INNOVATING IN THE CIRCULAR ECONOMY. MATERIALS, PROCESSES AND PRODUCTS

Priority areas and preferential line of funding for the industry in the Basque Country

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INNOVATING TO DEPLOY THE 2030 CIRCULAR ECONOMY

After analysing the drivers - business demand and the environmental and competitive impact-[1], nine key areas have been identified. These can be divided into product oriented (equipment ecodesign; components and mobility; packing and packaging ecodesign; remanufacturing and advanced repair; servitization for durability; European product environmental footprint) and material related (metal transformation technologies; key metals and critical materials; plastic, rubber and composites; minerals).

Those priority innovation areas, already anticipated in the prior assessment[2] and integrated in the Basque Circular Economy Strategy[3], are a substantial contribution to addressing the challenges of the circular economy in the Basque Country and, in particular, Challenge 2 of the Strategy: "Innovate in materials, processes and products".

TABLE 1.
CONTRIBUTION OF THE ECO-INNOVATION PRIORITY AREAS TO THE CHALLENGES AND LINES OF ACTION OF THE CIRCULAR ECONOMY STRATEGY AND OF THE SCIENCE, TECHNOLOGY AND INNOVATION PLAN 2020

FOCUS	PRIORITY AREA	2030 BASQUE CIRCULAR ECONOMY STRATEGY		
		Challenge 2	Other challenges (No.)	Lines of Action
PRODUCT	Ecodesign of equipment, components and mobility	●	3	4.2
	Packing and packaging ecodesign	●	6, 7, 8	4.4
	Servitization and new circular business models.	●	1, 3, 5	1.1
	Remanufacturing and advanced repair	●	1, 3	5.2
	European environmental footprint	●	5, 6	4.4
MATERIAL	Metal transformation technologies	●	4	3.2,5.1
	Key metals and critical materials	●	8, 9	3.1, 9.1, 9.2, 10.4
	Plastics, rubber and composites	●	7, 8, 9	3.1, 8.3, 9.1, 9.2, 10.4
	Minerals and construction materials	●	8, 9	5.5, 9.1, 9.2, 10.4

Those areas are also included in the Basque Country's Science, Technology and Innovation Plan (PCTI) 2020[4], in the "Ecosystem" and in the "Advanced Manufacturing" and "Energy" opportunity niches.

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1 Bmbf y Fona, *Ressourceneffiziente Kreislaufwirtschaft Forschungskonzept für eine kreislaufoptimierte Wirtschaftsweise,* 2018.

2 Ihobe, Environmental Management Agency. Basque Government, *The Circular Economy in the Industry of the Basque County. Diagnostics,* 2018.

3 Basque Government, *2030 Circular Economy Strategy of the Basque Country 2030 - Draft,* 2019.

4 Basque Government, *PCTI Euskadi 2020. A Smart Specialisation Strategy,* 2014.

FACTORS DRIVING INNOVATION

Innovative business initiatives based on clearly defined drivers, whether internal or external to the company, have greater potential for the solution to be established on the market.

The identified internal factors include cost cutting, increasing productivity, quality, brand image and differentiation from offering innovative products and services. External drivers[5] are mainly underpinned by European Commission policies. They are challenges that affect products, materials, production processes or the organisation itself.

TABLE 2.
MAIN DRIVERS GENERATING A NEED FOR ACTION AND INNOVATION IN THE PRIORITY AREAS

FOCUS	PRIORITY AREA	DRIVERS								
		PRODUCT				MATERIAL				ORG.
		ErP	GPP	Standard	PEF/ Label	IPPC	Rate	SUP Plastics	Waste/ EoL	SSCM
PRODUCT	Ecodesign of equipment and components	High impact	Low impact	High impact	Medium impact	Low impact	Low impact	Low impact	Medium impact	Low impact
	Packing and packaging ecodesign	Low impact	Medium impact	High impact	Low impact	Low impact	Low impact	High impact	Medium impact	High impact
	Servitization and new circular business models.	Medium impact	Medium impact	Low impact	Low impact	Low impact	Low impact	Low impact	Low impact	High impact
	Remanufacturing and advanced repair	High impact	Medium impact	Low impact	Low impact	Low impact	Low impact	Low impact	Medium impact	Low impact
	Sustainable food	Low impact	Medium impact	High impact	High impact	Low impact	Low impact	High impact	Low impact	High impact
MATERIAL	Metal transformation technologies	Low impact	Low impact	High impact	Low impact	High impact	Low impact	Low impact	Low impact	Low impact
	Key metals and critical materials	Medium impact	Low impact	Medium impact	Low impact	Medium impact	Medium impact	Low impact	High impact	Low impact
	Plastics, rubber and composites	Low impact	Low impact	High impact	Low impact	Medium impact	High impact	High impact	High impact	Medium impact
	Minerals and construction materials	Low impact	High impact	High impact	Medium impact	Medium impact	High impact	Low impact	Low impact	Low impact

● High impact ● Medium impact ● Low impact

ErP (Ecodesign Directive 2009/125), GPP (Green Public Procurement), Standard (technical standards and regulations), PEF / Label (Environmental Product Footprint and labels), IPPC (Industrial Emissions Directive), Rate (Landfill rate and landfilling ban legislation), SUP plastics (Single Use Plastics Directive), Waste/ EoL (Waste and end-of-life specific legislation), SSCM (Sustainable supply chain management).

The main product environmental innovation drivers are:

— Ecodesign Directive 2009/125 (ErP)[6]: the main innovation opportunity is early anticipation of future criteria or exceeding them and, particularly, of adapting to the circular economy and durability EN 45552-45559[7] standards.
— Green Public Procurement (GPP)[8]: integration of environmental criteria with a life cycle approach in the range of products.

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[5] Ihobe, Environmental Management Agency. Basque Government, *The Circular Economy: New Aspects from the European Commission to Anticipate and Innovate,* 2018

[6] European Commission, *Ecodesign Working Plan 2016-2019 COM(2016) 773 final,* 2016.

[7] Basque Ecodesign Center, *Standards to Support the Ecodesign Directive (2009/125/EC) and to the Transition towards a More Circular Economy. Mandate M/543 of the European Commission,* 2019

[8] Basque Government, *Green Public Procurement Programme of the Basque Country 2020,* 2016.

