First Report of the Horizon 2020 Advisory Group (AG) for Societal Challenge 5: 'Climate Action, Environment, Resource Efficiency and Raw Materials'

Background

1. In accordance with its terms of reference 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 period until 2020, based on:
   i. The results of the AG discussions and comments provided by the AG members on different subjects addressed;
   ii. Draft reviews and road maps prepared by the AG working subgroups.

2. The dates of the Meetings of the AG and a list of the members are given in an Appendix to this report.

Summary and Main Conclusions

3. The AG is of the view that the questions this challenge seeks to address are among the most pressing ones facing Europe and indeed the planet as a whole over this century. Climate change, resource pressures and environmental degradation are having and will continue to have a major direct effect on our wellbeing. For these reasons alone they need to be tackled. But if we do not act, these burdens will also make it increasingly difficult ensure the well-being of Europe's citizens, sustain Europe's prosperity, promote its competitiveness within the planet's boundaries – and ultimately allow for a sustainable future. That gives a second reason for making a major effort to address the problems they pose.

4. While this societal challenge deals with the major risks that we face, it also offers us opportunities for innovation and growth. The different policies and measures supported by such a programme can open up a great number of new tools, technologies and ways of doing things that, in turn, will define our society for the rest of this century and that will also provide its sources of prosperity in the short to medium term. The deliberations of the AG that are summarised in this report identify several pathways to such positive change. They include areas such as sustainable exploitation of marine resources (blue growth), creation of employment in nature-based solutions, innovative ways of using primary and secondary raw materials, markets for finance that support green growth (e.g., green bonds), development of skills in environmental policy and international negotiation and many others. To be sure, we cannot say with certainty how they will pan out and provide lasting solutions to the challenges of sustainability and become pervasive in symbols of our towns and cities, workplaces and homes in the future. After all we are dealing with a fast changing and uncertain world. Nevertheless, there are good reasons to think that with the right incentives and support the force of human ingenuity, when applied to these challenges, can serve to promote a newer, greener growth and prosperity.

5. The AG recognized that the challenge is huge and, furthermore, it is linked to the other six challenges of H2020, especially: Health, Demographic Change and Wellbeing; Food, Agriculture, Marine Research and the Bio-economy; and Energy and Transport. It will be critical therefore to make sure that the design of activities across each of these challenges is not done in isolation from the others and that Societal Challenge 5 is part of the whole

package of actions that, together, will make what can be described as the great transition to a low carbon sustainable future.

6. The primary purpose of the report is to help the Commission determine if it is on the right track to deliver a solution orientated programme with H2020, to deliver these ambitious goals. In making this assessment, the challenge was broken down into four key priority areas where the EU can make a difference and where R&I can be part of the solution: Systematic Eco-innovation, Climate Services, Nature-based Solutions and Sustainable Supply of Raw Materials[1]. A summary of the discussions under each area is given below. In addition, road maps for the period until 2020 capturing strategic actions, stakeholders and expected outcomes/impacts for each of the priority areas are attached in Annexes to this report.

7. Subject to a number of qualifications and conditions, the AG feels confident that focusing actions and investments in these four areas will put the societal challenge on track to deliver a solutions-oriented R&I programme in the spirit of Horizon 2020. It addresses the whole value chain in the supply of goods and services and rightly emphasises the need for a trans-disciplinary approach, including both the social and physical sciences. There are many issues that need to be addressed and there is bound to be some learning along the way (so feedback loops to re-orient activities are important) but the prospects for significantly contributing to addressing the sustainability challenge are high.

8. A wide range of stakeholders have been identified for the design and implementation of the societal challenge. These include industry representatives, public and local authorities, the research community, education providers, and the civil society through a number of citizen groups. A strong message that comes out of the discussions of the AG is the importance and the need to better understand the governance of such a multi-stakeholder model, which includes these different stakeholders. Furthermore, it is important to make sure that adequate platforms are made available for the stakeholders to be able to communicate with each other, maximizing therefore their role on this societal challenge for a successful and solution-oriented H2020.

9. This broad overall positive assessment is, however, subject to some important qualifications. In particular the AG would like to note:
    i. This is a very novel and forward-looking agenda, tackling problems that otherwise would become bigger over time. It thus involves a degree of risk-taking and, as noted, a need to learn from mistakes.
    ii. The success of this agenda will require that it be consistently put in a broader narrative that aims at creating societal value and inter-generational sustainability in addition to (just) economic value.
    iii. It will require an increase of the multi and inter-disciplinary actions across many different fields beyond research and innovation. There is no one magic bullet; the magic can only come from consistent, long term support for many actions.
    iv. Success requires that this is not a technology-only agenda, but a systemic one that makes a step change in trans-disciplinarity (moving beyond the domains of disciplinarity, generating new approaches to scientific knowledge production that

[1] In addition a 5th area was created within the societal challenge to deal with the role of social sciences and humanities (SSH). This was done so as to integrate SSH aspects across the other four themes.

can even either transcend the formalism of a discipline altogether, to co-design and co-deliver research and innovation). Without sufficient attention for social innovation and social acceptability, there will be a failure to uptake technical solutions.

