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Societal Challenge 5 'Climate Action, Environment, Resource Efficiency and Raw Materials'

Advisory Group Recommendations

Programming period 2018 – 2020

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Advisory Group Recommendations

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In accordance with the mandate of the Advisory Group, this draft report aims to identify future strategic research and innovation (R&I) priorities for the Horizon 2020 Societal Challenge 5 'Climate Action, Environment, Resource Efficiency and Raw Materials' for the programming period of 2018 – 2020. The priorities devised are based on the results of the AG discussions and comments provided by the AG members on different subjects addressed, and draft reviews by the AG working subgroups taking into account insights from the Gap Analysis conducted for SC5 by the European Commission.

1. FOREWORD

The Societal Challenge 5 Advisory Group includes a wide range of members with remarkably rich and diverse backgrounds and affiliations, including researchers, academics, representatives of industry groups, business owners, local authorities and other stakeholders, covering the whole spectrum of R&I domains relevant to Horizon 2020's Societal Challenge 5.

We understand that the Mission for Horizon 2020 Societal Challenge 5 Programme is to develop and implement an EU Research and Innovation policy for a smart green economy that contributes to sustainable development.

Our Advisory Group has met three times since our establishment in February 2016 and has had extensive discussion and engagement on the issues surrounding this Societal Challenge. The Advisory Group recognises that Societal Challenge 5 is extremely important as a challenge in itself but also its relevance across the Horizon 2020 Programme.

We recognise that the role of our Group is to provide consistent and consolidated advice to the Commission services on relevant objectives and scientific, technological and innovation priorities for the strategic programme and annual work programmes by way of opinions, recommendations and reports.

The Advisory Group's first task has been to prepare this succinct report, which answers five specific questions posed by the Commission to provide input into the next strategic programming cycle of the Work Programme for 2018- 2020. The Advisory Group has identified five Strategic Priorities that require action under the Work Programme 2018-2020: 1) Climate Action after COP21; 2) Circular Economy; 3) Innovative and resilient cities and rural areas; 4) The water-food-and energy nexus and 5) Enabling systemic transformation.

The Advisory Group would like to highlight that the cross-cutting nature of this programme necessitates an integrated approach across other challenges and a design for complementarity to maximise the overall impact of the Horizon 2020 programme. The five priority areas identified do not follow a linear logic or identify comparable categories of R&I. Instead they have been chosen to represent a matrix of actionable priorities. Raw materials and Earth Observation have been identified by the Advisory Group as important cross cutting issues and are incorporated across the five Strategic Priorities.

The Advisory Group hopes that this report is of assistance to the European Commission in developing the Horizon 2020 Work Programme for 2018- 2020. We also hope that the insights in this report may also assist in the identification and prioritisation of Research needs and strengthen the Commission's strategic and impact-oriented approach in the years ahead.

Laura Burke

Chair of the Advisory Group for Societal Challenge 5, Horizon 2020

Director General of the Environmental Protection Agency, Ireland

2. INTRODUCTION

2.1. Background

The challenge

Societal Challenge 5 of the European Commission's Horizon 2020 programme seeks to achieve 'a resource- and water-efficient and climate change resilient economy and society, protection and sustainable management of natural resources and ecosystems and a sustainable supply and use of raw materials, in order to meet the needs of a growing global population within the sustainable limits of the planet's natural resources and ecosystems'[1].

In accordance with the mandate from Horizon 2020, the recommendations for and actions under this challenge should help draw a clear pathway towards concrete actions, transform society, and drive innovation as part of a broader knowledge development and innovation chain.

The international context

The AG is of the view that the questions this challenge seeks to address are among the most pressing ones facing Europe and the planet as a whole over this century and beyond. Along with demographic change[2] and the economic rise of developing countries, climate change, resource pressures and environmental degradation are having and will continue to have a major direct effect on our wellbeing and that of future generations.

How we respond to these challenges will determine the well-being of Europe's citizens, Europe's competitiveness and Europe's prosperity. The consequences of our actions or inactions will extend well beyond Europe's borders and will have an impact globally. In our response therefore lie the opportunities for innovation and value creation to shape our sustainable future and demonstrate Europe's leadership. There has never been a more favourable and urgent time to act.

2015 saw the adoption of two historic agreements. In December 2015 at COP21, 194 countries adopted the Paris Agreement, which presents the first, universal climate agreement with the aim to hold the global temperature increase well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels[3].

Just a few months prior to the COP21 meeting of the UNFCCC, the UN General Assembly adopted the Sustainable Development Goals, which present a set of 17 goals for a new sustainable development agenda, balancing the three dimensions of sustainable development: the economic, social and environmental[4]. Together, they provide a strong, international framework for action on the societal challenges.

A number of international developments and stakeholder groups further shape the context for this societal challenge. The Aichi Biodiversity Targets agreed in 2010, the Task Force on Climate Related Financial Disclosures launched by the Financial Stability Board in 2016, and the upcoming UN Habitat III conference, to name a few, indicate the dynamic developments internationally.

