DRAFT WORKING DOCUMENT

Climate Innovation Impact Goals

Goal 7 Recast Materials Production

Climate-KIC is supported by the
EIT, a body of the European Union

Foreword

As part of our Theory of Change process, EIT Climate-KIC has developed a series of 12 Climate Innovation Impact Goals (see Table 1). These focus the attention and resources of our community, and offer a way of maximizing synergy and contribution to Europe's overall 2050 climate change and energy roadmap.

During 2017 we went through a process of consultation to select these Impact Goals and now in 2018, have worked to prepare theories of change tailored to each Impact Goal. This draws inspiration from the EIT Climate-KIC Theory of Change developed last year.

For each Impact Goal, we have prepared a 'Dossier'; collections of materials that:

- Justify why the EIT Climate-KIC Community believes the impact goal area to be so important.
- Explore the most important levers of change and the need for innovation, in the context of the pathways required for Europe to be on track with the Paris Agreement.
- Assess our current portfolio and what EIT Climate-KIC should do next.

The Dossiers have been designed to support the production of the EIT Climate-KIC Multi-Annual Strategy, and to inform our 2019 EIT Business Plan writing, business development efforts and communications with our Partner community.

The Dossiers have developed out of several evolving workstreams, including: mapping the systems that underpin our Impact Goals, co-creating theories of change, visualising our portfolio and sharing learnings from our organisation on how we deliver systems innovation. In addition to EIT Climate-KIC's input, our Partner community has fed into and further refined these workstreams through the 22 partner events that have taken place in 2018.

There are several key insights that can be extracted from the Dossiers and the process that EIT Climate-KIC has so far taken in creating them. This has highlighted:

- The importance of working across EIT Climate-KIC internal structures to better understand our Impact Goals; creating the Impact Dossiers has been an exercise of self-reflection and understanding, but also of analysis and forecasting, across EIT Climate-KIC teams.
- EIT Climate-KIC's previous experiments have supported incremental changes, but these are not enough to help us meet the decarbonisation targets required to build a zero-emission, resilient economy. To harness innovation for fundamental transformational change, we need to shift our focus to be working at a systems level. EIT Climate-KIC has a mandate to identify where innovation is most needed and a responsibility to create the wider framework for systems change.
- We must innovate to influence the intermediary driving forces that transform systems, particularly when they are acting as obstacles to progress. We have sharpened our focus on these drivers (such as policy, finance or skills) and see a need for more deliberate experiments on drivers that have previously been largely unexplored by our portfolio.
- The significance of the areas that lie between and binds together our Impact Goals. To achieve systems change we must not only foster change within these Impact Goals as some form of silo, but capitalise on the relations and inter-connections between them.
- Learnings can be extracted from Impact Goals of differing levels of maturity, for example some have evolved out of Flagships whist others were created within the last 12 months. This process has

emphasised the importance of learning from our more mature goals and experiments to build innovation communities and interventions around our new goals.

- The importance of creating feedback loops and hypotheses, and capturing learnings from our successes and failures. Our ability to foster innovation communities and experiments is underpinned by our capacity to learn from our actions. EIT Climate-KIC will help foster these learning mechanisms through our Monitoring Evaluation and Learning team, but a culture of deliberate learning and adjustment must be embedded across our Community.
- Historically our priorities have not been embedded across the whole EIT Climate-KIC community. Our Dossiers are an important mechanism to bring all our stands of work – from education, entrepreneurship, innovation, ecosystems and communication – together to transform systems.

Table 1. EIT Climate-KIC's Climate Innovation Impact Goals (1-12)

Theme	Climate Innovation Impact Goals
Urban Transitions	• **Goal 1: Promote retrofit and decentralised energy**: Drive a significant increase in urban retrofit rates and enable district-scale clean energy production, paving the way for deep cuts in emissions. • **Goal 2: Create green, resilient cities:** Harness the force of nature in infrastructure design to build livable climate-resilient cities. • **Goal 3: Accelerate clean urban mobility:** Trigger the switch to clean urban mobility to achieve considerable cuts in urban transport emissions.
Sustainable Land Use	• **Goal 4: Make agriculture climate-smart**: Instigate a substantial increase in the application of climate-smart agriculture solutions. • **Goal 5**: **Reform food systems**: Transform climate-damaging food value chains and enhance the climate resilience of food supply. • **Goal 6**: **Nurture forests in integrated landscapes:** Grow carbon sequestration in forests and linked value chains, while avoiding deforestation.
Sustainable Production Systems	• **Goal 7: Recast materials production**: Catalyse a switch to a circular economy and transform production for fossil-energy intensive materials. • **Goal 8**: **Reduce industry emissions**: Partner with key industry stakeholders in cutting scope 3 emissions to reach science-based targets. • **Goal 9**: **Reboot regional economies**: Transition carbon-intensive regions to become zero-carbon innovation hotspots.
Decision Metrics and Finance	• **Goal 10: Mainstream climate in financial markets**: Advance metrics, standards and instruments that enable transparent, true-cost and benefit accounting for a well below 2°C pathway • **Goal 11: Democratise climate risk information:** Enhance access to risk information through capacity building and a major expansion of the climate services market • **Goal 12: Foster bankable green assets in cities**: Develop capacity in preparing projects and investment vehicles to boost the availability of sustainable investment assets in cities.

Our Impact Dossiers are the first iteration of a high-level attempt to combine these streams of work and through further review and collaboration, both within and external to EIT Climate-KIC and its Partner community, we will strive to further refine this work throughout 2018.

We will therefore be inviting you, as key members of the EIT Climate-KIC community, to review this work and provide further feedback on our Dossiers.

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CSO, Climate-KIC

Theory of Change: Climate Innovation Impact Goal Dossier

Goal 7 Recast Materials Production

REPORT DATE: 15th June 2018

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Executive Summary

With the industrial sector being responsible for about 30% of global greenhouse gas emissions it is evident that our production systems need to decarbonize. In support of European and global efforts for avoiding dangerous climate change, EIT Climate-KIC is committed to reducing the emissions of the 3 highest-emitting industrial sectors: cement, chemicals (incl. plastics) and metals (steel, aluminium) in the value chains that make the highest use of these materials (eg automotive, packaging, electrical and electronic equipment),

At present, two thirds of industrial emissions come directly from materials processes, irrespective of the energy mix used. Implementing circular approaches has the potential to reduce EU CO_2 emissions associated with the production of steel, plastics, aluminium and cement by 60% in the next 30 years. The European Union is already paving the way towards a circular economy with the adoption of the 'EU Action Plan for the Circular Economy' (2015) and the '2018 Circular Economy Package', which includes the 'EU Strategy for Plastics in the Circular Economy'.

EIT Climate-KIC is supporting these efforts, with our Climate Impact Goal 7, whereby we aim to catalyse the transition from a liner to a circular, low-carbon economy.

Given the scale of the challenge, single point interventions or actions by individual organisations are not enough. EIT Climate-KIC catalyses change by identifying critical drivers to transform the system and innovating together with a multitude of stakeholders across society and sectors. In order to materialize the circular economy transition, it is crucial to work on multiple system drivers simultaneously, with the following ones being the most crucial: policy, capacity building, finance, behaviour change, new business models, information flows.

Our portfolio of experiments aims to test various innovative approaches on all crucial system drivers:

- Integration of circular economy in urban policies
- Development of capacity building activities, to equip society with the skills required in a circular economy
- New business models that support citizen behaviour change
- Technological innovations to optimize product design and materials recycling
- Optimizing information flows across the production value chain

Running innovation experiments in different geographies and environments has provided us with invaluable insights on challenges related to innovation take-up and scaling, which we share with our EIT Climate-KIC community and beyond – and also use these to inform our further activity portfolio development. In order to maximize our impact, we work together with the EIT Climate-KIC Community and world-renowned organisations in the circular economy field.

1. Introduction

1.1 Why is this impact goal important?

Goal 7 'Recast Materials Production' addresses a crucial priority within today's decarbonisation challenge. According to the IPPC 5th Assessment the industrial sector was responsible for 21% of total direct global greenhouse gas emissions and a further 11% of indirect emissions, totalling 49 giga tonnes carbon dioxide equivalent (CO_2e) in 2010[1] – see Figure 1 below. In order to remain below 2 degrees as committed to in the 2015 Paris Agreement, we need to reduce annual global emissions from 65 (as of 2015) to 39 billion tonnes carbon dioxide equivalent (CO_2e) by 2030. Existing climate policies related to renewable energy, energy efficiency and reducing deforestation can only contribute to half the necessary reduction (around 11–13 billion tonnes CO_2e)[2].

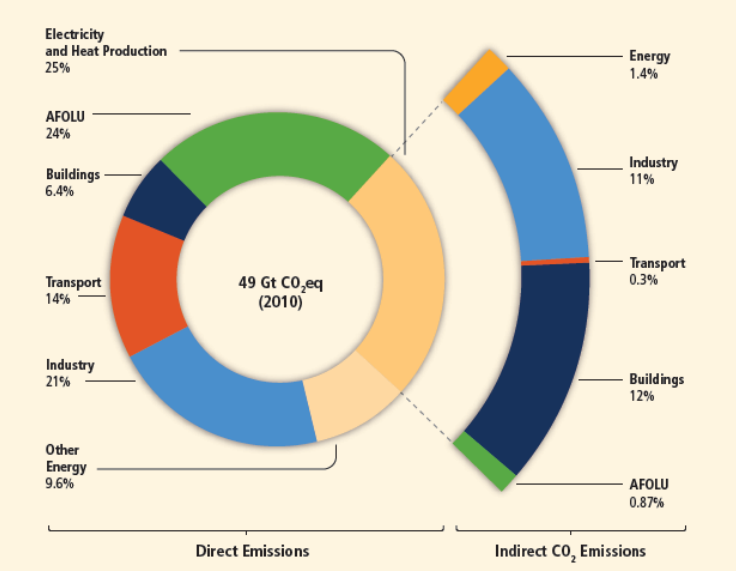


Figure 1. Global Greenhouse Gas Emissions by Economic Sector in 2010 - Direct and Indirect (IPCC, 2014:9)

EU CO_2 emissions constitute an important piece of the global emissions. EU CO_2 emissions come from various sources (see Figure 2); and although there is a diminishing trend, significant reductions would still be required.

[1] IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
Available from: https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

[2] Blok, K. et al. (2016) *Implementing Circular Economy Globally Makes Paris Targets Achievable*. Circle Economy and Ecofys, the Netherlands.
Available here: https://www.ecofys.com/files/files/circle-economy-ecofys-2016-circular-economy-white-paper.pdf

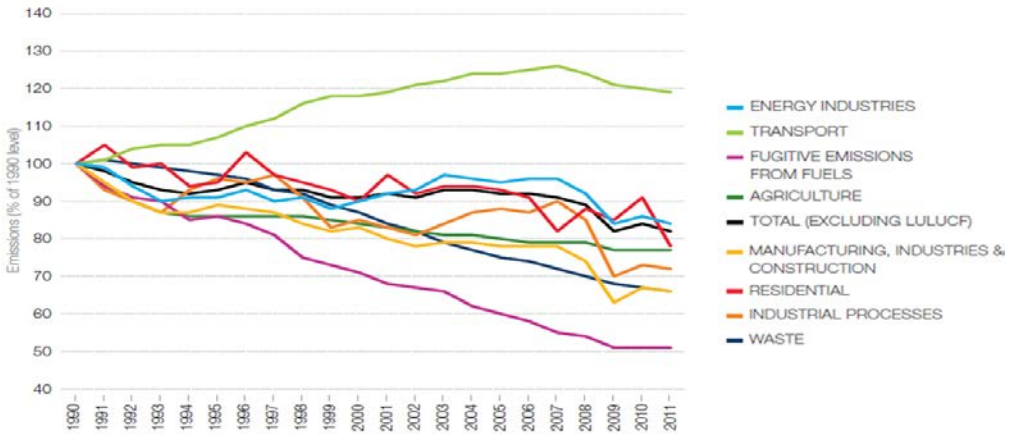


Figure 2. EU CO2 Emission Trends (European Environmental Agency, 2011)

Moreover, a recent study on 8 key materials (incl. primary crops and cattle) in the context of the circular economy conducted by Ecofys & WBCSD (2017) estimated that cement and steel are the materials responsible for the majority of carbon emissions (30% and 23% respectively), followed suit by chemicals (plastics) – see Figure 3 below.

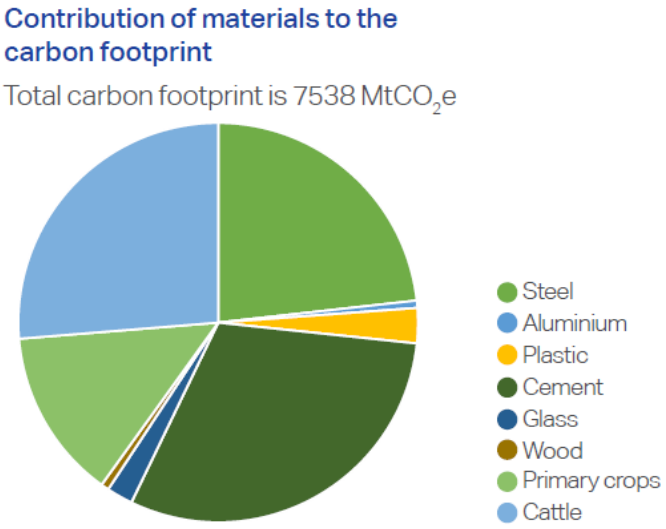


Figure 3. Contribution of materials to carbon footprint (Ecofys & WBSCD, 2017: 11)

The EU, as a frontrunner in the global climate debate, has set the following targets in its their 2011 'Roadmap for moving to a competitive low-carbon economy'[3]:

- By 2050, cut domestic GHG emissions to 80% below 1990 levels;
- Milestones of 40% emission cuts by 2030 and 60% by 2040;

3 European Commission, 2011. A Roadmap for moving to a competitive low carbon economy in 2050. Brussels. Available here: http://www.cbss.org/wp-content/uploads/2012/12/EU-Low-Carbon-Road-Map-2050.pdf

All sectors must contribute to the achievement of the goals, including industry. Due to the high energy-intensity of industry, most of the discussion to date at EU-level has focused on energy efficiency and the deployment of low-carbon energy sources. However, a 2/3 of the industrial emissions come from the actual material production process, i.e. they are a direct by-product that stems from the conversion of raw materials to metals, minerals and chemical products. Thus, they will occur irrespective of the energy source used.