— Environmental-technical standards (Standard)[9]: development or adaptation to technical standards, for example those allowing the introduction of secondary materials in products.
— Product Environmental Footprints (PEF/Label)[10]: externally verified Type III ecolabels or life cycle assessment with a harmonised calculation method using product category rules (PCR).

The main drivers regarding industrial processes and materials include:

— Industrial Emissions Directive (IPPC)[11]: anticipating future mandatory requirements, recommendations or emerging technologies to require emissions limits and material efficiencies.
— Landfill rate and landfilling ban legislation (Rate): landfill rate or landfilling ban[12] or limitation orders.
— Single Use Plastic (SUP) directive[13]: recyclability requirements, recycling and incorporation of secondary materials, along with restrictions on certain uses, as one of European Plastics Strategy instrument[14].
— Specific waste directives (Waste/EoL)[15]: end-of-life vehicles, waste electrical and electronic equipment, batteries and packaging (ELV, WEEE, etc.) directives, the related extended producer responsibility schemes and, more generally, the revised waste framework directive.

The main drivers in the organisation are the requirements of the "Green Supply Chain Management" (GSCM). Led by multinationals[16] from sectors such as renewables, mobility or food, they are deployed through private platforms (e.g. Ecovadis, Carbon Disclosure Project, etc.) and in the new business models with a life cycle approach.

Innovative business initiatives based on clearly defined drivers have greater potential for the solution to be established on the market.

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[9] Basque Government, *Order establishing the requirements to use recycled aggregates from the recovery of construction and demolition waste,* 2015.
[10] European Commission, *The Environmental Footprint Pilots,* 2019.
[11] European Commission, *Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control).*
[12] Basque Government, *Decree 49/2009 regulating the elimination of waste by means of landfilling and the execution of backfills.*
[13] European Commission, *Proposal for a Directive on the reduction of the impact of certain plastic products on the environment COM/2018/340 final.*
[14] European Commission, A European Strategy for Plastics in a Circular Economy SWD(2018) 16 final.
[15] European Commission, *Waste Policy Review,* 2018.
[16] Basque Ecodesign Center, *Committed to the Green Driving in the Supply Chain,* 2014.

THREE LINES OF FUNDING TO COVER THE PRIORITY AREAS

Published as a single call, the Ihobe lines of funding[17] for Basque industry seek to provide coherence and clarity for the companies and stakeholders interested in embarking on eco-innovation projects. Therefore, the following lines are proposed[18]:

— **Eco-innovation:** technological or industrial developer, up to €100,000 of funding.
— **Ecodesign:** industrial developer, up to €20,000 of funding.
— **Circular Economy Demonstration:** industrial developer, up to €30,000 of funding.

TABLE 3.
PRIORITY AREAS AND PREFERENTIAL LINE OF FUNDING FOR EACH CATEGORY

FOCUS	PRIORITY AREA	LINE OF THE CALL		
		Eco-innovation	Ecodesign	Circular Economy demos
PRODUCT	Ecodesign of equipment, components and mobility	Only 1.a and 1.b		
	Packing and packaging ecodesign			
	Servitization and new circular business models		All, except 3.e	
	Remanufacturing and advanced repair			
	European environmental footprint			
MATERIAL	Metal transformation technologies		Only 6.a	
	Key metals and critical materials		Only 7.a	All, except 7.a
	Plastics, rubber and composites		Only 8.a	
	Minerals and construction materials			

All aspects — A single aspect — Relation either with theEcodesign or demostration lines — Area excluded

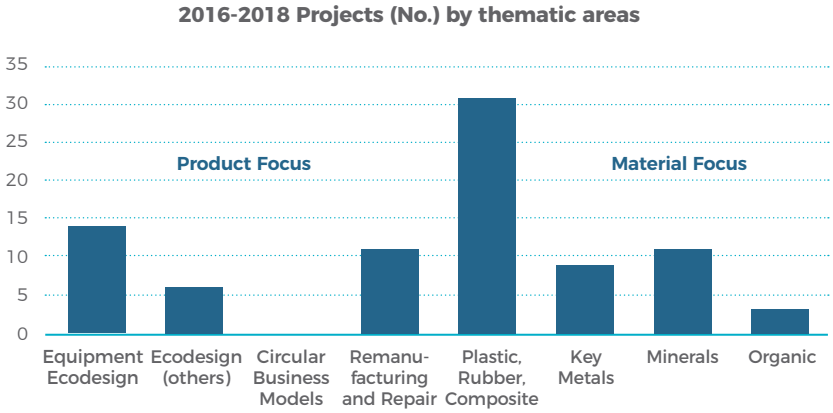
Green (all aspects of the area included, with a few exception), Yellow (in some cases, it includes a single aspect of the area), Amber (the area has a conceptual relation either with the Ecodesign or with the demonstration lines), Red (area excluded in that line)

All the priority areas are eligible for the eco-innovation line, however, not for the Ecodesign or circular economy demonstration lines. Furthermore, the attached tables indicate whether a specific sub-area is eligible, as an exception, in a different line to the other sub-areas.

[17] Ihobe, Environmental Management Agency. Basque Government, *Programme of Funding for Companies in Eco-innovation and Ecodesign for the Circular Economy in the Basque Country*, 2018.
[18] Ihobe, Environmental Management Agency. Basque Government, *2019 Funding for Ecodesign, Circular Economy Demonstration and Eco-innovation.*

The priority areas and their breakdown into sub-areas show significant continuity on the previous calls and have been refined according to the assessment of the 85 completed projects or in advanced state of implementation[19].

FIGURE 1.
DISTRIBUTION BY THEMATIC AREAS OF THE 85 PROJECTS SELECTED IN THE IHOBE FUNDING CALLS IN ECODESIGN, CIRCULAR ECONOMY DEMONSTRATION AND ECO-INNOVATION BETWEEN 2016 AND 2018



PRIORITY AREAS

The priority areas established in the Basque Country's 2030 Circular Economy Strategy are not exclusionary and therefore funding applications can be submitted in other non-priority areas.

