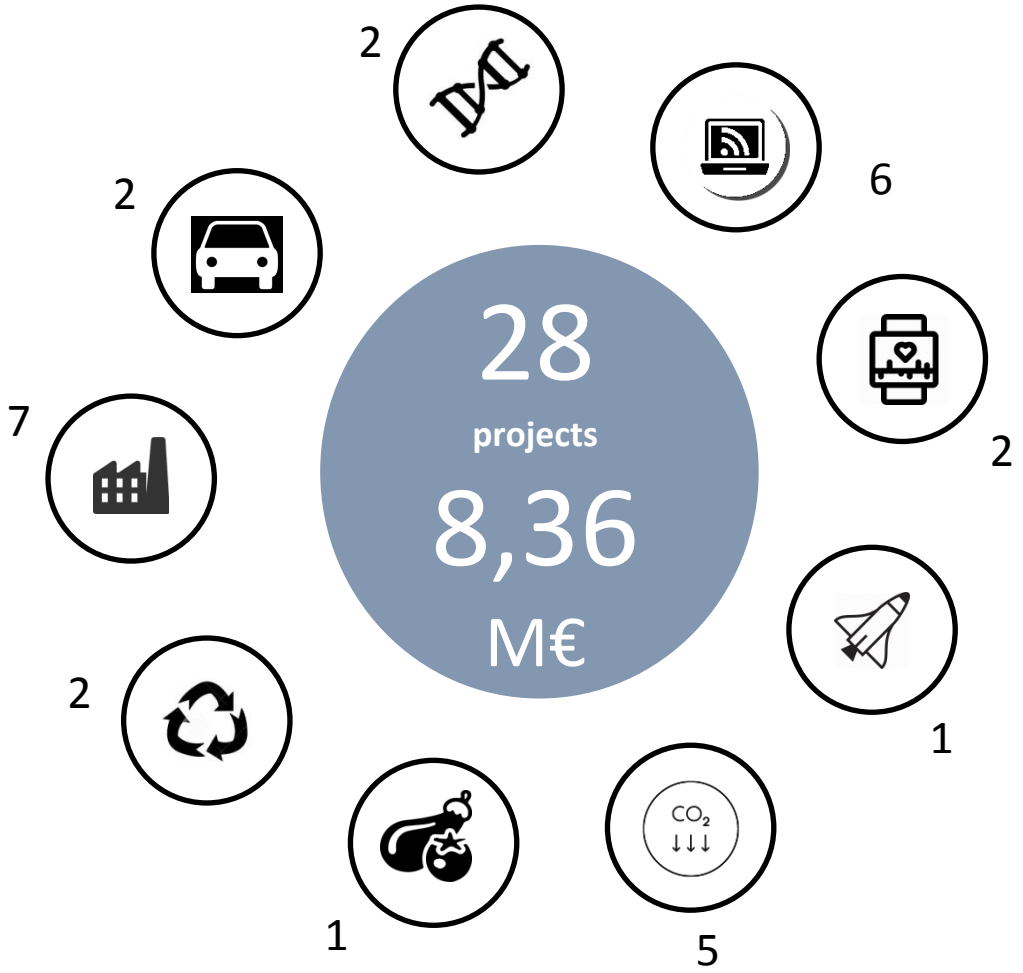
SME Instrument

General results of SME Instrument in Basque Region



[Source: http://observatorio.innobasque.com/index.php?lang=es]

SME Instrument

3 Basque companies with nano SME Instrument

Graphenea

[Graphene Oxide for advanced polymers APPlication]

Total budget: 2.252.875 € EU Contribution: 1.577.013 €

- **Large-scale production of GO** to enter/supply the advanced polymers industry.
- Reducing dramatically GO cost, increasing the production scale and supporting applications development.
- Producing tailor made GO materials to improve compatibility with different matrices, leading to a broad range of applications.
- Improving the mechanical, electrical and thermal properties of advanced polymers.
- Creating a cost-competitive final advanced polymer composites new market category using GO additives.
- GRAPHENEA has validated and patented a highly efficient GO production process and its application into polymeric matrices.
- GRAPHENEA will be able to introduce GO materials at industrial scale positively impacting the €48 billions polymer additives market.

SME Instrument

3 Basque companies with nano SME Instrument

Likuid

[Global business challenge: Breaking the oilgas water dependency with a cost-effective no-waste nanomembrane technology for water reuse]

Total budget: 1.387.708 € EU Contribution: 971.395 €

CleanOil consists on the introduction into the market of an innovative filtration solution to treat and reuse the produced water (PW), a highly polluted oily wastewater which is the largest volume byproduct associated to oil and gas production.

The solution will allow achieving up to 80% reduction of water demand for oil extraction through the reuse of up to 99% of the PW, and will be based on a proprietary product - ceramic nanomembranes with an innovative production process - installed in a fully integrated solution with the equipment, instrumentation and advanced fouling monitoring and control tools and software.

Objectives:

- Reducing the target membrane price up to 4 times, thanks to the **upscaling of the nanomembrane production process**,
- Launching worldwide highly competitive and cost-effective filtration solutions for the treatment and reuse of PW and
- International consolidation through the new subsidiaries and strategic partners in high potential markets, aiming for a 3% share of the Likuid's target industrial filtration market, doubling the existing actual staff and achieving a tenfold increase in EBITDA profit by 2020.

SME Instrument

3 Basque companies with nano SME Instrument

fresmak

[Nanostructured gripping material for clamping complex workpieces]

Total budget: 1.963.506 € EU Contribution: 1.374.454 €

FRESMAK, in collaboration with POLYMAT (University of Basque Country), has developed an alternative innovative clamping solution, called TGRIP, based on the principle of reversible adhesion.

The developed adhesive is a nanostructured bi-phase material with different adherence phases that is controlled with the temperature.

Temperature governance allows to stick and unstick any kind of materials with a high clamping force and without compromising cutting areas.

Main features of TGRIP that make it appropriate to respond to High Valued Complex Component clamping for machining needs that are not covered with existing solutions

- Adequate for complex high-value machining: High clamping force (1100N/cm2), Doesn't damage neither deform pieces, Allows uniform adhesion distribution (Reduction of vibrations) Doesn't compromise working areas, Works with any kind of material
- Cost-effective technology (50%-70% cheaper than clamping alternatives): low technology, operation and maintence cost.
- Environmentally friendly technology: Reusable and recyclable technology.

Thank you

Eskerrik Asko

Muchas Gracias

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