Recent analysis demonstrates that implementing circular approaches has the potential to reduce EU CO2 emissions associated with the production of steel, plastics, aluminium and cement[4] by 60% by 2050[5]. This translates into a circular abatement potential of 296 Mt CO2 per year by 2050, relative to the 530Mt CO2 per year forecast.[6] Both demand and supply-side strategies are necessary to reduce emissions, as they complement each other. The supply-side normally focuses on how to make production more efficient (e.g. product material efficiency: advanced, less carbon-intensive/secondary materials and lower material quantities), while demand-side measures can support the recirculation of materials through new business models and by supporting behaviour change.

Moreover, circular economy strategies also have the potential to deliver multiple co-benefits contributing to the achievement of various Sustainable Development Goals.[7] The European Union is already paving the way towards a circular economy with the adoption of the 'EU Action Plan for the Circular Economy' (2015) and the '2018 Circular Economy Package', which includes the 'EU Strategy for Plastics in the Circular Economy'[8].

To achieve the climate targets, set, our economies need to reconfigure material flows. We need to move from a linear model based on a 'take-make-dispose' pattern to industrial systems and economies aligned with circular economy principles. According to the British Standard Institute (BSI), the idea of a circular economy cannot be reduced to a simplistic definition, as it proposes a different way of thinking about the structure of our economies. This definitional challenge is also a legacy of its antecedents which can be traced back to different schools of thought ranging from industrial ecology, performance economy, biomimicry, cradle to cradle, blue economy, regenerative design and natural capitalism[9] (None-the-less, the concept has been defined in a variety of ways by different stakeholders[10]).

In 2017, following a length consultation process which underpins the process of developing national and international standards BSI defined the circular economy from an industrial point of view as a "systemic approach to the design of processes, products or services and business models, enabling sustainable economic growth by managing resources more effectively as a result of making the flow of materials more circular and reducing and ultimately eliminating waste. Moreover, the energy required to fuel this need must be extremely efficient and renewable by nature"[11] .BSI's definition echoes the essence of the Ellen MacArthur Foundation's (2015) definition of the circular economy as an "economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times"[12].

4 These four materials (aluminium, cement, plastics and steel), are responsible for 70 percent of the EU's greenhouse gas emissions.
5 Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/, p.5
6 Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/, p.5
7 Ibid, p.8-9
8 http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf
9 BSI, 2017. Standards Publication Framework for implementing the principles of the circular economy in organizations – Guide.
10 See Brennan & Saccani (2017) for an overview of definitiosn from business, policy and academia.
11 ibid
12 Ellen MacArthur Foundation, 2015) Why the circular economy matters. Delivering the Circular Economy: A Toolkit for Policymakers, p.19–32.

In the European Union's framing of the circular economy, they emphasise a circular economy model whereby the "value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised"[13] through adopting strategies such as re-use, repair, refurbishing and recycling to extend the useful life of existing materials, components and products.

Figure 4[14] below illustrates that to achieve decarbonisation goals by 2050, carbon intensive industries must reduce dependency on the extraction of virgin materials through optimisation strategies (for example, increasing eco-efficiency), as well as adopting circular strategies e.g. closing loops, repairing and refurbishing products and cycling materials as many times through the industrial system as is thermodynamically feasible. That is, carbon-intense industries need to optimise the use of the raw materials we already have available, increase the circularity of materials in the industrial system and avoid the unnecessary disposal of materials.

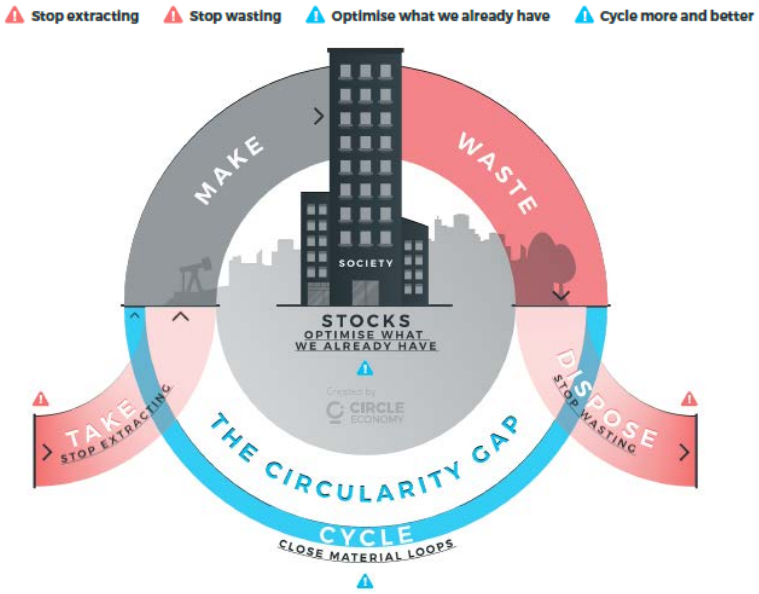


Figure 4. How to bridge the circularity gap (DeWit et. al, 2018:7)

EIT Climate-KIC's Impact Goal 7 is part of EIT Climate-KIC's work on supporting Sustainable Production Systems and aims to catalyse a switch to a circular economy by promoting the EU Waste Hierarchy[15.] Here the principle of 'prevention' is prioritised, which encourages using non-hazardous and less material in product design and manufacturing as well as ensuring that the product design enables repair and reuse of products, components and materials throughout their lifetime. This activity ensures the minimization of raw materials used and therefore the corresponding CO2 emissions. The next step is product reuse/repair and remanufacture, which all aim to keep products longer in the economy. The third preferred action according to the Waste Hierarchy, is 'recycling', which relates to the decomposition of products or components in order to re-process them into products or substances used for their original or other purposes. The last two steps of the Waste Hierarchy are to be used when the

13 European Commission, 2015. Closing the loop – An EU action plan for the Circular Economy. Brussels. Available here: https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF
14 DeWit et al (2018) The Circularity Gap Report. Circle Economy, The Netherlands.
Available from: https://www.circularity-gap.world/
15 European Commission, ND. Directive 2008/98/EC on waste (Waste Framework Directive)
[online] Available at <http://ec.europa.eu/environment/waste/framework/>

previous steps are exhausted, and these are the use of materials for energy 'recovery' (through incineration and other methods) and finally, waste 'disposal'.

Figure 5. Overview of Waste Hierarchy

Contribution to societal transformation in Europe

The main contribution to societal transformation in Europe from implementing circular economy solutions relates to the potential for economic growth (an estimated €320 billion investment opportunity up to 2025[16]) as well as associated co-benefits related to employment, health and well-being.

Based on a broad definition of employment associated with the transition to a more sustainable and circular economy, an estimated 3.4 million people were considered to be employed in circular economy activities across Europe in 2014[17]. An optimistic scenario suggests that based on the continued development of the transition, at its current pace, anywhere between 1.2 to 3 million additional jobs could occur. This could result in bringing circa 250,000-520,000 unemployed back in to work[18]. However, it is also acknowledged that there are likely to be different positive and negative employment effects for specific activities and sectors[19] - see Wijkman & Skanberg (2015, 2016) [20] for a number of EU country specific estimates.

While there is currently limited data related to the implications of this transition in terms of gender, skills, occupational and welfare effects, poverty and inequalities[21], it is recognised that circular economy strategies have

16 EMF, 2017. Achieving 'Growth Within'. [online] Available at: <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf>
17 WRAP, 2015. Economic Growth Potential of More Circular Economies. [online] Available at: <http://www.wrap.org.uk/sites/files/wrap/Economic%20growth%20potential%20of_more%20circular%20economies.pdf>
18 ibid
19 European Parliament Research Service (EPRS), 2017. Towards a circular economy – Waste management in the EU . [online] Available at: <http://www.europarl.europa.eu/RegData/etudes/STUD/2017/581913/EPRS_STU(2017)581913_EN.pdf>
20 Wijkman, A. and Skanberg, K., 2015. The Circular Economy and Benefits for Society Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency: A study pertaining to Finland, France, The Netherlands, Spain and Sweden. Available from: https://www.clubofrome.org/wp-content/uploads/2016/03/The-Circular-Economy-and-Benefits-for-Society and Wijkman, A. and Skanberg, K. (2016) The Circular Economy and Benefits for Society Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency: A study pertaining to the Czech Republic and Poland. Club of Rome. Available from: https://www.clubofrome.org/wp-content/uploads/2016/10/The-Circular-Economy-Czech-Republic-and-Poland.pdf
21 CEPS, 2017. The Circular Economy – A Review of definitions, processes and impacts. CEPS Research Report No. 2017/09. [online] Available at: <https://www.eesc.europa.eu/sites/default/files/files/ceps_report_the_circular_economy_a_review_of_definitions_processes_and_impacts.pdf>

wider co-benefits[22] which contribute to well-being particularly health benefits related to reductions in air pollution and contaminants which have bioaccumulated in our ecosystems and food chains.

Progress against decarbonisation can be seen in the global decarbonisation rates; according to PWC's Low Carbon Economy Index[23,] which tracks the G20's decarbonisation since 2000, carbon intensity has decreased by 2.6% annually since 2014. None-the-less, global decarbonisation still falls 3% short of the average decarbonisation rate of 6.3% required to achieve the Paris Agreement - see Figure 5 below for an overview.

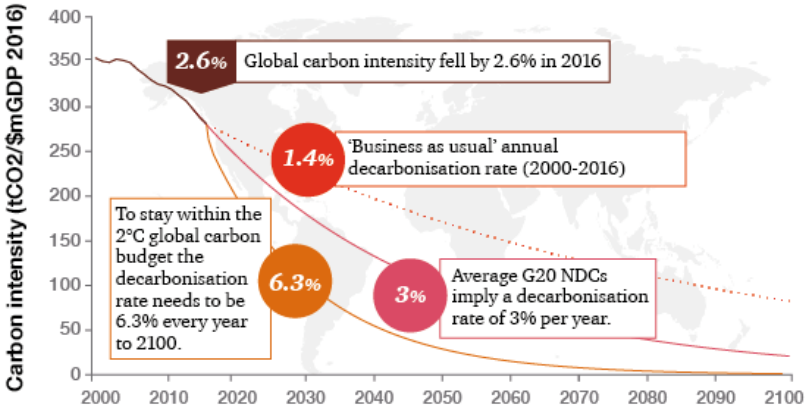


Figure 6. Low Carbon Index 2017 (PWC)

Advances over the last 20 years in the circular economy domain have predominantly related to technological innovation which enable material cycles. A 2016 study conducted by ENEA (in collaboration with the EIT Climate-KIC SPS theme), highlights how several sectors, ranging from the bio-based industry to waste collection and sorting, are using innovation to become more circular[24]. More specifically, the following technological innovations are of relevance: the uptake of radio-frequency identification (RFID); the advance of the "Internet of Everything"; technologies which enable the identification of partners for revalorisation; additive manufacturing and advanced reverse treatment technologies for biological waste streams[25.]

An illustrative example of how technological innovations can support circular economy practices, can be found in the metals industry (steel production). Key to achieving decarbonisation in this sector is reducing losses associated with the production of steel, enabling the use of secondary steel across a wider range of products and reducing (and eventually) eliminating the problem of material contamination. Advances in additive manufacturing now extend beyond plastics and are being utilised in the manufacture of metal parts contributing to resource productivity through facilitating the elimination of scrap, the affordable manufacturing of replacement parts and targeted production reducing the necessity of stocking superfluous products[26]. Laser Induced Breakdown Spectroscopy (LIBS) technologies (enabling the rapid determination of the content of alloys in steel) could be

22 Strenchock, L., 2017. Cargo-bikes, Conviviality and Conscious Food: Creative Partnerships and the Circular Economy – Insight 2.2. Climate Innovation Insights Series 2. Climate KIC. [online] Available at: <http://www.climate-kic.org/spsinsights/downloads>
23 Pwc, ND. The Low Carbon economy index 2017. [online] Available at <https://www.pwc.co.uk/services/sustainability-climate-change/insights/low-carbon-economy-index.html>
24Enea, 2016. Climate KIC SPS- innovation areas factsheets. Available here: https://eitclimatekic.sharepoint.com/sites/TOC/WA/Shared%20Documents/02%20Impact%20Goal%20Dossiers/07%20Materials%20production/02%20Research%20and%20thought%20leadership/_MUST%20READ_ENEA%20-%20Climate%20KIC%20SPS%20-%20Innovation%20areas%20factsheets%20final%20(quali%20+%20quanti)%20-%20July%202016.pdf
25 EMF, 2014. Towards the Circular Economy – Accelerating the scale-up across global supply chains. Available from: https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Towards-the-circular-economy-volume-3.pdf
26 Florin N., Madden B., Sharpe S., Benn S., Agarwal R., Perey R. and Giurco D., 2015. Shifting Business Models for a Circular Economy: Metals Management for Multi-Product-Use Cycles. UTS, Sydney. Available here: http://wealthfromwaste.net/wp-content/uploads/2015/11/P3-FINAL-SHIFTING-BUSINESS-MODELS-FOR-CE-ONLINE.pdf

successfully implemented to create a differentiated marketplace such that steel manufacturers can specify and obtain the scrap required. While a global market for scrap metals exists, transparency is still crucial for enabling the increased reuse of alloy elements negating the requirement for their production from virgin materials.