The AG strongly supports the notion that the science and innovation actions under Horizon 2020, this Societal Challenge in particular, must directly support[5] the implementation of these two agreements and other key international developments that will arise in the programming period of Horizon 2020.

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[1] EC(2013/743/EU) 'Council Decision of 3 December 2013 – establishing the specific programme implementing Horizon 2020 – the Framework Programme for Research and Innovation (2014 – 2020)', "Climate action, environment, resource efficiency and raw materials"
[2] I.e. population growth and global trend of ageing population
[3] UNFCCC/CP/2015/L.9/Rev.1 (2015) 'Adoption of the Paris Agreement'
https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[4] UN A/RES/70/1 (2015) 'Resolution adopted by the General Assembly on 25 September 2015 – Transforming our world: the 2030 Agenda for Sustainable Development'
[5] Support must also address the significant gap between the aggregate effect of Parties' mitigation pledges and the aggregate emission pathways.

The context of Europe

It is necessary to reflect and respond to the priorities of Europe. The Juncker Commission has outlined ten priorities, of which Climate Action and Energy is a key priority[6]. Other priorities relating closely to this challenge are 'Jobs, Growth and Investment', 'A Stronger Global Actor' and 'Democratic Change'. Overall, the political context is challenging, with sluggish economic growth, slow improvement on employment rates, the migration challenge and insufficient rate of innovation deployment. Yet, interest in the challenges and possibilities linked to climate change mitigation and adaptation in line with the Paris Agreement is growing among businesses, cities, nations and citizens.

It is becoming increasingly apparent that traditional economic growth aspirations are not enough and approaches going beyond GDP considerations are needed. Green growth is an emerging and powerful trend in the EU economy, capturing the vision of enabling the growth of jobs and competitiveness in businesses in an economy and society that is sustainable, inclusive, and provides products and services supporting a clean environment and healthy lifestyles. This requires a changing trajectory linking growth with different social demands and lifestyles, and envisioning a vast and deep economic and technological transition. Europe, through H2020, should capitalize on this opportunity and boost inclusive growth through targeted and effective research and innovation activities. By doing so, there is not only significant potential to create new domestic markets, but also to create a basis for new exports[7].

At the policy level, the Commission has also introduced new measures and been undergoing revision of major policy directives, which offer exciting opportunities and must be taken into account. The 7th Environment Action Programme (EAP) provides the guiding framework European environmental policy until 2020 through three key objectives[8], four enablers[9] and horizontal priority objectives[10]. It is a cross-cutting framework and builds on a number of initiatives, including the Resource Efficiency Roadmap and the 2020 Biodiversity Strategy, to name a few. Closely linked are also the Energy Union and the Circular Economy Package introduced in 2015, the Raw Materials Initiative and the European Innovation Partnership on Raw Materials, the revision of Waste Directive, the Ecodesign Directive, the integrated European Union policy for the Arctic and others.

While the 7th EAP provides a strong framework for environmental policy in Europe, there appear to be gaps and inconsistencies, which some of the recommendations provided by this AG seek to address.

Finally, in advancing its innovation priorities and international cooperation, the EU needs to find a balance between protecting the intellectual property of its innovations to ensure that the incentive to innovate remains and deploying them more widely in the pursuit of collective, international goals.

> *"There are four main obstacles for success in this emerging set of opportunities: obsolescence of the regulatory framework; unattractiveness of the context for inviting investment; contradictory policies and lack of experience-sharing mechanisms for accelerating mutual and cumulative learning."*
>
> European Commission (2016) *Changing gear in R&I: Green growth for jobs and prosperity in the EU*

[6] https://ec.europa.eu/priorities/index_en
[7] European Commission (2016) *How to change gear in R&I: green growth for jobs and prosperity in the EU*
[8] The three key objectives are to: protect, conserve and enhance the Union's natural capital; to turn the Union into a resource-efficient, green, and competitive low-carbon economy, and to safeguard the Union's citizens from environment-related pressures and risks to health and wellbeing.
[9] The four enablers are: better implementation of legislation; better information by improving the knowledge base; more and wiser investment for environment and climate policy; and full integration of environmental requirements and considerations into other policies.
[10] The horizontal priority objectives are: to make the Union's cities more sustainable; and to help the Union address international environmental and climate challenges more effectively.

The approach

The recommendations and results presented in the following are based on some key principles that form the approach of the AG's collaboration and work.

- Providing consistent and consolidated advice;
- Promoting a strong, systemic approach for impact;
- Keeping a focus on strategic priorities;
- Applying analytical rigour, by drawing on knowledge products provided[11];
- Embracing a co-design approach to research and innovation;
- Redefining value;
- Strengthening the value chain approach in future initiatives;
- Recognising the need for a stronger integration of social sciences and humanities (SSH). SSH includes economics, gender studies and sociology, to name a few, as well as disciplines and assessment of societal implications of migration and the need for social inclusivity;
- Strengthening the dimension of international cooperation;
- Recognising there is no one-size-fits-all solution;
- Emphasising that innovation enhances competitiveness and that the EU's path towards sustainable development and should reflect a balance of social, environmental and economic impacts; and
- Proposing a sequential and logical approach towards the design and implementation of actions based on the recommendations provided.