The aspects of the areas described below are indicative and aim to help companies pinpoint opportunities.

[19] Ihobe, Environmental Management Agency. Basque Government, *Ihobe Grants for circular economy innovation projects* as part of the SPRI – Innobaque symposium on "European Tools to Fund R&D&I in the Circular Economy", 2019.

PRIORITY AREA 1

ECODESIGN OF EQUIPMENT, COMPONENTS AND MOBILITY

JUSTIFICATION

In the European Union, ecodesign would mean additional income of €57 billion for industry and savings of €500 a year per household by 2030[20].

In the Basque Country, the turnover of 41 Basque companies from the sale of products and services where Ecodesign criteria were applied in 2016 was €2,852 million and accounted for 28% of their total turnover.

A turnover of €7,253 million is estimated for 2020, which would account for 46% of the turnover[21]. Over 150 Basque companies in total currently apply ecodesign criteria[22].

The key challenges and opportunities for Basque companies are:

— Ecodesign[23] generates around 20% savings in raw materials to manufacture products in numerous companies and a reduction in energy consumption and of emissions in the use phase of between 3% and 30% in motors, lighting and fans[24].

— The economic savings generated by ecodesign are higher than the greater costs incurred in the processes.

— The positive impact of ecodesigned products on the profits of Basque companies is 46%, compared to 64% in the European Union, and the additional profit margin is 24% greater than on conventional products[25].

— Ninety-four per cent of Basque companies that ecodesign expect turnover growth of the ecodesigned products and services on international markets to be equal or greater to those of the national market.

— Fifty-nine per cent of companies consider that ecodesign is essential to contribute to differentiation on the markets where they operate.

— Ecodesign increases the internal capacity for innovation in products, components and materials.

— Ecodesign aimed at product durability is an essential method to progress towards a business model based on servitization.

Ecodesign of metal pieces.

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20 European Commission, *Ecodesign impacts accounting. Status Report,* 2016.

21 Orkestra, Ihobe, *Business Opportunities that Ecodesign offers the companies of the Basque Country,* 2017.

22 Ihobe, Environmental Management Agency. Basque Government, *Ecodesign made in Euskadi. 15 years of product environmental innovation,* 2014.

23 Ihobe, Environmental Management Agency. Basque Government, *Ecodesign Sectoral Guides. Electric-Electronics. Automotive. Machine Tools,* 2010.

24 Ihobe, Environmental Management Agency. Basque Government, *Ecodesign made in Euskadi. 120 Case Studies,* 2014.

25 Pole Ecoconception, Institut de Developpement de Produits, *Profitability of Ecodesign. An Economic Analysis,* 2014.

R&D&I NEEDS

Ecodesign aimed at product durability is an essential method to progress towards a business model based on servitization.

a) **Ecodesign to extend lifetime.** Initial design or improvement to the design of a product or component aimed at optimising its lifetime. This aspect includes concepts such as ecodesign for optimum maintenance in the use phases, for renovation through modularity, for repairability, for dismantling, for reuse (e.g. Li Ion batteries) and for remanufacturinga[26]. It is particularly relevant for products and equipment coming under the Ecodesign Directive (ErP)[27] and the application of the new pre-EN 45552 to 45559 durability and circular economy standards[28].

b) **Radical redesign optimising functionality.** Starting from the required function allows products to be completely innovated from an integral perspective by substantially reducing the environmental impacts on their life cycle.

c) **Ecodesign for efficient resource consumption in the use phase.** Energy consumption in the use phase is the main environmental aspects for numerous products and equipment. Ecodesign can also reduce material consumption in the use phase, as is the case of Near Net Shape machinery or the moulds.

d) **Ecodesign aimed at dematerialisation.** Miniaturisation, lightening or including materials with a smaller environmental footprint help to reduce the environmental footprint of many products, particularly those that do not consume energy. Seeking to reduce the use of critical material with a high environmental impact and high supply risk, such as the neodymium and dysprosium of permanent magnets, based on standards such as the new EN 45558, is likewise essential.

e) **Ecodesign for recyclability.** Integrating criteria in the product design to facilitate the recycling of practically all materials[29]. It also includes replacing, minimising or designing for recycling critical materials, while prioritising cutting dependency on the neodymium and dysprosium of permanent magnets.

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[26] Basque Ecodesign Center, *Ideas Notebook No. 5. Product durability*, 2014.

[27] Basque Ecodesign Center, ErP Directive. *Ecodesign of energy-related products*, 2019.

[28] Basque Ecodesign Center, *Standards to Support the Ecodesign Directive (2009/125/EC) and to the Transition towards a More Circular Economy. Mandate M/543 of the European Commission*, 2019.

[29] Basque Ecodesign Center, *Ideas Notebook No. 17. Ecodesign for Materials Recovery*, 2017.

PRIORITY AREA 2

PACKING AND PACKAGING ECODESIGN

JUSTIFICATION

In the European Union, packing and packaging account for 39.7% of all plastic used[30]. Both the EU Plastics Strategy and the Single Use Plastics Directive[31] seek to ensure 100% recyclability, 50% recycling and 30% recycled material conten.

Plastic containers.

In the Basque Country, 196,000 tons of plastic a year are used for packing or packaging. Packaging manufacturers account for 85,000 ton/year of that amount and the marketing of plastic-packed products and drinks a further 110,500 ton/year.

There are ten Basque plastic manufacturers with a turnover of over €4 million a year. In addition, there is a sector producing cardboard and paper packing and packaging, along with high performance, mainly wooden, packaging of great economic significance.

The challenges and opportunities identified for Basque companies in packing and packaging ecodesign[32] include:

— Achieving a balance between lightweighting packaging, partly based on multilayers of different materials, and its recyclability from an integral and systematic life-cycle approach[33].

— Decoupling the functionality of the packaging and packing, a short-life product, from the large-scale use of raw materials. Packed or packaged industrial products may be an ideal innovation area to do so.

— Using ecodesign to anticipate packing and packaging that the European Commission is preparing in the framework of the Circular Economy Strategy, along with the Single-Use Plastics Directive. Both instruments will substantially modify the current extended producer responsibility schemes.