Business model innovation is a relatively newer phenomenon. A shift towards product-service-system (PSS) business models has started to take place, whereby the selling of goods has begun to be replaced with the delivery of the material's functionality - for example chemical leasing[27] and pay per kilometre for tyres (e.g. Michelin[28]). Remanufacturing business models, which are significant in product-centric recycling – are now commonplace in some industries, like heavy goods machinery (for example Caterpillar) and printers (Fuji Xerox, Canon)[29].

Another example demonstrating progress in the circular economy in the last decades, is the implementation industrial symbiosis[30], which is considered by the European Environmental Agency as an 'enabling factor' of circular economy[31] in the form of a new business model. Industrial symbiosis is where the waste of one industrial process is converted into a feedstock for another process[32]. An outstanding industrial symbiosis example is the case of 'Kalundborg Symbiosis'[33], a partnership of 8 public and private companies in Kalundborg (Denmark), who have been implementing exchange of materials since 1972, based on the principle that 'the residues from one company becomes the resource of another', creating both environmental and economic benefits.

Process innovation: Even more recently process innovations are starting to emerge – a prime example being "total cost of ownership" being promoted within public procurement as a key mechanism to enable the circular economy[34].

Goal 7 contributes to several of the Sustainable Development Goals (SDGs)

SDG	Goals and Targets	EIT Climate-KIC's contribution
Goal 9: Industry Innovation and Infrastructure	9.2: Promoting inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product.	Our activities on circular economy, which support the development of Sustainable Production Systems, are expected to lead to future economic growth (an estimated €320 billion investment opportunity up to 202535) as well as associated co-benefits related to employment, health and well-being. An optimistic scenario suggests that this transition can lead to anywhere between 1.2 to 3 million additional jobs.
Goal 12 Responsible consumption	12.2: By 2030, achieve the sustainable management and efficient use of natural resources,	EIT Climate-KIC Climate Innovation Impact Goal 7 aims to catalyse a switch to a circular economy by promoting the EU Waste Hierarchy36. Here the principle of 'prevention' is prioritised, which

27 UNIDO, ND. Chemical Leasing Programme. [online] Available at: <https://www.unido.org/our-focus/safeguarding-environment/resource-efficient-and-low-carbon-industrial-production/chemical-leasing>
28 Michelin, the French manufacturer of tires, produces 187 million tires per year and operates in 170 countries.
29 ibid
30 Chertow, M., Ashton, W. and Kuppalli, R., 2004. The Industrial Symbiosis Research Symposium at Yale: Advancing the Study of Industry and Environment. Report Number 3. Yale, Centre for Industrial Ecology, U.S.A. Available from: https://environment.yale.edu/publication-series/documents/downloads/o-u/symbiosis.pdf
31 EEA, 2016. Report No 2/2016. Circular Economy in Europe. Available at: < https://www.international-synergies.com/wp-content/uploads/2015/09/Circular-economy-in-Europe-Developing-the-Knowledge-Base.pdf>
32 EEA, 2016. Report No 2/2016. Circular Economy in Europe. Available at: < https://www.international-synergies.com/wp-content/uploads/2015/09/Circular-economy-in-Europe-Developing-the-Knowledge-Base.pdf>
33 https://symbiosecenter.dk/en/
34 European Commission, 2017. Public procurement for a circular economy – good practice and guidance. Available at: <http://ec.europa.eu/environment/gpp/pdf/Public_procurement_circular_economy_brochure.pdf>
35 EMF, 2017. Achieving 'Growth Within'. [online] Available at: <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf>
36 European Commission, ND. Directive 2008/98/EC on waste (Waste Framework Directive). [online] Available at: < http://ec.europa.eu/environment/waste/framework/>

SDG	Goals and Targets	EIT Climate-KIC's contribution
and production	12.4: By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment.	encourages using non-hazardous and less material in product design and manufacturing as well as ensuring that the product design enables repair and reuse of products, components and materials throughout their lifetime. This activity ensures the minimization of raw materials use and therefore translates into a reduction of the corresponding CO2 emissions.
	12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.	
Goal 13: Climate Action	13.2 Integrate climate change measures into national policies, strategies and planning.	EIT Climate-KIC works on multiple levels of circular economy policy-making that influence national policies EU level: o we are members of the European Commission Circular Economy Financing Expert Group. o we are members of a European Policy Centre (EU think tank) joint Task Force on recommendations for a Digital Roadmap to Circular Economy. Local level o 'Circular Cities' project, which offers a knowledge exchange platform for first mover cities and close follower cities with regards to embedding Circular Economy principles into their urban operations and strategies.

1.2 Why should it be a focus for EIT Climate-KIC?

The circular economy represents an estimated €320-billlion investment and innovation opportunity to European organisations, particularly in the mobility system, food system and built environment, who are committed to decoupling their economic growth from resource use[37]. More generally, investment in circular innovations offers the potential to avoid assets becoming stranded (fossil fuel reserves which must be kept in the ground)[38] or redundant, thereby offering greater resilience to the European economy[39]. As already outlined in Section 1.1. key enablers of the transition to a more circular economy are predominantly technological advances in conjunction with emergent business model innovation and process innovation.

Based on a broad definition of employment associated with the transition to a more sustainable and circular economy, an estimated 3.4 million people were considered to be employed in circular economy activities across

37 EMF, 2017. Achieving 'Growth Within'. [online] Available at: <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf>
38 http://www.lse.ac.uk/GranthamInstitute/faqs/what-are-stranded-assets/
39 EMF, 2017. Achieving 'Growth Within'. [online] Available at: <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf>

Europe in 2014[40]. An optimistic scenario suggests that based on the continued development of the transition, at its current pace, anywhere between 1.2 to 3 million additional jobs could occur.

Momentum is gathering behind low carbon circular policy evident in the accomplishment in 2015 of both the Paris Agreement and the European Circular Economy Package[41,42.] However, there is more work to be done particularly in Circular Economy policy which currently has a limited scope and level of ambition[43] and is characterised by high fragmentation of regulation and legislation addressing various parts of the economy, presenting a significant barrier to the scalability of circular solutions. Advocates argue[44,45] that policy-makers at multiple levels (European, national, regional and city levels) need to strengthen a broad policy platform through 1) removing policy barriers, 2) setting a clear direction and showing commitment through targets, strategies, public investments, and consistent international trade agreements, 3) developing standards, guidelines and procurement criteria which promote first movers as well as preparing cross-sector action plans, 4) implementing structural reform through extraction or environmental taxation and developing consumption based accounting, and 5) creating platforms for dialogue, cooperation and awareness creation.

The complexity of reconfiguring complex global and regional supply chains into circular configurations warrants the need for investment in multi-stakeholder collaboration. Multi-stakeholder collaborations by their nature can be challenging and require facilitator organisations to enable communication between a set of actors with diverse objectives, interests and languages.

Meeting future global materials demand is set to increase by two- to four-fold this century[46.] While in energy production, the implementation of low-carbon energy solutions can reduce emissions to zero, in the context of materials production, their application leaves two-thirds of emissions in place since the emissions result from chemical processes rather than the combustion of fossil fuels[47]. Scaling the implementation of circular solutions and business models that keep products and materials longer in the economy, is therefore critical to achieving the transition to a low carbon economy. Such practices reduce the volume of virgin materials required to provide essential services, and consequently relieving the requirement to decarbonise material production processes (which is extremely challenging)[48]. Figure 6 below provides an overview of the estimated circular economy abatement potential related to steel, aluminium, plastics and cement by 2050.[49]

40 WRAP, 2015. Economic Growth Potential of More Circular Economies. [online] Available at: <http://www.wrap.org.uk/sites/files/wrap/Economic%20growth%20potential%20of_more%20circular%20economies.pdf>
41 Circle Economy, 2017. Policy Levers for a Low-Carbon Circular Economy. [online] Available at: <https://www.circle-economy.com/low-carbon-circular-economy>
42 European Commission, 2018. Implementation of the Circular Economy Action Plan . [online] Available at: <http://ec.europa.eu/environment/circular-economy/index_en.htm>
43 Circle Economy, 2017. Policy Levers for a Low-Carbon Circular Economy. [online] Available at: <https://www.circle-economy.com/low-carbon-circular-economy>, p.5
44 EMF, 2017. Achieving 'Growth Within'. [online] Available at: <https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Achieving-Growth-Within-20-01-17.pdf>
45 Circle Economy, 2017. Policy Levers for a Low-Carbon Circular Economy. [online] Available at: <https://www.circle-economy.com/low-carbon-circular-economy>
46 Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: <http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/>, p.11
47Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: <http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/>
48 Ibid, p.5
49 Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: <http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/>, p.5

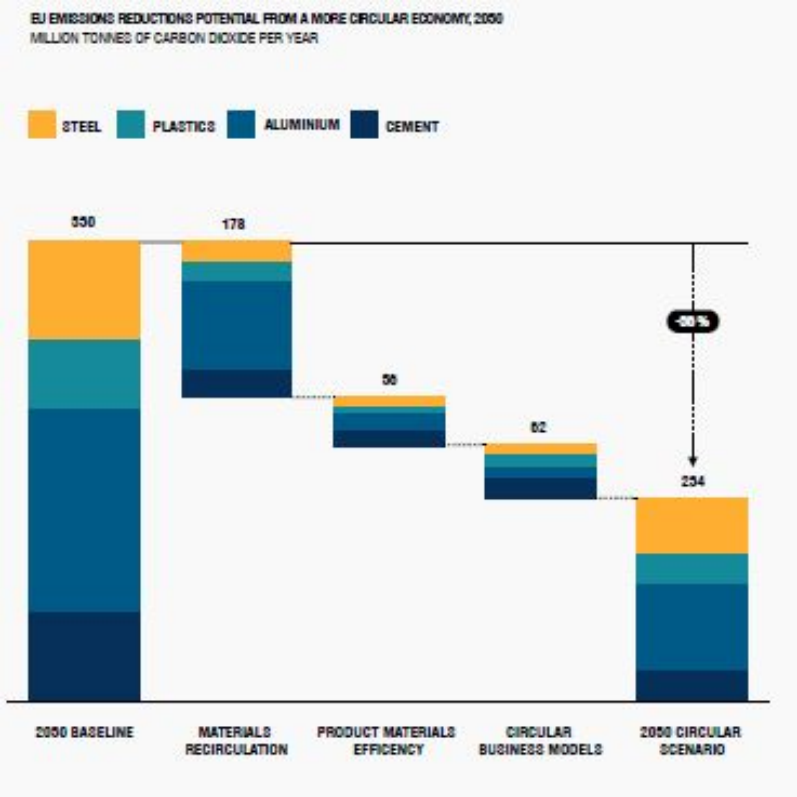


Figure 7. Overall abatement potential (Material Economics, 2018. The circular economy – a powerful force for carbon mitigation)

The circular economy is a new paradigm which seeks to inspire the transformation of our economies from a predominantly linear orientation (take-make-waste) to a more cyclical economy. Given the scale of the challenge of reconfiguring our economies and underlying production and consumption systems, systemic innovations are a necessity. The radical scale and pace of change required is unlikely to emerge from single point interventions, or actions from single organisations or individual sectors rather it necessitates the mobilization of a multitude of organisations, cross-sector collaboration and the involvement of a plurality stakeholders from across society.

As an example, in the context of plastics, it is estimated that by implementing circular strategies (e.g. re-use, collection and recycling, improving sorting processes and the quality of recycled material, strengthening secondary markets), could together contribute to a reduction of nearly 50% in associated carbon emissions in Europe by 2050[50]. None-the-less, to reduce emissions further a systems approach needs to be adopted whereby complementary strategies in conjunction with circular solutions are implemented, for example scaling up of the use of bioplastics and developing innovative ways to recycle thermoplastics and mixed plastic fractions, developing new materials and advancing mechanical recycling[51]. The transformation of plastics value chain illustrates why a systemic approach is required, as implementing single-point interventions are not sufficient to address the scale of decarbonisation required across the materials sector (steel, aluminium, plastics and cement) by 2050.

Furthermore, to enable the possibility for securing a deep transformation, a systems innovation approach is important, to create a supporting system that includes many different parameters that interact with each other: new policy initiatives, new technologies, new markets, behaviour change, capacity building, and – very importantly

50 Material Economics, 2018. The circular economy – a powerful force for carbon mitigation. [online] Available at: http://www.climate-kic.org/areas-of-focus/sustainable-production-systems/our-insights/, p.86
51 Ibid, 20-21

- supporting the sharing and flow of information among the community of practice evolving around the materials sector.

EIT Climate-KIC is a European knowledge and innovation community, working towards a prosperous, inclusive, climate-resilient society founded on a circular, zero-carbon economy. Keeping global temperature rise below 2˚C necessitates unprecedented change: new social dynamics, ways of doing business, capital flows, policymaking, economic models, and new ways of living. No one organisation can solve climate change on its own. Climate KIC can catalyse the rapid innovation needed across sectors by convening the brightest minds to tackle challenges, empowering leaders through capacity building, and seed funding the most promising climate-positive businesses.

Within the materials sector, having a pan-European co-operation platform is critical to: 1) build and maintain a network of experts addressing different challenges but with aligned goals, 2) generate momentum among policy-makers and on-the-ground practitioners in order to drive sector-wide and cross-sector change, and 3) utilise demand-side incentives to create market certainty as well as stimulate investment in capacity-building.