[11] These include the Gap Analysis, Strategic Foresight, and other knowledge products provided by the European Commission, expert groups and others.

2.2. Summary of Recommendations

The Commission outlined five questions to be considered by each Advisory Group, to which we provide our answer through a summary of our recommendations below.

1. What are the challenges in the field concerned that require action under the Work Programme 2018 – 2020? And would they require an integrated approach across the societal challenges and leadership in enabling and industrial technologies?

Building on the recommendations of the first Advisory Group Report in 2014, the AG has identified five strategic priorities[12]. These have been devised through careful consideration of a broad range of inputs from AG members, reflecting their rich expertise as well as the gap analysis and other analytical reports provided by the European Commission.

These strategic priorities are: 1) Climate Action after COP21; 2) Circular Economy; 3) Innovative and resilient cities and rural areas; 4) The water-food-and-energy nexus; and 5) Enabling systemic transformation.

The cross-cutting nature of this programme necessitates an integrated approach across other challenges and a design for complementarity to maximise the overall impact of the Horizon 2020 programme. The five priority areas identified do not follow a linear logic or identify comparable categories of R&I. Instead they have been chosen to represent a matrix of actionable priorities across thematic, territorial and strategic areas.

2. What is the output/impact to be foreseen? Which innovation aspects could reach market deployment within 5-7 years?

The priorities identified in the above are envisaged to enable the following outputs and outcomes. Specific impact and related indicators will be defined by respective Consortia in response to the European Commission's subsequent work programme:

Output	Outcome		
	Economic	Environmental	Social
Strengthening the knowledge base and developing holistic low-carbon pathways for climate action	Mitigating climate induced risk and realising low-carbon economic opportunities[13]	Making significant progress towards COP21 targets, including the pathway to 1.5°C	Designing effective mitigation and adaptation mechanisms
Developing and demonstrating approaches and mechanisms that enable a circular economy	Enhancing competitiveness and innovation through optimising resource efficiency and effectiveness	Facilitating sustainable production and use of primary and secondary raw materials and reducing negative environmental externalities through management and re-design of products, processes, material flows and services for a circular economy	Enabling stakeholder integration through co-design and supply chain approaches; Ensuring that EU externalities are not geographically off-loaded[14]

[12] Note: the strategic priorities set out by the AG are not taxonomic categories, but heterogeneous challenges on which we want the research and innovation community to focus.
[13] Report from World Business Council
[14] For instance, waste streams shipped to China

Output	Outcome		
	Economic	Environmental	Social
Develop and test solutions of integrated planning tools/design to strengthen holistic resilience and innovation in cities[15] and rural areas	Expanding economies of scale of solutions, supporting actions and initiatives with a co-benefits approach, including for the private sector, public authorities and citizens	Improving the environmental performance of cities and rural areas as well as the dynamics of resource consumption	Supporting holistic resilience and a framework for social inclusion in cities and rural areas, narrowing the health and wealth gap
Systemic understanding of the water-food-energy nexus to enable better policy response and management	Ensuring security of supply and cost-efficient management of water, food and energy resources	Supporting sustainable and secure water-food-energy systems	Safeguarding human health and stimulating more responsible lifestyles
New and tested management and governance methods and structures	Redefining market place "value" and facilitating more responsible, integrated economic and financial decision making as well as a new working culture	Streamlining governance[16] and strengthening the governance regime for lasting change towards better environmental impact	Nurturing a culture of sustainability, accountability and effective collaborative approaches

3. Which gaps (science and technology, innovation, markets, policy) and potential game changers, including the role of the public sector in accelerating changes, need to be taken into account?

The AG is of the view that technological innovation is happening but needs to be accelerated. There is need to build on the strong political commitment expressed at COP21 and in adopting the SDG by creating enabling conditions that will lead to transformative change. The EU aims to provide a systemic, integrated policy framework with effective governance that can enable innovation and transformation. However, innovation coupled with societal engagement and acceptance is needed. This can be enhanced through better understanding of the systemic potential of sustainable lifestyles as well as understanding current behaviour and socio-cultural dynamics and change. Action is initiated and carried out by multiple stakeholders, including people, communities, companies, workforces and nations, all of whom are crucial to accelerating change. The new international and European context for climate action requires accelerated R&I, including expansion of the knowledge base, more deployment and scaling-up of technical and socio-economic solutions[17], as well as better monitoring and analysis of transformation.

[15] Cities include peri-urban and metropolitan areas
[16] Managing complexity
[17] On the technological front, efforts should be made on integrating Big Data and analytics, while socio-economic solutions should include financial incentives

4. Which areas could benefit from integration of horizontal aspects such as social sciences and humanities, responsible research and innovation, gender aspects, and climate and sustainable development?