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30 Plastics Europe, *Plastics – the Facts 2018. An analysis of European plastics production, demand and waste data,* 2019.

31 European Commission, *Proposal for a Directive on the reduction of the impact of certain plastic products on the environment COM/2018/340 final,* 2018.

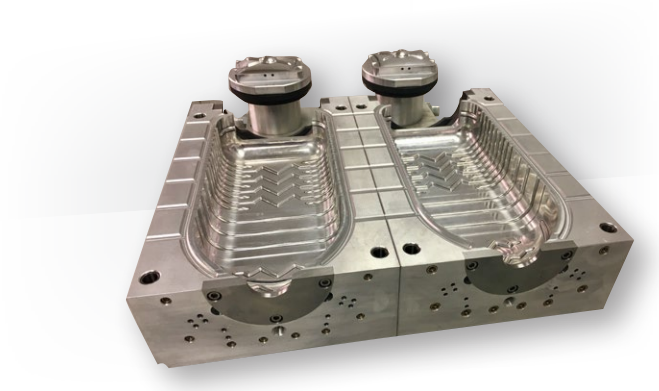
32 Ecoembes & Ihobe, Environmental Management Agency. Basque Government, *Packaging Ecodesign Guide. Packaging and Packing Ecodesign Guide,* 2017.

33 Ecoembes & Ihobe, Environmental Management Agency. Basque Government, *Environmental Labelling for Packing and Packaging Guide,* 2018.

R&D&I NEEDS

a) **Innovative packing and packaging systems.** Design or radical rethinking to protect products and equipment more efficiently and facilitate handling of solids and liquids, with a lower impact on transport and on end-of-life.

b) **Designing reusable packaging and packing.** Improving design by ensuring systems, techniques and materials that facilitate their repair and reuse, while enabling appropriate recycling after several life cycles.



Example of ecodesign.

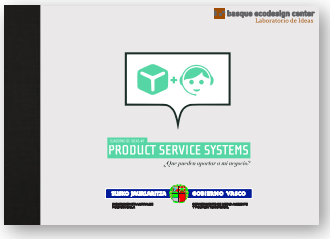
Some of the challenges and opportunities facing Basque companies when ecodesigning containers and packaging are the decoupling of the functionality of the container and packaging, a short-life product and the large-scale use of raw materials.

PRIORITY AREA 3

SERVITIZATION AND NEW CIRCULAR BUSINESS MODELS

JUSTIFICATION

In the European Union, the change from the traditional business model, where the manufacturer reduces its dependency on the sale of products and focuses on covering customer needs, means that Ecodesign strategies can be applied that were not previously compatible with the manufacturer's interests. Those models may mean a new stable source of income and growth of between 25% and 50% in one out of every 4 companies in the last 5 years[34], and independent from economic cycles.



Producto Service Systems
Ideas Notebook No. 1

In the Basque Country, a convergence can be seen between the Industry 4.0 concepts, - and therefore Smart products and production -, the development of advanced services and strengthening links between suppliers and users of products and services (servitization)[35].

Servitization.

The challenges and opportunities to be highlighted for Basque companies in servitization and new circular business models are:

— A transformation of this type requires integration with the chain upstream as per the ISO 14000 standards and the extended responsibility of the producer, and downstream through the generation of value networks. There is also the need for information transparency between the stakeholders involved.

— The sectors in the Basque Country that have shifted towards services playing a greater role in the business are aviation, machine manufacturing, chemical industry and, to a lesser extent, equipment and means of transport.

— Some companies provide a wide range of services throughout the product life. These include installation, predictive maintenance to avoid failures, repairing, continuous improvement programmes to increase efficiency, upgrading old equipment with new technologies to optimise its performance, extension of the service life by means of monitoring systems and structural improvements, reconditioning, uninstalling, dismantling and separation, recovery of parts, recycling and waste management.

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[34] Fundación Ambiental y Obra Social La Caixa, *Eco-innovation Outlook and its Potential in Spain*, 2016.
[35] Ekonomiaz, *Industrial Renaissance, Advanced Manufacturing and Servitization, No. 89*, 2016.

R&D&I NEEDS

a) Product as service. Preparing a proposal for the customer to use a product by means of a subscription or "pay per use"[36], along with offering the purchase of a predetermined service with a defined quality, guaranteeing a result agreed between both parties[37].

b) Product and equipment reuse systems. Innovative resale model aimed at industry (B2B) or the end consumer (B2C)[38] for a second- or third-hand market, by incorporating innovative aspects for the business with special impact to minimise environmental aspects.

c) Optimising the component and equipment use phase. Monitoring and digitalising using mock-ups, sensors, regulation and control to perform predictive and/or preventive maintenance allowing economic and environmental impacts to be reduced and the life of manufactured products lengthened.

d) Inverse logistics and cycle closure systems. Innovation in the interconnected organisation of the closed cycle supply chain logistics is highly important to plan and control the component and product cycles. Designing logistics or core centres for remanufacturing,[39] advanced repairing or reuse is one of the most common activities. It can include the development of information traceability system to assess the information of the materials or products to be recovered. The extended responsibility of the producer, which as a voluntary or legal requirement, makes it easier for manufacturers and retailers to recover products at the end of their lifetime, along with access to obsolete products by reuse platforms and remanufacturing companies.

e) Financial services to support servitization in SMEs. Servitization for durability" taken to apply to product and service alike, in general run on the basis of "pay per use", drives product durability and reduces the environmental impact, but has a limited viability in SMEs due to the financial risks[40], as it requires an increase in capital to pre-finance the equipment to be servitized[41].

In the European Union, the change from the traditional business model, where the manufacturer reduces its dependency on the sale of products and focuses on covering customer needs, means that Ecodesign strategies can be applied that were not previously compatible with the manufacturer's interests.

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36 Ihobe, Environmental Management Agency. Basque Government, *Product Servitization: New Business Models for a Circular Economy – Practical Guide,* 2019.