In light of the challenges associated with the complexity of reconfiguring our economy and scaling up circular systems, multi-partner/multi-stakeholder approaches can provide an effective way to enable the best systemic innovations in the shortest time. –An example which illustrates this point is food packaging – a product with a very short-lifetime. Transforming this complex plastics value chain will require innovative solutions and a major effort by key decision makers, plastics producers and consumer as well as recyclers

Collaboration between different stakeholders is necessary to transform a system. However, very often stakeholders with varying objectives (e.g. policy-makers, business, academia) speak very different languages. It is often the case that a mediator is needed to 'translate' the language of one to the other, to facilitate communication and exchange, and eventually joint decision-making.

A key differentiator for EIT Climate-KIC is being not only a multi-partner/multi-stakeholder platform but an international community. This enables EIT Climate-KIC to convene a unique pool of resources through our projects, experts, people and events enabling us to provide cutting edge expertise on a variety of topics to the manufacturing industry. Moreover, through our convening ability we can build bridges between different stakeholders catalysing the emergence of synergies. Climate KIC promotes early engagement and co-creation as well as supporting the growth of the projects we invest in, through our European offices supported by expert partners in local communities.

The EIT Climate-KIC partnership consists of different types of stakeholders (e.g. local authorities, business, academia, NGOs) that have complimentary skills. This collaboration can offer unique insights to these stakeholders and accelerate the pace of innovation and system change.

In the latest UN Environment Emissions Gap Report (2017)[52], UNEP report that global emissions from energy and industry have remained stable since 2014 but that overall GHGs continue to rise slowly. Moreover, the Nationally Determined Contributions (NDCs) underpinning the Paris Agreement only cover a third of the emissions reductions required to achieve a least-cost pathway while remaining well below 2 degrees. This difference between the target ambition and the trajectory forecast has become known as the 'emission gap' which UNEP argue needs to be

52 UNEP, 2017. The Emissions Gap Report 2017. [online] Available at:< https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf>

closed by 2030. UNEP are advocating for action by sub-national and non-state actors, in addition to a call for more ambitious NDC s by 2020. Conscious of both the significant emissions gap and UNEP's call to action of non-state actors, EIT Climate-KIC wants to enable the achievement of the circular abatement potential through financing and promoting new business models that could facilitate faster adoption of circular practices for instance through shifting incentive structures across supply chains. These business models are directly related to behaviour change.

Several circular economy advocacy organisations or programmes have emerged in the last five years. Most notable to date in Europe are the Ellen McArthur Foundation based in the UK, Circle Economy based in The Netherlands, the World Business Council for Sustainable Development (WBCSD) and the OECD Re-circle Project. The Ellen MacArthur Foundation currently have a number of programmes[53], e.g. Project Mainstream and CE100 (targeting businesses), Circular Cities and CE100 Government & Cities (targeting cities), and also programmes that develop circularity indicators, enhance capacity building and initiatives that support circularity in fashion, food, plastics. Circle Economy[54] have recently launched Circle Lab[55] which contains over a 1,000 case studies and resources and seeks to crowdsource circular economy innovation; it has a portfolio of programmes related to transforming the industrial system, built environment, cities, textiles and realigning the financial system. The WBCSD, an EIT Climate KIC Partner, are working to help companies to identify and prioritise Circular Economy opportunities. In collaboration with Ecofys[56] they analysed from an environmental perspective, global material flows and related carbon, water and land footprints for eight key materials[57]. They sought to understand the biggest opportunities in six groups of supply-chains namely: food, shelter, furniture and appliances, mobility, clothing and footwear and services and subsequently developed an inventory of available circular economy measures that can be applied to mitigate negative impacts. The OECD's "Re-Circle Project"[58] aims to provide policy guidance on resource efficiency and the transition to a circular economy. Most recently they launched[59] a critical review of modelling approaches in order to shed insight into the macroeconomic implications of the circular economy transition.

EIT Climate-KIC's work under Climate Innovation Impact Goal 7 builds on and complements the work of the above-mentioned organisations in two key ways. Firstly, while bodies like UNEP, and the European Union focus on the development of a favourable regulatory environment for the circular economy, Climate KIC invests in experimentation and strategic interventions at multiple scales, supporting circular innovations to get to market. Secondly, as an international multi-partner, multi-stakeholder platform we engage an even broader and differing set of stakeholders, enlarging the network of expertise. Climate KIC bring together a vast range of stakeholders and articulate knowledge and learnings from the projects and start-ups we support, in order to offer inspiration and recommendations to various stakeholders on circular economy implementation.

More specifically, through EIT Climate KIC's Loop Programme – which has been developed to support the achievement of Climate Impact Goal 7 - we provide a unique global innovation platform on circular economy that aims to close the loop on high-emissions material systems (such as cement, plastics, steel and aluminium) in the value chains that make the highest use of these materials (eg automotive, packaging, electrical and electronic

53 Ellen McArthur Foundation, ND. Programmes. [online] Available at: <https://www.ellenmacarthurfoundation.org/programmes>
54 Circle economy, ND. Programmes. [online] Available at: <https://www.circle-economy.com/programmes/>
55 Circle Lab, ND. [online] Available at: <https://circle-lab.com/>
56 Ecofys & WBCSD, 2017. Circular Economy and Environmental Priorities for Business. [online] Available at: https://www.ecofys.com/files/files/ecofys-wbscd-2017-circular-economy-environm-prio-for-business.pdf>
57 Ibid, p.8
58 OECD, ND. Re-Circle: resource efficiency and circular economy. [online] Available at: <http://www.oecd.org/environment/waste/recircle.htm>
59 McCarthy, A., Dellink, R and Bibas, R., 2018. The Macroeconomics of the Circular Economy Transition: A Critical Review of Modelling Approaches. OECD Environment Working Papers, No. 130, OECD Publishing, Paris.
Available at: http://dx.doi.org/10.1787/af983f9a-en

equipment), and dematerialise demand in urban areas. The programme accelerates the transition to a low-carbon, closed-loop society by supporting innovation on all elements crucial for transforming from a linear to a circular economy: new business models, technologies, standards, policies and finance. By working on a combination of parallel interventions, it aims to create closed loops in five city districts in the next five years. One of the key activities within the Loop programme, is its flagship project, eCircular, which seeks to accelerate the circularity of plastic-based material systems and dematerialisation of plastic demand. The flagship seeks to enable the scaling up of radical digital innovations with a focus on waste prevention in the plastic value chain, e.g. by promoting smart manufacturing solutions, advanced eco-design approaches, new business models and alternative consumption patterns. Furthermore, advanced policies and industry standards will also be explored to scale-up systemic innovations[60].

A recent study delivered by Material Economics and funded by – among other actors EIT Climate-KIC focuses on looking at the climate mitigation potential of circular economy in the materials sector. The need for materials will grow strongly with economic development to fulfil the global material demand. Meeting this materials demand could result in huge CO_2 emissions toward 2100[61]. This puts current materials use on a collision course with climate objectives. Even with the adoption of best available technologies, and with increases in recycling of steel, plastics and aluminium, emissions would nearly double during the century. Furthermore, it was highlighted that the reuse of renewable energy does not reduce emissions from materials production to levels compatible with a 2 °C objective. Also, using a greater share of low carbon energy is not applicable as a strategy to reduce CO_2 emission when looking at material production because much of the emissions result not from the combustion of fossil fuels, but from chemical processes. Unlike energy emissions, these process emissions cannot be reduced by replacing fossil fuels with lower-carbon sources of energy.

Our portfolio under this goal consists of several projects at different stages of the innovation cycle, for example:

- CE Guide (early stage innovation): This project developed the Guide to the Circular Economy (www.CEguide.org) to facilitate the private sector's transition to the circular economy. The goal of this initiative is to empower companies and individuals within them to understand their role in the circular economy and the steps they can take in moving towards a regenerative business model.
- BBC 2.0 (later stage innovation): This project works on upcycling end-of-life-tyres into high quality carbon black, bringing an innovative circular solution to two major global challenges in the tyre industry: waste streams of tires and sustainable supply of raw materials. The objective is to be able to replace 60% of the different types of carbon black used in car tyres by the end of 2019.
- BECIRCLE (later stage innovation): a shared-IP project, focusing on enhancing circularity of industrial parks. It prototypes digital solutions which assist to identify of the best system layout design in industrial parks, order to share and mutualize material and energy flows.

60EIT Climate-KIC, 2018. Supplement for Impact Goal 7: Recast materials production, and Impact Goal 9: Reboot Regional Economies. Available here:
https://eitclimatekic.sharepoint.com/sites/TOC/WA/Shared%20Documents/02%20Impact%20Goal%20Dossiers/07%20Materials%20production/01%20CKIC%20working%20docs/Supplementary-Guidance-on-Impact-Goal-7-and-Impact-Goal-9-Call-3.pdf
62 A Theory of Change is essentially our hypothesis for how change happens and the pathways we need to follow to achieve our vision.

2. Theory of Change

2.1 How can society tackle climate change through systems innovation and transformation?

Scientific models tell us that if we are to avoid the worst impacts of climate change (above 2°C), Europe must stop being a net emitter of greenhouse gases by 2050 at the latest. While there are some encouraging signs of progress, we are currently only taking baby steps towards this target. To be on track, the evidence is that we need to be cutting emissions at least six times faster than we are now. Gradual improvements are not going to be enough to achieve the scale and speed of decarbonisation we need. Instead, we need change that is much more radical; in the way all of us live, work, travel and play.

We believe that this challenge presents that world's biggest, most exciting and most urgent innovation opportunity. As Europe's foremost climate innovation network, EIT Climate-KIC has the responsibility to act and offer a **Theory of Change**[62] for how Europe is going to achieve its decarbonisation and resilience targets, and create jobs and growth in a new climate-compatible economy. This must be credible, bold, inclusive, radical and inspiring.

We are working towards an **inclusive, climate resilient society with a circular, zero emissions economy.** Our economy won't generate waste, won't emit greenhouse gases and people will have the capacity to adapt to a changing climate that minimises negative impacts. By 2050 at the latest, buildings, industry and transport must not be contributing to emissions and land-use should be net-zero emissions too. By 2050, everyone should have the ability and the capacity to avoid, reduce and minimise remaining climate change impacts.

But 2050 may be too far in the future to be motivating, so we have set nearer term, 2030 Climate Innovation Impact Goals that we will contribute to achieving. These serve as a lightning-rod for our combined efforts, pinpoint where innovation is most needed and provide an indication of whether we are on track for 2050. These impact goals have been chosen by our community for (a) their consistency with the Sustainable Development Goals, (b) the precise nature of Europe's decarbonisation and resilience challenges and (c) where our collective expertise is concentrated. These goals are focused on cities, land-use, industry and finance.

Our impact pathway

Transformation of whole systems (such as those detailed by our impact goals) can be achieved by exposing the weaknesses of existing systems and nurturing something better. We can contribute to this by unleashing a series of strategically-targeted experiments on the different forces that shape such systems. For example, the future of urban transport in Europe will be influenced by policy and regulation, finance and investment trends, people's behaviours and choices, and the technologies and skills people possess. EIT Climate-KIC will build on our existing work to assemble a portfolio of experiments that enact on these forces simultaneously; testing and learning what works and helping to create a stronger agency that leads to change. We want to catalyse and instigate options, momentum and excitement that gives Europe a chance for achieving 2050 targets. Innovation in just one area alone will not be enough, so instead we must connect communities of change-makers across Europe and beyond, to reach tipping points quickly.

62 A Theory of Change is essentially our hypothesis for how change happens and the pathways we need to follow to achieve our vision.

Table 1 shows EIT Climate-KIC's Innovation Impact Goals, with cities, land-use, industry and finance describing the systems requiring change.

Theme	Climate Innovation Impact Goals
Urban Transitions	• **Goal 1: Promote retrofit and decentralised energy**: Drive a significant increase in urban retrofit rates and enable district-scale clean energy production, paving the way for deep cuts in emissions. • **Goal 2: Create green, resilient cities:** Harness the force of nature in infrastructure design to build livable climate-resilient cities. • **Goal 3: Accelerate clean urban mobility:** Trigger the switch to clean urban mobility to achieve considerable cuts in urban transport emissions.
Sustainable Land Use	• **Goal 4: Make agriculture climate-smart**: Instigate a substantial increase in the application of climate-smart agriculture solutions. • **Goal 5**: **Reform food systems**: Transform climate-damaging food value chains and enhance the climate resilience of food supply. • **Goal 6**: **Nurture forests in integrated landscapes:** Grow carbon sequestration in forests and linked value chains, while avoiding deforestation.
Sustainable Production Systems	• **Goal 7: Recast materials production**: Catalyse a switch to a circular economy and transform production for fossil-energy intensive materials. • **Goal 8**: **Reduce industry emissions**: Partner with key industry stakeholders in cutting scope 3 emissions to reach science-based targets. • **Goal 9**: **Reboot regional economies**: Transition carbon-intensive regions to become zero-carbon innovation hotspots.
Decision Metrics and Finance	• **Goal 10: Mainstream climate in financial markets**: Advance metrics, standards and instruments that enable transparent, true-cost and benefit accounting for a well below 2°C pathway • **Goal 11: Democratise climate risk information:** Enhance access to risk information through capacity building and a major expansion of the climate services market • **Goal 12: Foster bankable green assets in cities**: Develop capacity in preparing projects and investment vehicles to boost the availability of sustainable investment assets in cities.

Table 1. EIT Climate-KIC's Climate Innovation Impact Goals (1-12)

Around each of our themes and impact goals, our portfolio of experiments focuses on levering change in finance, policy, skills, behaviours, and technologies. It builds on existing work to include the following:

- Experiments designed to accelerate learning and foster collective action in networks of high ambition places and organisations that are committed to transforming systems (climate innovation ecosystems and flagships).
- Testing innovative ideas, whether through start-up businesses or early-stage, exploratory innovation projects (entrepreneurship and early stage innovation).
- Trialling bigger demonstrations of innovations and pathways to scaling their uptake and impact (larger stage innovation).
- Taking the best and brightest and nurturing their skills to be leading climate innovation change agents.
- Exploring how communications, collaboration platforms, knowledge and learning processes can influence people's behaviours and catalyse social movements.