The AG recommends that social sciences and humanities (SSH)[18] are essential for the success of this challenge. SSH aspects should be woven into the work programme design for actions where appropriate. Climate and sustainable development need to be prioritised and quantified in each strategic priority. The AG promotes a strong participatory approach and co-design towards R&I for all areas, engaging a broad range of societal actors, which is in line with the guidelines for Responsible Research and Innovation (RRI)[19].

In addition, there are a number of cross-cutting issues. They do not naturally fall into the five priorities defined above, but they need to be addressed as part of this challenge. They are:

- Combined effects due to climate, environment and health;
- Biodiversity aspects as agreed in the Aichi targets;
- Global migration streams and demographic change;
- Raw materials as a cross-cutting priority;
- Impact of geopolitics on climate change, population change and resources;
- Role and potential of cultural heritage;
- Monitoring of progress and impact in innovation;
- Systemic and integrated policy making;
- ICT as a cross-cutting component and enabling agent;
- Promotion of sustainable lifestyles; and
- Redefining economic value to incorporate the contribution of social and natural capital.

5. In view of the recent evolution of the socio-economic and policy context (see part 3 of the AG consultation scene setter document), what are the emerging priorities for SC5?

COP21 and the UN's 2030 Agenda for Sustainable Development together with other key developments at the international, European and national level have set new and ambitious objectives. At the same time, we are seeing significant developments in the socio-economic and political spheres that give rise to the following priorities for SC5, which we divide into different priority components: knowledge, transformation & scale-up, and risk mitigation.

Knowledge

- Understanding interdependencies of climate, ecosystem, social inclusion and health and the economic risks in financial markets arising from environmental challenges;
- Innovation in business and understanding of market demand, market dynamics, and consumer awareness;
- Climate finance in the context of scaling-up; and
- Indicators for innovation activities, where feasible, to track impact of R&I.

Transformation and scale-up

- Methods of co-design for research and innovation;
- Framework and tools that enable systemic transformation and address barriers to transformation;
- Governance, engagement strategies and tools for holistic, integrated transformation; and
- Mechanisms to scale up innovation and building financial incentives to scale up market transformation towards the low carbon economy.

Risk mitigation

- Consideration of social inclusion, equity and migration challenges for SC5; and
- Fragmentation in the EU (North-South/East-West, between countries but also at the city level), is posing a risk for SC5, which requires adequate risk mitigation mechanisms.

[18] SSH includes economics, gender studies and sociology, to name a few, as well as disciplines and assessment of societal implications of migration and the need for social inclusivity

[19] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

3. STRATEGIC PRIORITIES

3.1. Strategic Priority 1: Climate action after COP21

Definition: Climate action encompasses action in the policy, scientific and socio-economic spheres. COP21, cumulating in the Paris Agreement, provides a key stimulus and framework for action and innovation. The objective here is to strengthen the knowledge base for solution-oriented climate action in the policy, technological and social spheres. Thus R&I actions under this priority should integrate the wide range of ongoing Earth Observation[20] activities through well-established climate services and contribute to the definition of the future generation of the EU Copernicus programme and related activities. Further, the aim is to implement these innovation findings in a social and ecological context, integrating behavioural change aspects and considering the implications for equity.

Rationale: The Paris Agreement needs to be translated into effective and quantifiable action that accelerates transition and transformation.

To do so, the R&I should follow the purpose, ambition and requirements of the Paris Agreement, including its climate stability and resilience goals, and its transformational imperatives. These include the aim to limit the global temperature increase to well below 2°C and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels. These scenarios need to be explored further in research, as do the acceleration of targeted innovation and deployment of services and solutions that enable transformation. Options for cost-effective, equitable and efficient climate policies need to be designed, with due regard for their side effects, especially with respect to their distributional impacts. Also, H2020 needs to work with the IPCC in its 6th Assessment Cycle to address specific issues including the responses of the Earth's climate systems to greenhouse gas emissions and key feedback loops.

The IPCC exemplifies open and transparent assessment of scientific understanding of climate change science as well as mitigation and adaptation solutions. Therefore, an essential part of this priority, climate action, is to promote participatory methods encouraging a socially inclusive approach to ensure acceptance of scientific analysis and development of new technologies.

People and communities are at the heart of climate action. Their understanding and acceptance of R&I in this field are therefore crucial and solutions need to be constructed together to reach that aim. In addition, companies have a critical role to play in this systemic transformation. For instance, Rockefeller oil fortune divest from fossil fuels over climate change[21]. And over 140 global companies have collectively committed to a diverse mix of low carbon technology partnerships which have the potential significantly to reduce emissions, create millions of jobs, and contribute trillions of dollars to the global economy[22].

Another aspect of climate action that could be enriched through SSH is to increase understanding of behavioural responses to climate change, and the associated science and innovation measures necessary to increase holistic resilience.