37 Basque Ecodesign Center, *Ideas Notebook No. 1. Product Service Systems,* 2014.

38 Zero Waste Scotland: *Procuring for Repair, Re-use and Remanufacturing Category and Commodity Guidance,* 2016.

39 Sundin E et al., *Map of Remanufacturing Business Model Landscape, European Remanufacturing Network,* 2016.

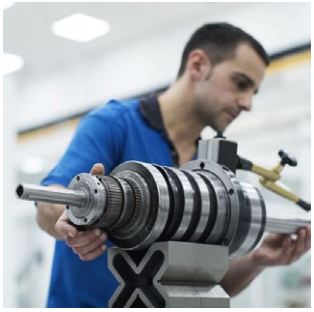
40 Kamp, B., Gil de San Vicente, I., Dealing with the financial implications of advanced services through alternative financial entities, in "Proceedings of the Spring Servitization Conference (SSC2019)", 2019.

41 European Investment Bank, *The EIB Circular Economy Guide. Supporting the circular transition,* 2018.

PRIORITY AREA 4

REMANUFACTURING AND ADVANCED REPAIR

JUSTIFICATION



In Europe, remanufacturing generates sales of nearly €30 billion a year and employs 190,000 people. By 2030, it is expected to generate up to €98.9 billion per year and employ 587,000 people, with growth of over 200%[42].

The European Commission has started to incorporate remanufacturing and reparability criteria into the products affected by the Ecodesign Directive, has worked with the UN to develop the "product value retention"[43], supports the "right to repair" and has developed a product reparability inde[44].

In the Basque Country, the turnover from remanufacturing and reconditioning by 42 Basque industries is currently estimated to be 74 million current euros. Growth up to €192 million is expected by 2025 and an estimated increase of 1,162 in the current number of people employed[45,46], if the 33 new companies identified with high potential in this regard, particularly in the capital goods, machinery, lifting, energy and automotive sectors, embark on remanufacturing and reconditioning.

The key challenges and opportunities for Basque companies are[47]:

- Savings in high value materials and reduced emissions are 100 and 300 tons, respectively, per million euros invoiced in the automotive component and electrical equipment sectors
- The remanufactured product price is 40% lower than the original[48] and there is a significant lower lead time to the customer.
- Eighty-three per cent of companies that remanufacture consider the business benefit of this activity as the most important asset[49].
- Knowledge of product failures and inverse engineering contribute to better product design, according to 67% of companies that remanufacture equipment.
- Remanufacturing can account for up to 12% of the turnover of industries that manufacture own products and equipment.

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42 European Commission, European Remanufacturing Network, *Remanufacturing Market Study,* 2015.

43 UNO Environment – International Resource Panel, *Redefining value, the manufacturing revolution. Remanufacturing, refurbishment, repair and direct reuse in the circular economy,* 2018.

44 European Commission, Joint Research Centre, *Analysis and development of a scoring system for repair and upgrade of products, JRC Technical Reports,* 2019.

45 Ihobe, Environmental Management Agency. Basque Government, *Current Status and Development of the Remanufacturing Potential in the Basque Country from Private-Public Partnership,* Basque Ecodesign.

46 Eguren JA, Mondragon Unibertsitatea, *Opportunities and incentives for Remanufacturing in the Basque Country,* Procedia CIRP 73, 253–258, 2018.

47 Basque Ecodesign Center, *Ideas Notebooks No. 15 and 16. Ecodesign for Product and Part Recovery,* 2017.

48 Ihobe, Environmental Management Agency. Basque Government, *Circular Economy Business Initiatives in the Basque Country. Description of 36 Projects,* 2017.

49 European Remanufacturing Network and Bayreuth University, *Map of Remanufacturing Processes Landscape,* 2016.

— Remanufacturing is necessary to ensure the profitability of new business models based on pay-per-use of the equipment.

— The remanufacturing marketing is steadily growing, according to 70% of European companies that remanufacture.

R&D&I NEEDS

a) Developing and/or optimising the remanufacturing/advanced repairing process. Making the remanufacturing process more efficient and productive[50] by means of developing innovative protocols, of technological adaptation and its operational comparison in the plant. It includes applying specific remanufacturing /repairing technical standards, value stream mapping, along with optimising the production organisation. Advance repairing is taken to be the development of an "innovative product value retention".

b) Pre-diagnosis, diagnosis, control and testing innovative technologies. Incorporation of new technologies or optimising the pre-diagnosis and diagnosis techniques needed to drive the excellence of the remanufacturing activity. Testing and measuring the interim and final quality of the parts, components and/or equipment to be remanufactured or repaired regularly undertaken by the companies. This aspect includes the initial digitalisation of parts and components to facilitate decision making, along with the interactive and augmented reality that analyses and processes the AR or VR digital images to provide criteria.

c) Innovative cleaning technologies. Optimising cleaning techniques that allow greater process productivity and quality of the remanufactured components.

d) Automating series remanufacturing of parts and components. Developing technology to remanufacture large series with a lower economic model, to be able to make products profitable where the originals have unit manufacturing costs of between approximately €100 and €1000.

e) Manufacturing high value 3D spare parts. Equipment durability depends on the availability of spare parts. The most sustainable solution is a combination of remanufactured parts with others produced using 3D technologies based on digital libraries, provided that it is a more environmentally and economically advantageous alternative.

f) Advanced mechanical repair technologies. Demonstration of additive repair technologies, such as LMD laser, PVD coatings and other surface treatments, case hardening and innovative extraction technologies, such as finite-element machining.

g) Industrial-scale repair of electronic elements and circuits. Large-scale repair and testing of electronic control units (ECUs) to then incorporate them in components and equipment. Working with the original manufacturer is usually necessary to ensure operational profitability.

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[50] Mondragon Unibertsitatea & Ihobe, *Practical Guide of Remanufacturing Technologies*, 2018.

PRIORITY AREA 5

EUROPEAN ENVIRONMENTAL FOOTPRINT

JUSTIFICATION

The European Union has established rules to calculate, compare and communicate the environmental performance of 24-product categories[51]. This transparency and communication instrument has recently completed its pilot scheme after three years of work involving European industries. From 2019 onwards, the necessary documents will be prepared to assess new product categories, which are expected to be released on the market with markings that can be clearly identified by companies and consumers European-wide, thus avoiding the confusion caused by the proliferation of hundreds of eco-labels with different scopes.