We will continually assess the results of these experiments in terms of the prospects for change, and regularly adapt our approach.

2.2 Our Theory of Change in Impact Goal Area 7

Our Theory of Change under this Climate Impact Goal has been developed through a 3-fold approach:

a) literature review for exploring the system, the system actors and their relationships
b) incorporation of learning from our innovation experiments in this area
c) Feedback and validation from EIT Climate-KIC partners and EIT Climate-KIC staff, under the following instances:

EIT Climate-KIC partners

- EIT Climate-KIC general Assembly 2017
- Sustainable Production Systems Partner Workshops on the Impact Goals: 24 & 25/04/2018
- Regular exchanges with the EIT Climate-KIC partners on different instances

EIT Climate-KIC staff

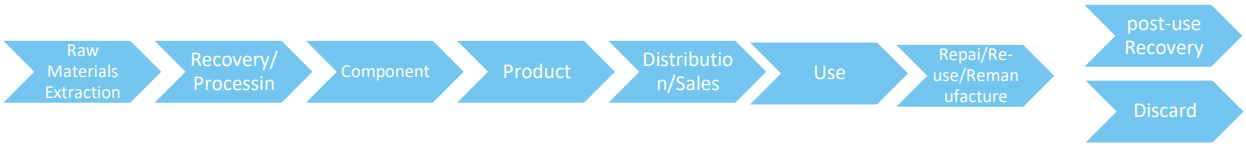
- 'Embedding the Theory of Change' workshop: 09-10/05/2018
- Whole EIT Climate-KIC event: 16-17/05/2018
- Webinar with EIT Climate-KIC staff: 06/06/2018 (see process below, in section 3.1, outlining the work undertaken on Systems Mapping)
- Regular exchanges with the EIT Climate-KIC staff on different instances and through use of virtual systems mapping tool

We live in a world of 7.5 billion people, projected to increase to 10 billion people by 2050. This increasing human population needs to fulfil certain basic needs in order to survive. Basic needs are physiological (e.g. water, food, breathing, sleep) and safety-related (shelter, health, economic security). When the basic needs are met, more advanced needs follow, such as belonging, esteem, self-actualization (Maslow's Hierarchy of Needs). Human societies have created systems that build products to support meeting these needs. However, the rapid population increase in the last century has resulted in increased production, which has in turn put extreme strain on the planet and its limited resources - and has consequently rendered this model unsustainable.

Materials production is the cause of one third of global Greenhouse Gas emissions. The highest emission quantities come in particular from chemicals (incl. plastic), metals (steel, aluminium) and cement. As mentioned in previous sections, in order to reduce emissions rapidly, we need to reconfigure our production model in these sectors, from a linear, 'take-make-dispose' model, to a 'circular' one, which keeps products and materials in the economy for as long as possible. Our activities under Climate Impact Goal 7 aim to support the transition from a linear model into industrial systems and economies aligned with circular economy principles. We are aiming towards production systems where:

- human needs are met by extracting (almost) zero raw materials
- nothing is considered as 'waste', but rather as feedstock for new processes
- products remain in the economy during very long timeframes
- significantly smaller amounts of products are used to meet increasing human needs (eg through leasing, sharing etc)

The current production system operates under the following value chain model:



Section 3.1 describes in detail how this system is currently organised. Below follows a summary of the main points, that have lead us develop our Theory of Change.

The production system is organised around the supply and demand of products:

1. businesses producing the materials and transforming them into end-products
2. citizens or other businesses who use the end-product (end-users)
3. citizens/businesses who can re-use, repair, remanufacture products
4. businesses who take care of the product recycling or discarding

In order to continue catering for human needs while reducing the current production system's negative impact on the planet, there are only 2 streams we can act upon:
a) improve the products/materials supplied in the system
b) reduce product demand

In order to do this, we need to work with the main stakeholders in the system:

- Businesses
- Citizens
- Policy Makers
- Workforce
- NGOs/local initiatives
- Media
- Financiers

Some stakeholders have influence on more system actors than others, and therefore their assumed 'power' to influence and change the system is higher. The most 'powerful' stakeholders seem to be:

- Citizens (demand)
- Policy makers
- Financiers
- Media

As a consequence of the most powerful system actors, we see the implicit 'drivers' (leverage points) that have the highest potential to change this system, to be the below; these are the leverage points to be prioritized for further action (more details under section 3.1):

- Behaviour (to change consumption habits and eventually influence demand)
- Policy
- Finance
- Markets (whereby all stakeholders are brought together)
- Skills (for supporting the transition to new paradigm)

Our activity portfolio aims to work on different aspects of these leverage points, in order to ensure a smooth system transformation. Some examples of the link between our activities (including envisaged future activities) and how we believe these can lead the ambition we have for this impact goal, are displayed below (Figure 8).

We also recorded the assumptions EIT Climate-KIC is holding that need to be true for the theory of change to reach the impact goal and the wider enabling conditions they relied upon. The process of developing a Theory of Change results in a number of **choices for EIT Climate-KIC**:

- we need to build up resources for policy influence
- collaborate with other (aggregating) system actors (e.g. NGOs, local influencers) to support CE take-up by public
- better communication of learnings from our experiments
- collaborate with key actors that have expertise on the different system levers
- co-creation opportunities for producers and consumers

Figure 8. The Theory of Change in Impact Goal 7 Recast Materials Production

Assumptions

awareness will increasing behaviour Change/sharing

consumers behave rationally

favourable policies will enhance CE activities

education and tool availability will support behaviour change

Enabling Conditions

waste materials can be used legally

system stakeholders open to collaboration

culture that supports sharing

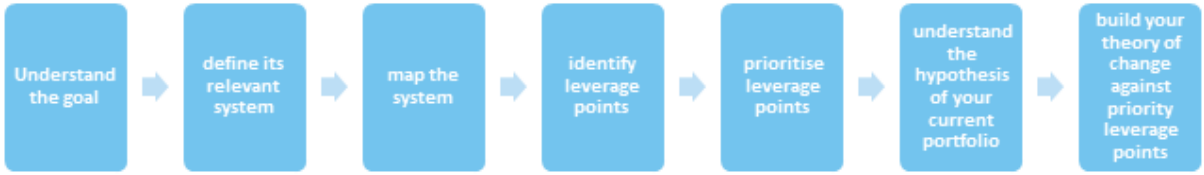
increasing raw material Prices

3. Our Portfolio and Approach

3.1 How does EIT Climate-KIC understand the system associated with the impact goal?

System Mapping

To develop and set out the theory of change at the goal level, EIT Climate-KIC has followed a process facilitated by the system change and sustainability non-profit, Forum for the Future. The stages of this process are illustrated in the figure below. It starts with a review of the current articulation of the goal and a discussion on what the change the goal is creating is. Through a set of questions EIT Climate-KIC built its understanding of what the system is that we need to create change within, in order to further our goal and to set clear in-out scoping boundaries for this system. The next stage was to map this system as it currently is. This was done onto the Multi-Level Perspective Framework, an analytical approach to describe processes of innovation and transitions in socio-technical systems with the aim of better understanding the context for system innovation projects. The mapping was conducted in facilitated sessions in person and in virtual work spaces.



Identifying Leverage Points

Through discussion and EIT Climate-KIC's existing analysis the next stage was to identify potential leverage points in the current system that if activated would create change towards the outcome of the impact goal. We then rated the current ability of EIT Climate-KIC to activate each leverage point against 'resources' and 'power'. Resources include skilled staff, financial funding; power includes remit, agency with the stakeholders involved. This enabled us to understand which leverage points we are already equipped to have high impact with and those that we would need to increase power and/or resources to activate.

Reviewing the Portfolio Hypotheses

We then reviewed the hypotheses within our current portfolio of projects and initiatives that support the goal to review which leverage points these currently activate and how they cumulatively impact the goal.

Theory of Change

Recording assumptions ensures that there is an understanding of what those developing the theory of change are relying on outside of the agency they have to run their portfolio of work that is nonetheless important to its success.

Figure 9. Systems Map on Impact Goal 7 Recast Materials Production

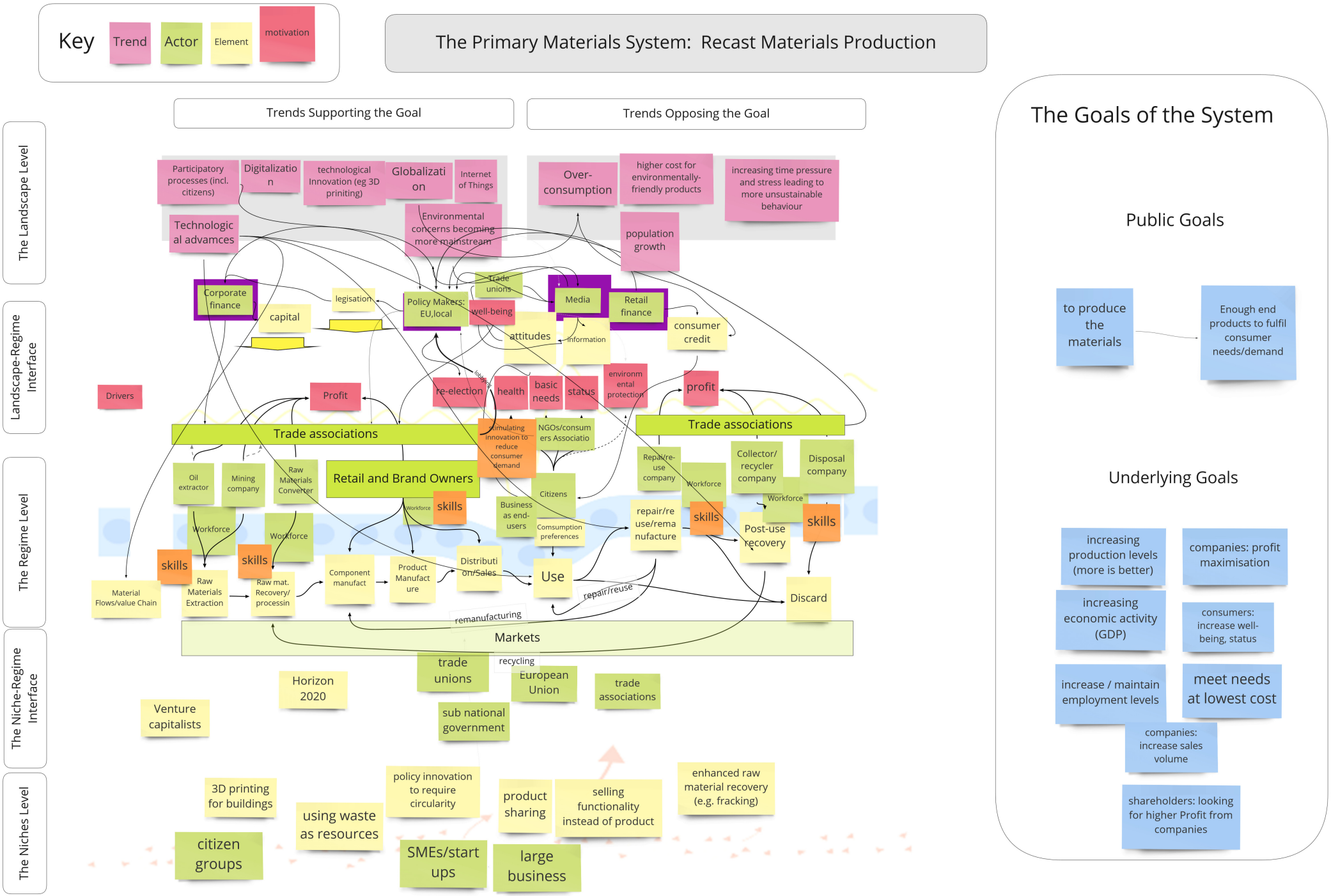


Figure 9 (above) shows the system stakeholders, their motivations and the influence they have over other actors.

This system is organised around:

1. businesses producing the materials and transforming them into end-products
2. citizens or other businesses who use the end-product
3. citizens/businesses who can re-use, repair, remanufacture products
4. businesses who take care of the product recycling, discarding and incineration

These are the assumptions underpinning the systems map:

- over-consumption and increased population is driving up material use
- the media drives lifestyles of high consumption
- consumers behave economically rationally unless influenced by media/citizen initiatives/NGOs
- system actors (eg policy/business) tend to be reluctant/respond slowly to system changes (eg circularity)
- most finance is going into the high-carbon system
- trade unions and industry 'fear' change to circularity for different reasons
- trade associations are powerful lobbyists
- slow moving industries/difficult to adopt innovation
- companies are motivated only by profit
- cheap personal debt is driving consumerism
- products are not currently designed for easy disassembly and repair
- fossil raw materials are currently cheaper than secondary materials
- materials are not easily traceable within the system

The main stakeholders in this system are:

- **Businesses**: business have control over the type of products produced. The primary drive for organising business activities in our economy, is to maximize profit. Businesses collectively organise themselves in Trade Associations, which constitute a central source of information about the industry and its challenges, promote the industry image and also represent the interest of the industry towards third parties (including policy-makers). The work cycle of businesses is influenced by market trends (demand), legislation, financiers and trade unions.
- **Citizens**: citizens/consumers have control over the type of products they select to buy/ask for and they vote for politicians that represent their own opinion. Citizens are motivated by the drive to meet their basic and advanced needs: food, health, shelter, sleep, communication, mobility, self-esteem, achievement etc. Consumers collectively organise themselves in local initiatives (that could encourage certain consumption models) or larger Consumer Associations (they support and represent consumer rights and interests towards third parties). Citizen activities are influenced by policy, local initiatives, consumer associations, NGOs - and most importantly – by the Media.
- **Policy Makers:** policy makers have control over the legislation they produce, to regulate the market- could be either the supply or the demand side. Their motivation is to be re-elected by the electorate body. They organise themselves in local, regional, national, supra-national (EU/global) settings, depending on the activities to be undertaken. Policy makers are influenced by citizens, trade unions, trade associations and the media.