Recommendation:

- **Diversification of data collection:**
  Enhancing data collection, utilisation and analysis of emerging Earth Observation data, 'unconventional' climate records such as tree rings and historical accounts, crowd and citizen sourced data and Essential Climate Variables (ECV) from local to global scales – with special attention paid to the polar regions and other regions vulnerable to climate change .

- **Development of next generation climate models:**
  Development of climate system models with improved parameters that enable understanding of underlying processes between all biological, chemical and physical systems, and variability of extremes.

[20] Earth Observation includes not only satellites, but also other type of platforms, e.g. under-water platforms and new sensors (undersurface and ground level platforms)
[21] http://www.theguardian.com/environment/2014/sep/22/rockefeller-heirs-divest-fossil-fuels-climate-change
[22] http://lctpi.wbcsd.org/wp-content/uploads/2015/11/LCTPi-PWC-Impact-Analysis.pdf

- **Multi-sectorial impact analysis**
  Conducting multi-sectorial impact analysis of different climate change scenarios, including accounting for the impacts on the natural system, human health, economic risk, the distribution of life chances, infrastructure and cultural heritage from mitigation and adaptation activities and policies as well as from climate change itself.

- **Responsive model for low-carbon pathways**
  Developing responsive models for low-carbon pathways that provide insights into potential and optimal trajectories, as well as into gaps in technical and infrastructure solutions, developed through co-designed R&I projects[23].

- **Integration of social and behavioural action and responses to climate action and services**
  Integrating civil society in co-designing mitigation and adaptation mechanisms as well as conducting R&I on the adaptation of societies to climate change and understanding underlying causes of their behavioural responses.

- **Communication and outreach**
  Enhancing communication of and education about climate science, climate risks, mitigation risks and adaptation risks as well as technological potential, policy and business best practices for policy makers, the private sector, consumers and communities.

[23] Several critical raw materials, particularly rare metals, will play an important role on the development of low carbon technologies (see *Critical Metals in the Path towards the Decarbonisation of the EU Energy Sector* https://setis.ec.europa.eu/sites/default/files/reports/JRC-report-Critical-Metals-Energy-Sector.pdf)

3.2. Strategic Priority 2: Circular economy

Definition and objective: There are many different definitions of the Circular Economy, the most comprehensive describes a circular economy as 'a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows [at every scale]'[24]. To realise this vision, the circular economy relies on a number of levers to ensure its development: 1) regenerate (renewable energy and raw materials), 2) share and optimise (prevention, waste reduction), and 3) loop (improved recycling technologies, digitalise) and exchange (breakthrough technologies). The objective of this priority is further to support, develop and realise these levers for a circular economy – both for the bio-cycle and technical cycle.

Rationale: The circular economy leverages on optimisation, design and regeneration, through a circular instead of a linear approach towards the extraction, utilisation and management of resources. Such an approach is already leading and will lead to significant shifts in technology, sharing, recycling, eco-design, industrial symbiosis, and waste prevention. It is therefore an important priority to ensure a resource-secure, sustainable future for Europe. At the same time, the circular economy opens up new business models towards value-chain integration of primary and secondary resource use and strategies for industrial symbiosis (e.g. PPP SPIRE[25]) that can enhance companies' and Europe's competitiveness internationally.

To enable a circular economy, it is essential to mobilise companies by providing incentives for greater experimentation with new technologies, design methods and business models that encourage innovation and inclusive growth, facilitate business dynamism (transition from competition to cooperation between organisations), the development of a civic economy sector and the growth of young firms, encourage women entrepreneurs, connect people/consumers and resources to circular economy opportunities. It is also essential to mobilise individual citizens. The role of economic tools, such as pricing, taxes and subsidies, and the sources of market failures inhibiting the development of the circular economy need to be examined further and consistent policy frameworks ensured.

The transformation to a circular economy will re-shape the flow of resources and for some material streams may become more localised. In the transformation, special attention must be paid to ensure that the circular economy leads to net reductions in environmental externalities and does not lead to a re-location of environmental burden.

The sustainable production and use of primary and secondary raw materials continue to play a fundamental role in maintaining the economic sector activities and competitiveness of industry, albeit differently by expanding the focus from the availability to the optimised use and management of both primary and secondary raw materials. This is important for a systemic and integrated value chain and resource management. At the same time, the use of existing resources needs to be optimised, including current waste disposal site and brown field sites.

R&I on technologies for the sustainable access, extraction and processing of primary and secondary resources as well as the closure of brown field sites will be needed to facilitate the transition to and enable the circular economy. Deployment of these technologies into the EU and global market can contribute to economic growth as other nations will face the same challenges.

Some H2020 projects are already looking into the legal, social aspects and market structure, but greater research in this area is needed. Multi-design approaches through big data and analytics are seen as drivers to enable the circular economy through the "Next Production Revolution – innovation, entrepreneurship and the digital economy".