In the Basque Country, there are currently 25 companies, which account for 30% of the total in the Spanish State, that have implemented at least one Type III ecolabel[52] based on environmental product declarations[53] using product category rules. The commitment to ecodesign in the last 20 years underpinned by private-public partnership has made it easier to transparently communicate environmental excellence to the market.

The challenges and opportunities contemplated with respect to the product environmental footprint are:

— An implementation of the European Organisation and Product Environmental Footprint in those sectors for which the European Commission has approved the product or sector category rules (PEFCR, OEFSR). Products such as batteries, UPS, metal plates, plastic piping, bottled water or wine already have an applicable PEFCR.

— Anticipating possible customer requirements by means of actions in line with the PEFCRs for new product categories that the European Commission will launch in 2019.

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51 European Commission, *The Environmental Footprint Pilots,* 2019.

52 Basque Ecodesign Center, *Ideas Notebook No. 4. Environmental Reputation. The Value of the Intangible in the Brand Value,* 2014.

53 Ihobe, Environmental Management Agency. Basque Government, *The Environmental Product Declaration - EPD. An Environmental Information and Comparison between Products,* 2015.

R&D&I NEEDS

a) **Development of a new European Environment Footprint product category (PEFCR).** Leadership or participation in the design of new product environmental footprint category rules, provided that this proposal is in the process opened by the European Commission and chosen as one of the new categories to be developed. The product to be chosen must have a key economic impact in the Basque Country and/or be manufactured by numerous companies of the country.

b) **Coordinated application of the product European environmental footprint to Basque companies.** Application of the product category rules approved up until the end of 2018 to a set of companies of an affected sector, in a collaborative and coordinated process. Products such as batteries and accumulators, decorative paints, intermediate paper products, thermal insulators, metal panels, UPS, animal feed, bottled water or wine already have a PEFCR developed pending implementation, even prior to the European Commission deciding on the way to showcase it on the global market.

The commitment to ecodesign in the last 20 years underpinned by private-public partnership has made it easier to transparently communicate environmental excellence to the market.

PRIORITY AREA 6

METAL TRANSFORMATION TECHNOLOGIES

JUSTIFICATION

Innovative metal transformation technologies are particularly effective when they are integrated into the productive processes from a comprehensive approach, i.e., beginning with the design of the component, then with the materials and ending with the optimum organisation of the manufacturing processes. The material efficiency of the main metal transformation differs between 95% in the case of sintering or 90% of casting to 77% of hot forging or even 45% of machining.

In the Basque Country[54], around 4 million tons of metal, worth €3.3 billion, are consumed each year. Steel is the main one in terms of value, accounting for 58% of the total cost, followed by copper (13%), aluminium (11%), molybdenum (7%), nickel (6%), chrome (3%) and zinc (2%). In the Basque Country, materials account for 58% of the total production costs in the metal sector and 72% in the automotive sector, which are generally also linked to metal. The competitiveness of Basque metal transformative companies greatly depends on innovating to optimise the harnessing of the raw material, metal.

The challenges and opportunities to be highlighted for Basque companies in key metals and critical materials are, that:

— The best available near net shape technologies for transforming metal (laser cladding, wamp, powder metallurgy, flash-free forging, etc.) avoid wastage and the generation of shavings that account for between 5% of the metal consumed to manufacture certain steel products to 90% in titanium structures for aeronautics. In addition, greater control of the processes to fuse ferrous and non-ferrous metals can cut current losses by up to 30%.

— The Basque List of Clean Technologies[55] subject to a 30% corporation tax deduction, an instrument aimed at driving the large-scale implementation of innovative techniques, only contains one type of metal transformation equipment.

— The eco-productivity increase in the metal transformation processes optimising the performance of the technological investment and ensuring smart production management that minimises rejects and generation of wastage.

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[54] Ihobe, Environmental Management Agency. Basque Government, *Basque Circular Economy Indicators 2018. European Monitoring Framework,* 2018.

[55] Ihobe, Environmental Management Agency, Basque Energy Board (EVE), SPRI, *Basque List of Clean Technologies 2016,* 2017.

— Anticipating the mandatory material efficiency requirements that the European Commission is gradually integrating particularly in the metal transformation under the umbrella of the IPPC directive based on the mandate of the European Circular Economy Strategy.

The competitiveness of Basque metal transformative companies greatly depends on innovating to optimise the harnessing of the raw material, metal.

R&D&I NEEDS

a) **"Near Net Shape"[56] innovative manufacturing technologies.** Demonstration and optimisation of the "Near Net Shape" technology application such as flash-free forging or tailor welded bank involving machinery manufacturers / retailers and can be transferred to numerous local users, thus contributing to cut the manufacturing unit cost and to raw material savings. The most efficient technologies that can be transferred to a high number of Basque SMEs will be candidates to be included in the Basque Clean Technologies List.

b) **Simulation, regulation and control of the production processes.** Smart production management, i.e., the manufacturing simulation, sensor, regulation and control systems in order to make the metals more efficient, provided that the eco-efficiency is the driver and that it is confirmed with the appropriate measurements. It can include artificial vision to acquire, process, analyse and understand digital images.

c) **Best Available Technologies for ferrous casting and surface treatment processes.** Demonstration of the cleanest technologies eco-efficiency, given the forthcoming review of the Industrial Emissions Directive (it is estimated that it will affect over 100 Basque companies of the ferrous casting and surface treatment sectors). It opens up the way to include emerging technologies in those documents aimed at establishing mandatory air and water limits, and, gradually, regarding waste generation and materials efficiency in production, for the whole of European industry.

[56] Knowledge Transfer Network, *Near Net Shape: Manufacturing as a Sustainable Production Process*, 2010.

PRIORITY AREA 7

KEY METALS AND CRITICAL MATERIALS

JUSTIFICATION

In the European Union, over 30% of the metals processed in the European Union comes from recycling[57]. However, the variation between metals is very high: 12% in aluminium compared to 31% of nickel or 55% of copper. Even though there is room for improvement, 18% of Al, Cu and Ni waste generated in Europe is exported. The recent establishing of copper, aluminium and iron flows Europewide has allowed significant metal wastage and future opportunities to be detected[58]. A threat for European industry is the dependency of a series of metals called as critical materials that, apart from generating a very high environmental footprint, have high supply and price fluctuation risk[59].