- **Workforce**: the workforce is present at every part of the production value chain. Their motivation is to secure their well-being. Workers organise themselves in trade unions, who represent their interests towards third parties. Trade unions influence business and policy-makers and are also influenced by decisions taken by the same two stakeholders.
- **NGOs**: NGOs are non-profit, non-governmental organisations that operate on local/national/international levels. NGOs are active in areas aligned with their individual objectives (e.g. social, environmental, developmental etc), either by undertaking campaigns, projects or influencing policy-makers. Sometimes they organise themselves in groups of NGOs (umbrella-NGOs). NGOs influence public opinion (citizens) and policy-makers and are meant to strive for citizen well-being.
- **Media:** Media produces information that shapes attitudes and lifestyles. They are influenced by their funders, which are often the entities that use space in the media to communicate their activities (advertisement). These are often businesses, who also use the media as a marketing but also Public Relations instrument. Media have most influence on citizens (public opinion), which in turns affects the activities of all other system actors (as the activities of the latter depend on the public opinion and product demand): policy makers, business, financiers. Emerging topics in the media can bring about significant shifts in awareness and attitudes, e.g. as in the case of plastics pollution.
- **Financiers:** Financial institutions (e.g. banks, pension funds) and other players in the financial system (eg shareholders) provide the capital inflows that are necessary for the system to operate. The supply-side (business) need capital for CAPEX and OPEX investments that will allow them to produce materials and products and the demand side (citizens and some businesses) need purchasing power in order to fulfil their needs. Financial institutions tend to organise themselves in associations. Financial institutions and investors operate in view of acquiring profit from their activities – although there is a recent trend for investments that fulfil other goals (e.g. social, environmental). The decisions of financiers influence business (supply), workers and citizens (consumption/demand) while, as a sector, they influence policy-makers. The activities of financiers are influenced by citizens (public opinion) and policy makers.

System Stakeholder	What do they do/produce? Which part of the system do they control?	Motivation	How do they organise themselves?	Who do they have influence on?	Who are they influenced by?
Business	Materials and final products manufacture	Profit	Trade Associations	Policy makers	Citizens (demand), legislation, financiers, trade unions
Citizens (demand)	citizens have control over the type of products they select to buy/ask for	Meet their basic and advanced needs: food, health, shelter, sleep, communication, mobility etc	Consumer Associations Local Initiatives	Policy makers Business Financiers	Media, Policy makers, Local initiatives, NGOs, Consumer Associations

Policy makers	Legislation	Re-election	Local/regional/national/supra-national bodies	Business Citizens (demand) Workforce Financiers	citizens, trade unions, trade associations, media
Workforce	Labour for manufacture (enabler)	Well-being	Trade Unions	Policy makers Business	Policy makers Business
NGOs	Campaigns Policy-influence	Citizen well-being	Umbrella NGOs	Citizens Policy makers	Citizens
Media	Information	Profit Information-sharing		Citizens, and through citizens they influence ALL system actors	Business
Financiers	Provide capital to supply & demand sides	Profit	Bank/Fund Associations	business workers citizens policy-makers	Citizens Policy-makers

As can be seen from the table above, some stakeholders have influence on more system actors than others, and therefore their assumed 'power' to influence and change the system is higher. The most 'powerful' stakeholders seem to be:

- Citizens (demand)
- Policy makers
- Financiers
- Media

In direct relation to the most powerful system actors, we understand the implicit 'drivers' that have the highest potential to change this system, to be:

- Behaviour (to change consumption habits and eventually influence demand) – linked to Citizens
- Policy – linked to Policy Makers
- Finance – linked to Financiers
- Markets (whereby all stakeholders are brought together) – linked to all
- Skills (for supporting the transition to new paradigm) – linked to all

In order to achieve highest impact, EIT Climate-KIC focuses its work with the relevant ecosystem actors around the system drivers (leverage points) with the highest potential:

1. **Behaviour**: The circular economy represents a new societal and economy model. The dominant value-system related to hyper consumption in our society are currently a barrier to the scaling-up of circular solutions. We need to further develop our activities in the fields that will change consumer behaviour. These are: media outreach (to show what is possible and promote a new vision for the future, eg refurbishment of high-value products which is starting to gain consumer acceptance), digital tools and platforms that will enable consumption reduction (e.g. online sharing platforms, product-as-a-service), and also work with NGOs/consumer associations/consumer

initiatives that can mobilize citizens to act differently in their everyday choices and also demand low-carbon products.

2. **Policy**: policy has the potential to influence almost all stakeholders in the system, from the supply (business) side, to the demand (citizen) side, to the finance stakeholders and also support the transition of the workforce to new paradigms. Shifting to a new economy will affect all policy domains given the systemic nature of the transition. The current fragmentation of regulation and legislation addressing the various parts of the system present a barrier to the scalability of circular solutions. European, national, regional, and city-level policymakers need to promote clear long-term circular policies so that decision makers adopt and support this new system, including ambitions, targets, investments, while acknowledging and seeking to address trade-offs.

3. **Finance**: financial flows have the potential to influence both the supply (production) side, as well as the demand side (consumer purchasing power). While the transition to a circular economy has the potential to yield many benefits, it is likely to involve considerable costs related to R&D and asset investment, stranded investments, subsidy payments to promote market penetration of new products, and public expenditure for digital infrastructure. New capital flow models have the potential to unlock circular economy infrastructure and innovation. In order to unlock these, relevant metrics are important to support financial decision-making and provide a basis for measurement which captures the added value created by a circular approach.

4. **Markets**: The circular economy provides multiple value creation opportunities to scale mechanisms decoupled from the consumption of finite resources. New digital technologies and business models are a key driver of change as they have the potential to address the structural waste in many sectors and create new consumer choices. Increasing utilisation and longevity of materials, components and products would have significant economic upsides and go far towards avoiding negative system effects.

5. **Skills**: In order to change the behaviour of a system, it is ideal that all system actors envision and support the development of the new paradigm. New skills can equip all system actors to support this shift from the angle each of them is working on, and also boost the engagement of consumers in a circular economy society.

There are several types of interventions that can be undertaken to push the above system drivers (leverage points) and many different angles to take. In brief, we are looking at activities like the below, in order to ensure a smooth system transformation:

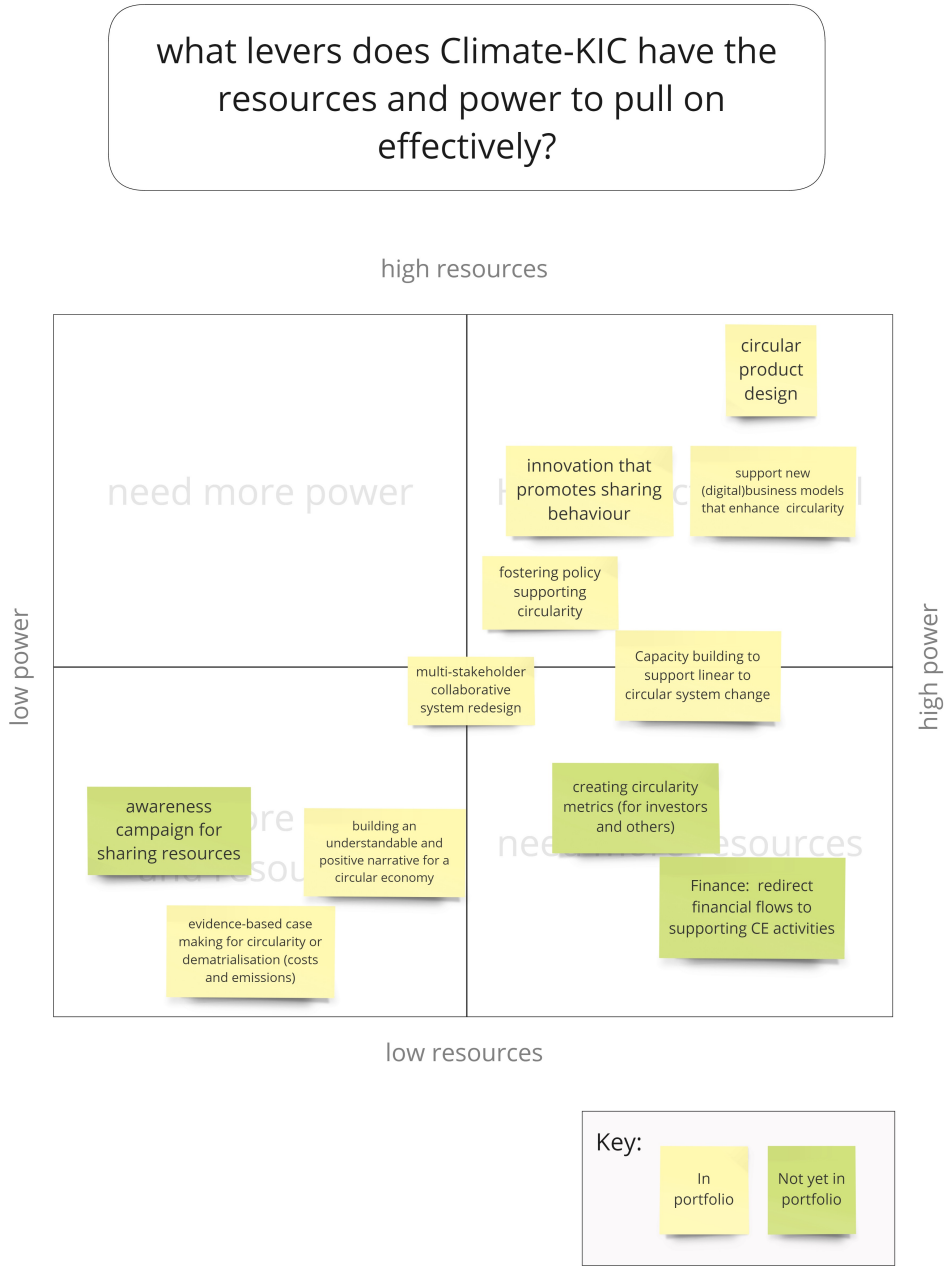
1. **Behaviour**
   - Innovation that promotes sharing behaviour
   - Awareness campaigns for sharing resources
   - New (digital) business models that enhance circularity
   - Building an understandable and positive narrative for a circular economy
2. **Policy**:
   - Evidence-based case for circularity/dematerialization (costs and emissions)
   - Fostering policy supporting circularity (eg fiscal instruments to incentivise the use of secondary raw materials)

- Building an understandable and positive narrative for a circular economy

3. **Finance**:
    - Creating circularity metrics (for investors and others)
    - Redirect financial flows to support circular economy activities (eg circular procurement)
    - Building an understandable and positive narrative for a circular economy
4. **Markets**:
    - Multi-stakeholder collaborative system redesign
    - Circular product design
    - New (digital) business models that enhance circularity (eg material passports)
    - Building an understandable and positive narrative for a circular economy
5. **Skills**:
    - Capacity building for students and professionals, to support linear to circular system change
    - Building an understandable and positive narrative for a circular economy

Below is the mapping of the perceived EIT Climate-KIC position, in relation to activating each of these leverage points. We rated EIT Climate-KIC against 'resources' (skilled staff, financial funding) and power (remit, agency with the stakeholders involved).

Figure 10. Leverage Points of Impact Goal 7 'Recast Materials Production'



It is worth noting that although efforts are done in all fronts in order to ensure a smooth system transformation, the level of progress and innovation uptake can differ between geographical environments, due to different dynamics among key stakeholders. For example, in relation to circular economy, Northern European countries have demonstrated to date higher intentional implementation of circular economy practices across key stakeholders such as national governments, cities, business and entrepreneurship (eg Netherlands, Denmark, Finland). Southern European countries - with a few exceptions of course – do not seem to always practice such a streamlined approach and thus their performance in circular economy (e.g. recycling rates) is not as strong.

3.2 How are we currently intervening in the system?

Transforming entire systems does not only require a good understanding of the systems themselves, but also a good understanding of how EIT Climate-KIC is currently intervening in them. To capitalise on the relations and inter-connections between the interventions, we are taking a much stronger "one portfolio approach" in which we treat all we do as contributing to one or more Impact Goal (s).

On the following page, we have included a graphical representation of our 2016-2017 portfolio addressing the Impact Goal to provide you a snapshot of the work we have done over the past couple of months. You will see funding, intervention types (types of programmes), driving force focus, geographic spread and stakeholder type breakdowns - the sort of information that can be valuable in making choices about where we put our efforts and resources.

What is important to note is that while an intervention might be addressing multiple driving forces, the current view only captures one of them (the one we considered as main contributor) due to the static format this is taking. See ANNEX 1 for more background information on the data and design of the visuals.

A few highlights to note from the preliminary analysis are:

- Part of the Low Carbon City Lab Flagship (LoCaL) contributes to this Impact Goal area, but there is no Flagship addressing this area as primary focus.
- While Demonstrators are consuming the most funding there is a comparatively strong Thematic Priorities & Ideator and Start-up Accelerator portfolio. This is also why there are many interventions supported in this area in relation to the total funding amount
- Funding is relatively evenly spread across the different stakeholder types in this area, with strong clusters in the Netherlands and France
- Many of the interventions contributing to Impact Goal 7 were also addressing Goal 5: Reform food systems

This is just the beginning. For the next development round, we are exploring ways to make these portfolio views more dynamic and interactive to facilitate learning across the EIT Climate-KIC network.