International collaboration is needed to carry out these aims in order to integrate and support circular global supply chains solutions. Particular attention should be paid to key European trading partners.

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[24] Ellen MacArthur Foundation - the 3 elaborated principles of the circular economy are: 1) Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows; 2) optimise resource yields by circulating products, components and materials in use at the highest utility at all times in both technical and biological cycles; and 3) foster system effectiveness by revealing and designing out negative externalities

[25] Public-Private Partnership for Sustainable Processing Industries for Resource & Energy Efficiency (http://www.spire2030.eu/)

Recommendation:

- **Defining new values**
  Devise tools and mechanisms to model the multiple value-creation mechanisms that the circular economy brings by decoupling the production of economic value from the consumption of primary resources. Tools for valorisation and quality assurance of secondary raw materials is also required.

- **Co-designing an industrial innovation strategy and policy framework**
  Co-design an industrial innovation strategy and demonstration projects of new types of business models, organisational and network structures, (value chain) financing mechanisms and policy instruments, including economic tools such as taxes and subsidies, that mobilise private sector action to develop the circular economy.

- **Design and technology**
  R&I on the definition and optimisation of material streams for both technical and bio-cycles as well as design for disassembly and nature-based solutions where appropriate. Support R&I for technologies for secondary processing to make waste a resource, including critical raw materials, and raw materials and nutrients recovered from wastewater streams, such as phosphorus.

- **Awareness, participation and demand**
  Support R&I on drivers of behavioural change in consumers, public bodies and other stakeholders in the circular economies with the goal to increase their participation in the circular economy and consumers' demand for products in a circular economy.

- **Big data, analytics and visualisation of data**
  Create systematic approaches towards harnessing, analysing and visualising data to understand and influence crosslinked interaction of value creation in a circular economy, and providing platforms to access the information.

- **Demonstration projects**
  Support development and scale-up of successful demonstration projects at different scales and across different geographical spaces, including local, city, regional and rural areas, evaluating specific resource streams and regional value capture.

3.3 Strategic Priority 3: Innovative and resilient cities and rural areas

Definition and objective: This priority on cities and rural has been chosen to allow for focus on a territorial dimension for action. Innovation and holistic resilience are key to this priority. Nurturing holistic resilience in cities and rural areas is to go beyond resilience in the sense of reacting to shocks of unpredictable adverse events and chronic stresses, and to adopt approaches that strengthen the socio-economic fabric within these areas to enable more effective responses to these events. Such an integrated approach allows the city to have the opportunity to not only just bounce back but also to move forward and find new pathways to resume and improve ordinary operations and the quality of life. The second objective focussing on innovation is to promote the use of cities and connected rural areas as incubators for innovative, cross-cutting climate solutions with co-benefits, including nature-based solutions, low-carbon infrastructure, social inclusion, integrated urban planning and governance, and competitiveness. Since we have considered raw materials as a cross-cutting topic through all selected priorities, the access to primary and secondary resources within Europe is a third objective addressed here[26].

Rationale: Due to the increased melt of land ice and glaciers, the sea level rice will be a threat for huge land areas and coastal cities, not only in Europe, but all over the globe. Actions will be needed both at the global and local level and call for the development of strategies and actions that go beyond technical solutions.

Cities and rural territories play a crucial role in addressing climate change. Urbanisation continues at a rapid pace with approximately 60 per cent of global population estimated to live in cities by 2030 and cities will be key implementing agents of national and international mandates, goals and agenda, such as the SDGs and the 2030 New Urban Agenda.

However, urban areas need to be reconsidered as part of an integrated system with adjacent metropolitan, peri-urban and rural areas, which connect to cities by providing essential lifelines of food, water, other resources and crucial ecosystem services/ resources. In the context of a low-carbon and circular economy, there is a need to think about the resource flows between urban and rural areas – what developments in one have on the other (whether that is land use, mobility etc.) through integrated, participatory planning approaches.

There is an emerging need for more integrated, participatory planning approaches to shape resilient and healthy urban and rural environments, including gender dimensions. Nature-based solutions developed with integrated planning and participatory approach should be further explored and scaled up in order to meet this challenge.

Thus, cities and local rural territories are where climate action, from policy decisions to infrastructural changes can take place directly and immediately – giving rise to opportunities to efficiently and economically address climate change.

Health [in relation to the environment] is a reoccurring theme. We need to consider this cross-cutting issue when looking for integrated equitable solutions that link work, mobility, physical exercise, recreational areas, green space, food, networks, and culture into our daily lifes.

International cooperation in this area is essential.

Recommendations:

- **Integrated planning for resilient cities and rural areas**
  R&I on integrated planning approaches increasing climate resilience capturing multi-dimensional relationship within and between urban and rural areas, including for instance dynamics of demographic change, resource consumption, land use, mobility, recreation, human health, biodiversity, job creations and access to jobs and education, social inclusion, inclusive spatial planning, and bridging of health and wealth gap etc.