In the Basque Country, reducing external dependence on the supply of aluminium, copper and zinc by innovating in recycling processes and optimising the management of internal and external scrap from steelworks and foundries are priorities. The value of the key metals consumed is over €3.3[60] billion and that of the critical metallic materials[61] supplied come to a further 164 million. It is also possible to save metals to the tune of €12 million/year, which are currently eliminated in landfill as complex waste[62] (honing and polishing sludge, galvanic sludge, aluminium sludge, ...).

The challenges and opportunities to be highlighted for Basque companies in key metals and critical materials are, that:

— The ecodesign of parts and metal alloys can reduce the environmental footprints of special steels and alloyed aluminium up to 40%.
— The lightning strategy in the mobility sector (automotive, aviation, rail) will facilitate the differentiation of companies that innovate in new steel and aluminium alloys.
— Optimised management of the different types of metal shavings and waste generated in the production process allow income from selling those second materials to be at least doubled[63].
— The diagnosis of the criticality and risk in the supply of key metals[64] would facilitate the anticipation of Basque industries through action plans based, mainly, on innovation[65].

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57 European Commission, *Accompanying document on a monitoring framework for the circular economy COM(2018)29.*
58 JRC European Commission, *Material Flow Analysis of Aluminium, Copper, and Iron in the EU-28, JRC Technical Report,* 2018.
59 European Commission, *Report on Critical Raw Materials and the Circular Economy SWD(2018) 36 final.*
60 Deutsche Rohstoff Agentur DERA y BGR, *Metals Volatility Monitor,* 2019.
61 Ihobe, Environmental Management Agency. Basque Government, *Critical Materials in Basque Industry,* 2016.
62 Ihobe, Environmental Management Agency. Basque Government, *The Value of the Materials Contained in Waste: Opportunities for a Circular Economy in the Basque Country,* 2016.
63 UNEP - International Resource Panel, *Metal Recycling: Opportunities, Limits, Infrastructure,* 2013.
64 VDI, *Richtlinie VDI 4800 Blatt 2 Ressourceneffizienz - Bewertung des Rohstoffaufwands,* 2016.
65 CEN, Cenelec, *EN 45558 General method to declare the use of critical raw materials in energy related products,* 2019.

R&D&I NEEDS

a) **Ecodesign of metal products with a smaller environmental footprint.** Redesigning metal alloys to reduce the environmental environment based on life cycle assessments (LCA) of parts, components and products manufactured in large amounts and, in general, in steel or aluminium. This design, which needs inter-company collaboration, will maintain or improve the performances required and incorporate the concept of the critical material supply criticality in the European Union.

b) **Internal recovery of production metal waste.** Innovative technologies and internal procedures to recover the production metal waste and use them again in the processes, such as the internal recycling of aluminium alloy chips from machining.

c) **Optimising the management and separation of alloyed scrap.** Separation of external scrap using innovative technologies to detect and control alloys (LIBS, neutrons, etc.) to optimise the smart incorporation in the smelting and/or refining processes. Integration of companies from the value change as scrap managers can help to contribute to improving the traceability and efficiency of the system.

d) **Selective collection and recycling systems for high value alloys.** Recovering highly allowed metal parts with a high degree of traceability and uniformity, such as machine tools, to manufacture small casts of high value special steels or non-ferrous alloys.

e) **Recovery of metals based on complex waste.** Technologies to recycle complex mix metals generated in large volumes (copper lees, etc.) or different wastage that are still dumped or downcycled.

f) **Control of the high temperature processes.** Optimising the simulation, senor, control and regulation of smelting and steelmaking processes in order to avoid alloy wastage in the slag or through products. Innovating to measure more parameters makes it easier to adjust the furnace atmosphere, the additives in the thermal processes and control of the operational procedures.

g) **Minimising metal wastage in slag.** Innovating for optimum recovery of metals in the slag provided that the furnace process parameters have been efficiently controlled beforehand.

A threat for European industry is the dependency of a series of metals called as critical materials that, apart from generating a very high environmental footprint, have high supply and price fluctuation risk.

PRIORITY AREA 8

PLASTICS, RUBBER AND COMPOSITES

JUSTIFICATION

Recycled chippings.

In the European Union[66], all plastic packaging will have to be recyclable by 2030; microplastics that are intentionally added to products will be banned by means of a restriction procedure in the framework of the REACH Regulation[67,68]. Furthermore, the European Commission is preparing a legislative proposal to reduce consumption of disposable plastics.

In the Basque Country, the incorporation of secondary plastic in products must be at least doubled. In addition, should the current high amounts of imported residual plastic be maintained, recycled chemicals and material must be increased tenfold, which in turn would generate over 830 jobs stemming from collection, recycling and manufacturing. This will reduce the current 500,000 tons going to landfill and the current squandering of over €12 million a year[69].

The challenges and opportunities to be highlighted for Basque companies regarding plastics, rubber and composites are; that:

— Codesigning plastic packaging to reduce consumption of materials, increase repairs, reuse and recyclability means saving raw materials and standing out on the market[70].

— Optimising processes to manufacture plastic, rubber and composite products can reduce material consumption by 8.2%, and these figures can be increased with the incorporation of innovative "Near Net Shape" technologies for polymers.

— The 43 innovative circular economy demonstration projects driven by Ihobe in Basque companies between 2014-18 envisage recovery of plastics, rubber and composites of 64,000 ton/year, increasing the turnover of the companies by €22.5 million and generating 119 new jobs, based on the recommendations in the framework of the 2020 Horizon Programme[71,72].

— The incorporation of secondary plastics and rubber in the products substantially reduces their environmental footprints. They can therefore be differentiated in key sectors such as the automotive industry, construction and some types of packaging.

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66 European Environmental Agency, *Preventing plastic waste in Europe, 2019.*

67 ECHA, *Guidance on waste and recovered substances,* 2019.

68 ECHA, *Plastic additives initiative Supplementary Information on Scope and Methods,* 2019.

69 Ihobe, Environmental Management Agency. Basque Government, *The Value of the Materials Contained in Waste: Opportunities for a Circular Economy in the Basque Country,* 2016.