DRAFT WORKING DOCUMENT

Goal 7: Recast materials production

Total Funding:

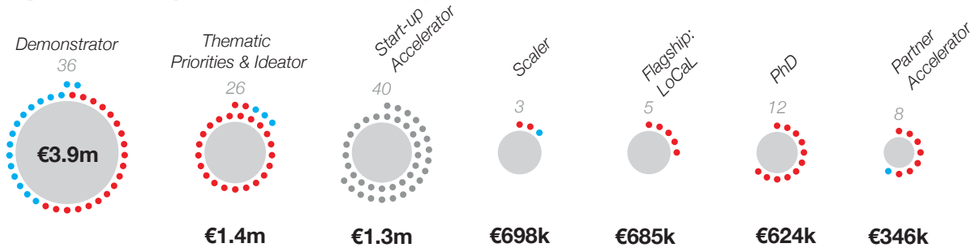
€8,946,000

Key

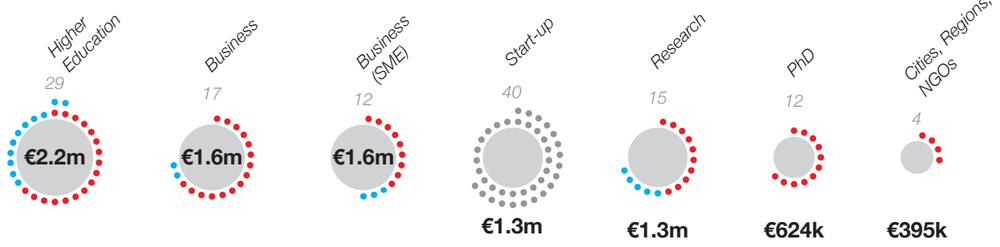
Driving force

- Information / Knowledge
- Individual behaviour
- Technology
- Market structures
- Finance
- Skills
- Policy
- No driving force
- Startup

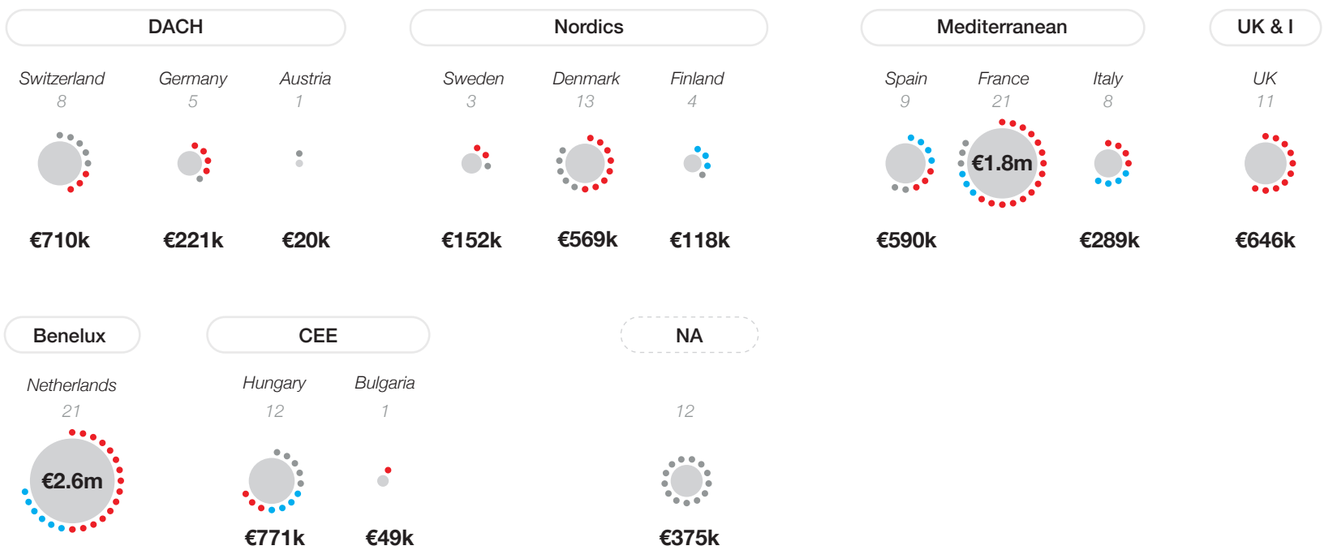
Organised by **Intervention Types**



Organised by **Stakeholder Types**

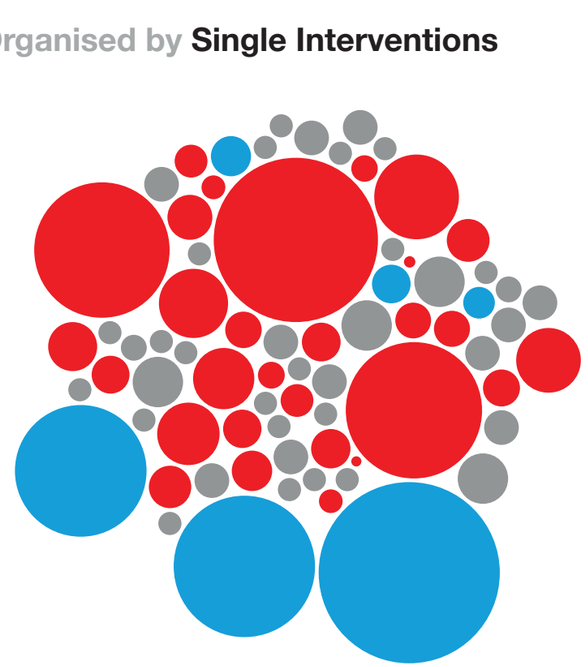


Organised by **Geography**



Data shown for combined years of 2016-17. All figures rounded to nearest thousand. The figures show the total intervention funding (i.e. EIT-funding + Co-funding)

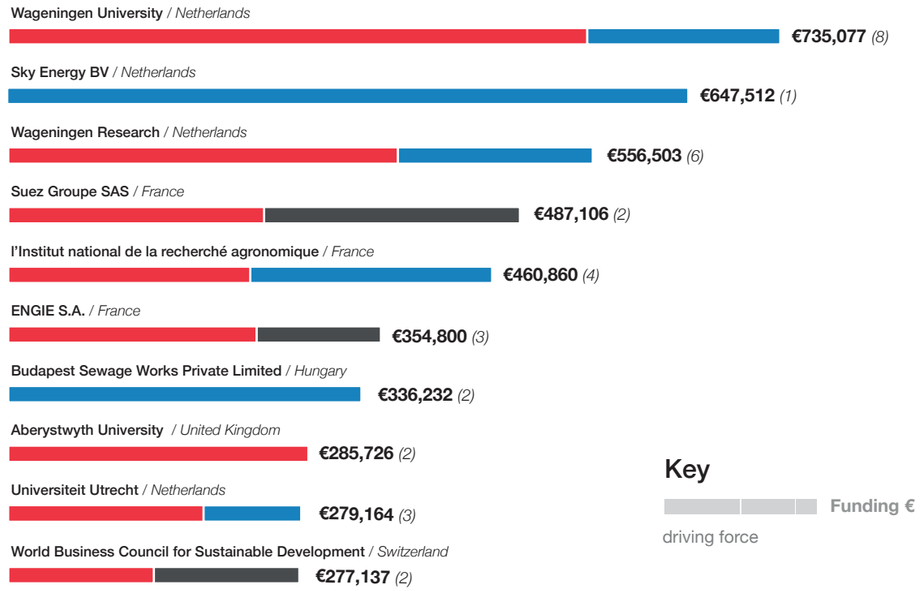
Organised by **Single Interventions**



Total Interventions:

72

Organised by **Top 10 stakeholders**



3.3 What have we learned from our interventions?

In the past years, we have developed a portfolio of interventions that mainly focus on technology and information/knowledge. As mentioned before, in order to transform the system from linear to circular, innovation needs to be systemic. Therefore, in 2018, we have started to transition our portfolio and activities from sectoral and single technologies to a more systemic approach with cities and regions as innovation test beds, working on various drivers of change, eg finance, skills, policy, markets and technology. Our aim is to accelerate the go-to-market for scalable, open source, shared IP innovation and business models through collaboration between different knowledge triangle stakeholders (e.g. corporates, SMEs, academia, NGOs).

We are aiming to work more on earlier and later stage innovation that can support circular product design or influence citizen behaviour, we are bringing together communities deep-diving on a single topic (flagship: eCircular, focus on plastics), we will be developing materials that aim to establish us among the thought leaders in this area and we are in the process of developing capacity building programmes based on our innovation experiences. Some examples from our portfolio of interventions can be seen below:

Case Study	**BECIRCLE: A shared IP project to enhance circularity of industrial parks and assist to identify the best system layout design, share and mutualize material and energy flows.**
Impact	Developing new services and a web-based tool, which business and production managers can use to plan, find input synergies or evaluate locations and cost.
Stage	Later stage (Demonstrator) Started in 2017 to develop the tool and as well as the business plan.
Scale	The tool, aiding the proximity and connectivity required to share resources and accelerate the circular economy is expected to be market-ready end of 2018.

Case Study	**CE Guide: This project developed the Guide to the Circular Economy (www.CEguide.org) to facilitate the private sector's transition to the circular economy. The goal of this initiative is to empower companies and individuals within them to understand their role in the circular economy and the steps they can take in moving towards a regenerative business model.**
Impact	Aims to scale up the number of circular strategies that companies implement through education and resource sharing. To achieve this, the Guide provides a framework of how companies can evaluate their current practices and processes and give them the tools to act.
Stage	Earlier stage (Pathfinder) - concluded in 2017.
Scale	Following the June 2017 launch of the Guide at both the World Circular Economy Forum in Helsinki and the National Circular Economy Summit at Washington, D.C., WBCSD has conducted a Roadshow hosting five workshops and three webinars with audiences in five countries and three continents to educate representatives from all sectors, industries, and company sizes on how they can contribute to the circular economy.

Case Study	**BBC2.0: This project is working on upcycling end-of-life-tyres into high quality carbon black, bringing an innovative circular solution to two major global challenges in the tyre industry: waste streams of tires and sustainable supply of raw materials.**

Impact	Replace 60% of the different types of carbon black used in car tyres by the end of 2019.
Stage	Later stage (Demonstrator) - started in 2017. Develop a larger scale industrial recycling plant to produce higher quantities of carbon black and meet tyre manufacturers' demand.
Scale	Develop a new modular industrial scale plant, a broader range of carbon black products and make a modular design to reduce construction time.

Our activity portfolio has shown us that transitions to new paradigms have long timeframes and need a systemic approach, that works simultaneously on several system levers.

We often notice variable timeframes for market take-up for new technologies and business models. This variability normally relates to the market maturity for embracing the respective innovative solutions. In most instances, it is very important to create the supporting environment (e.g. standards related to innovative materials recycling – e.g. BBC2.0) or find ways to educate the key 'system agents' towards the envisaged paradigm (e.g. CE Guide).

One element that stands out is the importance of multi-stakeholder collaboration, so that stakeholders can understand different perspectives and co-develop a shared vision. Collaboration between different types of actors (eg academia, business) is also very beneficial, as it enables system actors to complement each other's strengths (eg in the project BECIRCLE).

3.4 Where should EIT Climate-KIC focus in the future and who should we work with?

The Climate Impact Goal 7 focuses on the materials with the highest CO_2 impact. We aim to continue our work on developing strong innovation communities around these materials; we have already done considerable work in the plastics value chain and aim to enhance our activities in the metals and cement ones.

Our work in the plastics value chain will focus on the below elements:

- Digital technologies that increase interoperability of data used within a circular plastics value chain.
- New business models that foster prevention of plastic waste and dematerialisation of plastic demand.
- Digital technologies and Industry 4.0 solutions fostering circularity of plastics.
- Eco-design approaches that aim at achieving changes in current manufacturing practices.
- Regulation, industry standards and policies to promote plastic waste prevention.

Further areas of work for the near future relate to our Theory of Change, aiming to unlock the potential of the most important system drivers:

- **Behaviour:** We need to work on changing current consumption behaviours, towards a paradigm that ensures society needs are met by the use of a minimum input/output of products and materials, in human settlements where the demand is high (urban demand dematerialization).

- We need to do this by supporting activities (projects, start-ups) aiming to demonstrate such practices in real environments, and display, through innovative business models, how such a future looks like in practice (eg collaborative lifestyles, re-thinking consumption patterns and redistribution markets)
- We need to work on financial social innovation using demand power of consumers to push Business to Consumer (B2C) industries in delivering low carbon products, working on new business models to dematerialize demand (e.g. product as a service, sharing models, etc.), focussing on eco-design to increase re-use and re-manufacturing models, using distributed models of production and marketing to foster local production systems, etc.
- We need to ensure that best practices and learnings are systematically shared among all system stakeholders, to increase awareness of what is possible, what works and what doesn't, and inspire further action.
- As a general rule, we need to take into account the trends that shape the system (for example digitalization, artificial intelligence, blockchain) that are going to have a significant impact on the way we produce and consume in the future

- **Policy:** We need to ensure the development of policies at EU/national/local levels, which support/enable circular economy practices. In that respect, we need to:
  - raise the understanding among EU/national/local policy-makers of the role of circular economy can play for reducing emissions, but also for achieving other social and environmental goals (eg jobs creation, air quality etc)
  - demonstrate in practice how circular economy can be integrated in different policies and support policy-makers in taking these steps (eg fiscal instruments to incentivise the use of secondary raw materials)
  - We need to ensure that best practices and learnings are systematically shared among all system stakeholders, to increase awareness of what is possible, what works and what doesn't, and inspire further action

- **Finance:** We need to ensure that future financial flows will be supporting circular solutions and not the current linear paradigm. We need to:
  - Have a deep understanding of the barriers faced by financiers, prevent investments in circular solutions
  - Support the development of appropriate metrics, that support informed decision-making and thus unlock financial flows towards circular business models and practices
  - Explore initiatives/financial instruments that can support de-risking the profile of circular business models and boost capital flows into closed-loop solutions
  - We need to ensure that best practices and learnings are systematically shared among all system stakeholders, to increase awareness of what is possible, what works and what doesn't, and inspire further action
  - Working with cities focussing on their financial/demand power (procurement) to drive change in how industry and businesses are delivering solutions that are present (e.g. built environment) or are consumed (e.g. products & services) in the urban environment.