[26] For instance, through improving access to resources from urban mining and integration of management of materials deposits into spatial planning tools (e.g. construction materials).

- **Innovation and smart infrastructure**
  Development and demonstration of approaches and smart technologies to enable behavioural change to co-construct new climate-friendly practices, upscale nature based solutions, innovative business models, and ways of interaction (so-called 'living labs'). R&I and demonstration of new types of digital knowledge infrastructure for planning and modelling, including remote sensing to support integrated planning.

- **Finance**
  Strengthening framework, tools and innovative mechanisms for financing development and implementation of nature based and other solutions for resilient urban and rural environments, including for instance natural capital accounting methodology.

- **Solutions**
  R&I and demonstration projects on how nature based solutions support climate and biodiversity policies, international impact of local environments, environment and health, turning underutilised assets to multi-productive assets, making use of cultural heritage etc., providing extended ecosystem services and social benefits.

3.4. Strategic Priority 4: The water-food-and-energy nexus

Definition and objective: Water, food and energy constitute the most fundamental pillars of our lives. They are also by nature interconnected and one of the key societal challenges. This priority thus aims to contribute towards security in all three spheres in the context of overall sustainable resource use by looking at them as an integrated whole – both resources at environment, land and sea. Eco-efficient symbiosis and management can create a lower environmental footprint and availability of different type of resources during all seasons.

Rationale: At a regional and global level, there is a need to develop a more sustainable AFOLU (Agriculture, Forestry and Other Land Use) sector, which provides wellbeing but at the same time thanks to sustainable management can reduce GHG emissions, conserves water quantity and quality, supplies the growing world population with sufficient quality and quantity of food, and protects biodiversity[27]. These issues have a strong cultural and historical dimension. Both producers and consumers need to be associated in future societal evolution, with education of present and future generations and gender dimensions taken into account.

Despite policy and research-driven efforts at the national, European and international levels, water resources are still under relevant pressure in numerous regions. Water crises have been identified by the World Economic Forum as the Top 1 risk in terms of impacts on economy and society for the upcoming years[28]. According to the European Environment Agency (EEA), pressure will increase in the years to come. Immediate action is therefore necessary to address existing and emerging challenges in the field of water resources. Competition for water among different uses has turned this resource into a limiting factor for societal wellbeing, and in some areas for economic development (e.g. for the agriculture sector, including its energy production and contribution).

Within the new post-2015 development agenda, the place of water-related issues has been further strengthened. Indeed, water is at stake not only in Goal 6 to "Ensure availability and sustainable management of water and sanitation for all", divided into seven specific targets, but in almost all of the 17 SDGs.

So far the "full" interactions between energy, food provision, water use and links to other important environmental and societal challenges are understood conceptually and are already captured in cross-compliance frameworks to EU policies and the UN SDGs[29]. Changes in climate come with drastic changes in the system dynamics of biodiversity, water, and ecosystems that are essential to our food security. These are also inextricably linked to human health.

However, there remains a significant knowledge gap on the dynamics of the interactions and they are not well quantified. One particular aspect is the response between the different elements of the nexus to economic incentives such as the price of water and energy. Understanding the political economy of how these can be changed to make the system function more effectively as a whole is a real challenge that needs to be addressed.

Land plays a key role in energy, food, water and biodiversity. Sustainable, integrated land use and management is therefore important to revert the trend of declining areas of arable land. Special attention must be paid to degraded land, including wet and arid land[30] and the resilience of soil infrastructure.

The water-food-and-energy nexus is a key nexus that fosters growth and jobs, and if capitalised on will play a crucial role in Europe's leadership in integrated technologies. International consensus and cooperation in these areas is essential to progress towards sustainable and integrated global solutions.

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[27] AFOLU is a major GHG emitter, but also contributes to mitigation. This priority results from a need to improve the systematic look at the major drivers of change and their interrelationships through cross-disciplinary research programmes.

[28] World Economic Forum (2016) *Global Risks Report 2016*

[29] Cross-compliance to EU policies: the Water Framework policies but also some other thematic policies such the CAP (cf. greening the CAP – 2014 EU Court of Auditors recommendations): Agriculture is suffering from climate change but is also contributing to climate change. As recognised by UN (see SDG 6 / Target 6 - "*By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies*"), these global challenges will request more international cooperation, including in the RDI area. This will require specific cooperation instruments which will permit funding cooperation with well-established RDI countries and developing countries

[30] The Mediterranean region and Africa should be of particular concern

Recommendations:

- **Migration of species and loss of species through changes in climate**
  Understand migration of species and loss of species through changes in climate through R&I on dynamics of species[31] in spatial distribution, effect on ecosystems, and associated economic and political consequences.

- **Integrated approaches towards management of food, water and energy resources**
  Assess, develop and test integrated approaches towards management and production of food, water and energy resources.

- **Large scale demonstration projects**
  Design and test large scale demonstration projects using ICT and smart technology to optimise water management, soil use and productivity, consumption of food resources, and waste management (pre-production and post-consumption).