70 Ellen MacArthur Foundation, *The New Plastics Economy: Catalysing Action,* 2017.

71 EUPC, *New Innonet Project - Technological Roadmap to Near Zero Waste in Plastic Packaging,* 2016.

72 European Commission, *A circular economy for plastics. Insights from research and innovation to inform policy and funding decisions,* 2019.

— The upcycling of secondary plastics must be accompanied by stable solutions for wastage and low-quality plastic waste. The development of a recycling solutions for these streams of the Basque Country would allow the material cycle to be closed completely and be near to "zero dumping" of that stream.

The 43 innovative circular economy demonstration projects driven by Ihobe in Basque companies between 2014-18 envisage recovery of plastics, rubber and composites of 64,000 ton/year, increasing the turnover of the companies by €22.5 million

R&D&I NEEDS

a) **Eco-efficient manufacturing of plastic products.** Ecodesign or demonstration of innovative plastic transformation technologies (injection, extrusion, etc.) to minimise material losses during the production changes or rejects, provided that they have great transfer potential.

b) **Industrialised and advanced repair of plastics and composites.** The innovative repair of those products must avoid loss of value, particularly in the case of composites, and/or the wastage of large amounts of thermoplastics.

c) **Innovative protocols to ensure selective collection of plastics.** Ensuring and demonstrating the high-quality and traceability requirements of secondary plastics preferably from high-quality post-industrial origin.

d) **Manufacturing high-value products based on post-industrial plastic waste.** Incorporating post-industrial secondary thermoplastic with a high degree of traceability to produce high-value parts and products on the global market, such as car parts or technical textiles.

e) **Innovative polymer detection and segregation technologies,** taking into account the relevance of the substances of very high concern (SVHC) or other chemical substances that hinder recycling and the integration of specific chemicals.

f) **Manufacturing plastic products or composites based on post-consumption plastic waste.** Incorporating post-consumption secondary thermoplastics (used packaging, end-of-life vehicles - ELV, waste electrical and electronic products – WEEE, construction and demolition waste – CDW, textile) with a high degree of traceability to prepare parts and products.

g) **Condensation plastic chemical recycling.** Manufacturing polymers using chemical recycling (PA, PET, PUR and other condensation plastics) to be made to manufacture resins, to weave new fibres or to obtain high-value chemical products.

h) **Downcyling thermoplastics, rubber or composites.** Downcycling low-quality polymer or reduced recyclability as asphalt additives or loads in other products.

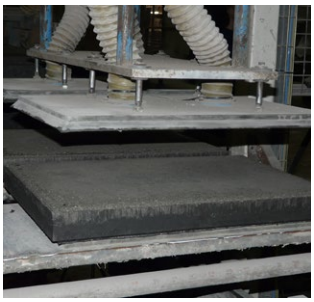
i) **Recycling or recovery of rubber and silicones.** Demonstration of the partial devulcanization of rubber and silicones, along with rubber pyrolysis processes for the black recovery of smoke and oil.

PRIORITY AREA 9

MINERALS AND CONSTRUCTION MATERIALS

JUSTIFICATION

The European Union has prioritised construction and demolition in the Circular Economy Action Plan[73] and on the other hand is working on the roadmap for the implementation of the Construction Products Regulation (305/201).



Recycled slab.

In the Basque Country, 7.2 tons of minerals a year are extracted, i.e., 15% of the total materials consumed in the Autonomous Community[74]. They are mainly used on work sites and in construction[75]. On the other hand, 1.26 million tons a year of construction and demolition waste are generated, along with 0.52 million tons of slag from the metallurgy sector, whose recovery ratios of 67% and 62%, respectively, can still be improved[76].

The challenges and opportunities to be highlighted for Basque companies in minerals and construction materials are, that:

— Developing high value construction products with verified low environmental footprint (ecolabel III) that are subsidised in green private and public procurement[77].

— Incorporating high quantities of complex slag and construction waste[78] with no viable solution so far into construction materials, while ensuring their long-term recyclability.

— Harnessing value materials present in buildings and infrastructures in small quantities for greater upcycling.

— Anticipating the application of a landfill rate aimed at complying European targets of cutting waste to 10%.

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[73] European Commission, *Resource Efficiency Opportunities in the Building Sector, COM(2014) 445 final* 2014.

[74] Ihobe, Environmental Management Agency. Basque Government, *Basque Circular Economy Indicators 2018. European monitoring framework,* 2018.

[75] Basque Government, *Order establishing the requirements to use recycled aggregates from the recovery of construction and demolition waste,* 2015.

[76] Ihobe, Environmental Management Agency. Basque Government, *The Circular Economy and Waste Management in the Basque Country,* 2019.

[77] Ihobe, Environmental Management Agency. Basque Government, *Guide for the Use of Recycled Materials in Construction,* 2018.

[78] Ihobe, Environmental Management Agency. Basque Government, *Guide to Applying the Decree on Black Slag Recovery from the Steelmaking in Electric Arc Furnaces and its Use as Steel Aggregate,* 2019.

R&D&I NEEDS

a) **Innovative technologies to concentrate and/or separate materials contained in construction and mineral waste.** Techniques to detect and separate "in situ" and "on site" of different materials, based on ceramic waste, ash, slag and construction and demolition waste (CDW).

b) **Manufacturing new materials using mineral waste.** Developing new construction materials that allow the consumption of high amounts of mineral waste (magnesite tundish, ash and fines, slag, sand, CDW, plaster), thus contributing to the unit cost of the aforementioned products.

c) **Manufacturing refractories using secondary materials.** Recovery of silicon, aluminium, magnesia-carbon refectories to manufacture value ceramic products.

d) **Recycling multifunctional construction goods and materials.** The growing use of multifunctional materials and components in modern buildings will help to generate combinations of materials that cannot be reused using the standard procedures to recycle construction materials. The current procedures must be adapted to the correct recycling of mineral material flows and modern functional materials.

In the Basque Country, 7.2 tons of minerals a year are extracted, i.e., 15% of the total materials consumed in the Autonomous Community . They are mainly used on work sites and in construction.

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