- **Markets:** We need to ensure that the future market will operate on circular product and material value chains. We need to:

- Demonstrate through our projects increased materials and products circularity in the upstream and use-phase of value chains, eg:
  - Materials level: Address persistent and toxic substances by promoting pure material inputs for new products and streamlining/standardizing feedstocks.
  - Product level: Create new open design requirements endorsed by significant value chains or regions. Scale 'Design for Product Integrity'[63] strategies to improve the durability and extending the useful life of products. Invest in the development of innovative manufacturing 4.0 processes such as low-carbon closed-loop additive manufacturing.
  - Urban value-chain level: Invest in experimental projects which; explore whether symbiotic relationships within EU cities can be created through circular material flows, as well as innovations that build and connect cross-EU regions/cities facilitating open materials stocks dynamics and enable matchmaking synergies.
- We need to ensure that best practices and learnings are systematically shared among all system stakeholders, to increase awareness of what is possible, what works and what doesn't, and inspire further action

- **Skills:** I order to transform the current linear to a circular paradigm, new skills will be needed at all levels. We need to:
  - Invest in solutions that boost the engagement of consumers in a circular economy society through leveraging local living labs and eco-centres in relevant communities which promote capacity building and engagement activities
  - We need to support capacity development of the current and future workforce, by continuing integration and development of professional/graduate education offerings based on our innovation experiments and learnings (eg our professional education offering under development, the "Climate Innovation-driven Lab")

To realise the aspirations outlined above we need to engage with several system actors, that are in the position to bring about change, the most influential of them being:

- **Policy-makers**: new/improved policies can be applied to and highly affect every part of the system, from raw material extraction to consumption and recycling/disposal
- **Industry associations**: they can aggregate our impact, as they represent whole parts of the production system (collections of businesses in the same sectors) and have considerable influence on policy-makers and consumer needs. Through industry associations we can possibly influence product designers, who are a very important target group for transitioning to more circular products (by design).
- **NGOs/consumer associations/local consumer initiatives**: they represent consumer preferences towards policy-makers, assuming great influence due also to their relation to mainstream media (which influence consumers). We can work together to enhance public engagement and accelerating behaviour change.

63

"Product integrity is the ability of a product to meet or exceed a customer's expectations for performance, quality and durability over the life of the product." Evans J.W., Evans J.Y., Ryu D. (2001) Introduction to Product Integrity and Reliability Assessment. In: Evans J.W., Evans J.Y. (eds) Product Integrity and Reliability in Design. Springer, London

- **Media**: very important channel for communication between business, policy-makers and public. Media are trend-setters, and through providing information they influence behaviours and opinions.
- **Financiers**: the system transition towards circular economy practices requires the flow of funds into activities that support the new paradigm, be it in the supply-side (capital inflow to businesses) or on the demand-side (consumer credit). When funds flow in the desired direction, there is a high possibility that the desired outcome will be achieved.

Key to maintaining EIT Climate-KIC's credibility as a leader in this area, is to display a portfolio of experiments, that provide a glimpse on how the circular economy can be materialized and what that means. We will keep expanding our portfolio to include experiments of different type and sizes, under different circumstances, geographical scopes (e.g. cities in different EU countries), and different maturity levels (e.g. start-ups and early-late stage innovation projects)

The most important activity is to continue learning from our innovation experiments what has worked well and what hasn't. Continuous exchange and sharing with our partners, projects, start-ups, education colleagues will ensure that our strategy is updated, to include projects on the leverage points where more 'push' is needed at each point in time.

Very important is that our insights from these experiments are communicated to our partnership as well as external stakeholders, in order to influence and inspire. Insights from our experiments will also be employed under our educational offering, promoting EIT Climate KIC as one of the leading global education centres on circular innovation. We plan to further enhance our communication activities on circular economy (e.g. by hosting / co-organising / participating to related events) and celebrating our community of practitioners in this field (e.g. partners, start-ups etc). We will also continue working with established, well-respected experts in this field to act as a sounding board and provide strategic insights to our activities.

4.5 How will we monitor, evaluate and learn from our approach?

Purpose

EIT Climate-KIC is developing a comprehensive Monitoring, Evaluation and Leaning (MEL) Framework. The primary purpose is to institutionalise a continuous reflection, learning and adaptation process (i.e. adaptive learning) on the relevance, effectiveness, efficiency, impact and sustainability of EIT Climate-KIC's Theories of Change (ToC) and the associated logic models, interventions and their results and the use of evidence. The MEL Framework also promotes accountability by demonstrating a strong narrative about how resources and activities (grants, networking, knowledge, etc.) will lead to intended outcomes and impact goals.

Design Principles [64]

The MEL Framework is developed based on EIT Climate-KIC's ToC and its associated logic models and serves as regular feedback loop to improve them. The framework focuses on delivering the essentials at

[64] Monitoring: regular systematic capture and examination of data on resources (e.g. funding and employees), interventions (e.g. summer schools and supporting innovation projects) and its results (e.g. change agents educated and new business models designed). By providing

a high standard (i.e. stay away from "nice-to-have") while securing flexibility that allows rapid adjustments. It is both, comprehensive and flexible enough to embrace different objectives, approaches, indicators and system requirements set by EIT, DG EAC and other potential funders.

Monitoring

EIT Climate-KIC will monitor its inputs, activities and outputs on a regular basis. Beyond supporting operational monitoring measures (e.g. tracking financial flows, work load allocation and employee knowledge), the MEL team will:

a. develop a close-to-real-time portfolio dashboard of all our interventions. This will build in rapid feedback and learning loops from on-going activities to help EIT Climate-KIC make strategic decisions how to best allocate available resources and keep its portfolio closely aligned with the overall intended objectives;
b. conduct climate impact assessments on on-going interventions and develop an annual portfolio-level climate impact potential report in collaboration with Quantis (a EIT Climate-KIC partner). This will enhance investment decisions and provide ongoing learning opportunities on how to improve the positive climate impact of interventions;
c. monitor direct deliverables of its interventions to keep track of delivery against funder requirements (e.g. KPIs) and facilitate smooth annual funder reporting. No additional KPIs will be developed at the monitoring stage apart from fine tuning the existing ones.

Evaluation

EIT Climate-KIC will conduct periodic evaluation and learning activities along the entire impact pathway(s) of the ToC and logic model. While some of the evaluation and learning activities are closely tied into the strategy development process, the MEL team will focus on the delivering the following evaluation and learning activities every 2-3 years:

a. develop a framework to assess its maturity as a platform to catalyse systemic climate innovation. This will cover elements such as nature of our portfolio, knowledge on system innovation, degree of community engagement and reputation;
b. obtain an external evaluation of our operational delivery capacity and performance by conducting a comprehensive review of our funding streams, intervention formats, partner mix and so on.
c. assess our societal impact by 1) developing a multi annual climate impact assessment report that reviews our historical climate impact trends and identifies ways to improve our interventions' positive climate impact and 2) periodically conduct in-depth case studies on how our interventions have brought about change by addressing key "drivers of change" (finance, behaviours, skills, technology and policy)

Learning

We treat learning as a key purpose of both monitoring and evaluation. Therefore, we build learning components into every M&E activity. For instance, to support our monitoring activities, we will organise regular "action learning workshops" prior/ post to major company milestones (e.g. proposal intake) in order to extract immediately actionable learnings to continue to improve ourselves as an organisation. An

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an indication of the progress and achievements of objectives, it supports on-going portfolio management and periodic reporting to funders.
Evaluation: the systematic and objective assessment of an on-going or completed intervention, its design, implementation and results. The aim is to determine the relevance and fulfilment of objectives, efficiency, effectiveness, impact and sustainability. An evaluation shall provide information that is credible and useful, enabling the incorporation of lessons learned into the decision– making process of all relevant stakeholders.
Learning: the process through which monitoring and evaluation findings are reviewed, communicated, synthesised and used for evidence uptake and to improve future design and implementation.

effective MEL Framework also requires nurturing a culture that embraces failures and appreciates the opportunities for learning and ongoing improvement. The MEL team will focus on building joy and trust into its MEL activities. Together with the CSO, the MEL team will also ensure good leadership and management across the organisation to enable this.

Annex 1 Portfolio View Rationale

This annex provides supplementary information on the objectives, scope, design and next development steps of the portfolio views.

Why are we developing this?

The main objectives of developing a graphical overview of EIT Climate-KIC's interventions is:

- to develop a 'one version of the truth' graphical representation of what EIT Climate-KIC does and facilitate active collaboration and learning;
- to capitalise on the relations and inter-connections between our interventions to develop a holistic approach to transform entire systems;
- to support information-driven decision making; and
- to improve transparency and accountability.

What is the Scope?

During the first development phase of the portfolio views, our priority was to focus on areas where we can rapidly develop tangible prototypes and collect feedback for the next improvement rounds. Therefore, over the past couple of month, we focused on our 2016 and 2017 portfolio where we had a reasonably well-structured dataset aligned with our current understanding of the theories of change.

Data included in current portfolio views are shown in the table below.

Year	Innovation	Entrepreneurship	Education	Others
2016	All (with exceptions described below)	n/a	PhD only	n/a
2017		Start-ups only	PhD only	

Approximately 80% of all non-management related intervention are visible in the current portfolio views. Interventions not included in the visuals are:

- **2016 start-ups**. As you know, the Impact Goals is a new logic we have introduced in 2017/ 2018. At the time of data collection and cleaning, 2016 start-ups were not categorised into Impact Goals. The categorisation has been progressed in the meantime, so that we can include this in the next development round
- **Non-start-up related entrepreneurship interventions.** We support many more interventions beyond start-ups, such as the Climate Launchpad. While these are extremely important to us, we prioritised providing you with a tangible graphic rather than taking more time to process the data.
- **Non-PhD related education interventions.** Similar to above, we are extremely proud of our master label, online education, executive education programmes. It was a matter of prioritisation at this stage.

It is also important to note that some "n/a" values appear in the visualisations. This could be because the data was missing (not collected at the time) or because it could not be validated. Our aim is to include all interventions into the portfolio view. Over the next couple of months, we will increase the scope and improve the data quality (see What's Next).

What does the Portfolio View Show You?

Each visualisation shows the spread of funding for a single impact goal by visualising the interventions in this area. EIT Climate-KIC interventions often span across multiple impact goals; for this reason, all interventions that are categorised as a certain Impact Goal (whether primary, secondary, tertiary) are included in the relevant portfolio views. Interventions also often span across multiple Driving Forces; however, due to the nature of the visual design we are only highlighting one Driving Force (the one we considered as main contributor) for each intervention at this stage.

As a whole, the graphic is meant to answer a series of questions:

- Which types of interventions are receiving the most funding?
- Which types of stakeholders are most active?
- Where are funding and interventions distributed geographically?
- What are the most common driving forces across the entire impact goal?
- Who are the top stakeholders with the largest amount of funding? What kind or driving forces are they addressing?

These questions are answered through three key modules. On the left, you can see the **breakdown of funding and stakeholder participation in three key areas** (Intervention Type, Stakeholder Type, Geography).

- Grey bubbles show the total funding contributed for each category.
- The dots surrounding the bubbles show, for each type, how many partners contributed to this funding. Each dot is also coloured by the primary Driving Force associated. Please note that the number of dots are especially high whenever there is a Flagship involved. This is because Flagships tend to have numerous working streams under them which we treat separately.

In the top right, a group of bubbles shows **how funding has been spent by each driving force**.

- One bubble = One project
- More red bubbles mean a higher amount of interventions in the Information / Knowledge driving force

Finally, the bottom right module shows the **top 10 stakeholders ranked by the total amount of funding** they have contributed to projects within this impact goal.

- Bars show total funding per partner
- The end of each bar also shows the number of projects that this funding was contributed to
- Each bar is then divided into the driving force associated with the projects funded by that partner

As a set, all portfolio views share the same colours. This allows for comparisons to be drawn easily between two different Impact Goals, and to visually see how funding is spread across all EIT

Climate-KIC activity. The stacked bars in the bottom right are also scaled evenly across all 12 Impact Goals to allow for comparing top stakeholders between different Impact Goals.

At the current stage there are some interventions that have not been assigned a Driving Force. For example, start-ups are not shown as a colour because they do not have a driving force yet. These instances are represented by a shade of grey to represent "n/a" values. The same treatment has been applied for missing data.

What's next?

Ultimately, we want to get to a place where we have an interactive and dynamic portfolio view that allows you to run analysis on needs basis. The content it covers will also go far beyond what is captured now.

Over the next couple of weeks, you will have an opportunity to provide feedback on what you liked/ disliked about the current version and ideas on how it could be improved. We will also make the backend dataset we used for the visualisation available so that you have an opportunity to review that as well.

Over the next 3 months, we will (1) integrate 2018 data (and data before 2016 if deemed valuable, (2) integrate other 2016 & 2017 data to extract more insights of our portfolio (e.g. KPIs) and (3) explore other analytical methods to better understand our portfolio (e.g. network analysis). Building on that, we will work on the back-end IT infrastructure that allows us to mine, clean, analyse and visualise our portfolio data semi-automatically. Moreover, we will also work on making the SPV more dynamic and interactive.