- **Technological and systems solutions**
  Develop and demonstrate effective technological and systems solutions implementing integrated approaches towards managing water and food supply, wastewater discharge, environmental water quality and flood risk.

- **Valuation of water-food-energy sources**
  R&I on the valuation of water-food-energy sources in the context of increasing volatility and scarcity due to changes in climate.

[31] This covers food crop, commercial crops, pollinators, pest-diseases etc.

3.5. Strategic Priority 5: Enabling systemic transformation

Definition and objective: Enabling systemic transformation describes the range of institutional, social and cultural systems and innovations necessary to accompany and manage change and transition in a responsive and equitable manner.

Rationale: Enabling systemic transformation is a cross-cutting strategic priority that enables the successful planning and implementation of global objectives on sustainability, holistic resilience and climate.

The challenges we are facing today cannot be solved through technology alone. Awareness, understanding of the societal and cultural aspects of key challenges is necessary, as is the need to increase public awareness and understanding of innovative solutions proposed. Moreover, the transition to a sustainable future requires fundamental changes in culture and behaviour which the population will have to be associated with and apply. One aspect of managing transformation thus relates to social and cultural innovation/change through awareness and consistent training.

The other aspect is that of institutional innovation. This stems from the AG's understanding that this challenge cannot solely focus on content related priorities, but also on procedural priorities, i.e. institutional innovation. Institutional innovation needs to happen across all types of institutional structures from public administration over business management structures, education systems, all the way to individual people. Existing barriers to addressing the challenges identified need to be alleviated to enable truly systemic transformation. Effective transformation and lasting change cannot be created through conventional approaches, but require changes from:

- Linear to circular:
- Simple to complex;
- Departmental to integrated;
- Centralised to decentralised;
- Top-down to bottom-up;
- Consumer to co-designer;
- Large-scale to small-scale;
- Single-actor to networks;
- Ownership to shared use;
- Analogue to digital;
- Protectionism to open source;
- Employment to entrepreneurship;
- Service provision to co-delivery; and
- Companies to civic models.

Of particular importance is the design of a systemic, integrated policy framework in line with the priorities of a sustainable Europe, and the governance framework itself enabled through enriching participatory methods. Recent OECD analysis for instance has shown that there is policy misalignment between policies at the national and European level, but also across the different policy Directives[32]. Policy misalignment presents a key barrier towards implementation.

Furthermore, the majority of CEOs report that the global financial system and the lack of financial incentives are the key barriers to accelerating business action on sustainability and climate change.[33] Therefore, the transformation towards a low carbon future in Europe (and beyond) is dependent upon financial incentives and potentially a significant transformation in financial markets.

Recommendations:

- **Approaches and tools for systemic policy making**
  Research on alignment of policies necessary to enable systemic transformation; development and demonstration effective participatory approaches on policy design, inclusive of gender equality and vulnerable groups.

- **Governance structures**
  R&I about co-designing management structure and decision making processes needed for public governments to enable systemic transformation, including productive methods of participation.

- **Processes and tools to manage complex systems**
  Development and testing of processes and tools to manage policy, business and societal

[32] OECD (2015) '*Aligning Policies for a Low-carbon Economy*'

[33] https://newsroom.accenture.com/industries/sustainability/global-ceos-remain-committed-to-sustainability-but-report-frustrated-ambition-and-call-for-policies-to-align-market-incentives-with-sustainability.htm

responses in the context of complexity – this could include business models.

- **Technological solutions**
  Development and demonstration of technological solutions, including necessary digital infrastructure, to facilitate and manage aspects of transformation e.g. networks.

- **Re-defining value and risk assessments**
  Strengthening and broadening risk assessments to integrate ecosystem dynamics and redefining economic value to incorporate the contribution of social and natural capital.

- **Education and culture**
  Research about the skills needed to manage integrated processes and solutions as well as demonstration projects with the aim to foster a culture and awareness and enable new generations to meet the above listed challenges.
  Role of education and training for the upcoming generations and the enormous task of the trainers/teachers now

- **Behavioural response**
  Analyses of public perception of climate change and other priority areas of action as well as effectiveness of means, including nudging, awareness campaigns and targeted knowledge provision, that can stimulate behavioural change and consumer acceptance needed for the priority actions of this societal challenge.

- **Measuring, monitoring transformation**
  Research and improvement of methods for measurement, description and monitoring of the systemic, integrated economy, including utilisation of advanced tools such as Earth Observation data and development of qualitative indicators for social inclusion and participative dimensions.

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ANNEX I

Horizon 2020 Societal Challenge 5 Advisory Group members

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Meetings of the Horizon 2020 Societal Challenge 5 Advisory Group in 2016:

8th meeting of the SC5 AG – 19 February 2016

9th meeting of the SC5 AG – 22 April 2016

10th meeting of the SC5 AG – 17 May 2016

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