v. Inter- and trans-disciplinarity, which is critical for the success of the Horizon 2020 programme will not come automatically, it will need to receive sufficient incentives. This may require specific instruments, for example an annual award for the most integrated trans-disciplinary collaboration. The systemic nature of the objectives and proposed actions will impose a consistent consideration of the whole value chain of products and services.

vi. The improved speed and flexibility of R&I funding instruments will be key. There will need to be innovative in the use of the array of instruments available through Horizon 2020 and to shift direction where the evidence indicates this is warranted.

vii. In the light of the novelty of the approach, there will need to be capacity building within and beyond the research community to network and engage many different actors and stakeholders and to scale up to the European level smaller scale solutions. Demonstration projects can catalyse such capacity building and networking, without pushing one-size-fits –all solutions across a diverse Europe.

viii. Sufficient attention will need to be paid to education so that the required skills will become available in the future.

ix. Policy-makers will need to monitor and act on market, regulatory and other obstacles that innovators will face.

x. The development of effective science-policy and science-society interfaces at all levels of governance will be another key factor for achieving the objectives of H2020 Societal Challenge 5 as the relationship between science and political decision-making will be increasingly important. Officials involved in fields such as energy, trade, human rights, telecommunications and health will also need knowledge about SC5 issues.

10. There are also a number of cross-cutting issues that need to be taken into account. They do not naturally fall into the four areas defined above but they need to be addressed as part of this challenge. They are:

i. Environment and health. Issues relating to environment, human health and wellbeing need to be addressed. There is a risk that as this area does not naturally fit solely in SC5 or SC1 (Health, demographic change and wellbeing) that it will not be prioritised for action under Horizon 2020.

ii. Challenges of sustainable provision of food and water.

iii. Sector level challenges that raise specific environmental issues, such as those for the building industry.

iv. Migration. It comes up in climate services but it is wider than that and perhaps merits consideration on its own.

v. The impacts of geopolitics for climate change and resources. More generally the impacts of climate change in regions outside the EU may have consequences for Europe's ability to adapt and sustain growth and these have to be understood and planned for.

vi. The role and potential of cultural heritage.

vii. Earth Observation /monitoring: Developing Comprehensive and Sustained Global Environmental Observation and Information Systems is a task that is necessary and relevant to the links between this societal challenge and the others. Such

systems can create business opportunities for a green economy given that Eaerth Observation is strongly linked to new technologies.

Priorities in the Area of Systematic Eco-innovation

11. The objective here is to position Europe as a front runner in developing a closed loop circular economy, enhancing its international industrial competitiveness through resource productivity (higher added value per unit of resource, recycling and development of renewable resources) and continuously improving its leading position for resource efficient technology, products and services on the EU and the world markets without compromising the quality of deliverables.

12. The need for action in this area arises for three reasons:
    i. Systemic eco-innovation will destabilise society systems. Therefore the means to address fundamental destabilisation need to be provided. It is necessary to anticipate and design change rather than reacting to upcoming challenges;
    ii. We need to develop new business models which allow for a higher degree of circular economies and resource efficiency to set a European example, and which are exportable to other regions of the world.
    iii. We can multiply the impact of research and innovation by using a systemic approach: exploiting cross-sectoral, international and cross-generational, opportunities and benefits.

13. The EU has some specific drivers that justify taking the lead on systemic eco-innovation. It is currently unexplored for resources (especially fossil resources) and also faces problems from pollution and misuse of renewable resources such as water. This acts as a driver for eco-innovation in resource efficiency and reuse. At the same time there are several opportunities Europe can exploit. It can build on a set of progressive environmental and resource efficiency policies, which enjoy wide societal acceptance. EU companies and universities have a "niche" in eco-innovation, which can be developed further to increase the region's industrial competitiveness.

14. If the program is implemented successfully it will lead to a stock of research outputs and capacities with a clear capacity for problem solving and market development. Furthermore incentives to systemic eco-innovation should foster collaboration among EU regions and sectors. The EU will realise its potential to lead the world in the market for technologies based on circular economies and resource efficiency. Given progressive policies for the environment and for promoting resource efficiency in the region we are well placed to take advantage of opportunities offered by such innovation. The challenges are to bring industry, society and other stakeholders together and to develop ways by which markets can be oriented to support such innovative solutions and measures by which individuals behaviour can be modified to respond positively to the solutions.

15. The subgroup identified actions at three levels: the systemic, the case and the global. At the systemic level the aim should be to create new research venues for "multi-stakeholderism": new models of governance, new business models, and self-organizing of companies towards new value networks. It is not clear how this can be achieved but working across disciplines and economic and social sectors will have to be strengthened. The subgroup noted that eco-innovation and social innovation are interdependent.

Success in the first will require us to understand these linkages and design the implementation of new ideas taking them into account.

16. At the case level a number of actions were identified. These covered the following:
    i. Development of systemic approaches for energy, water and other resource efficiency, and waste reuse. Research into new recycled or renewable green materials to replace non-renewable and/or toxic ones. This will involve public authorities, citizens, industry and the research community. If successful, it will decrease total use costs for these systems and provide a better service to the citizens,
    ii. Understanding the interactions between various sub-systems related to eco-innovation, such as energy, water, material flows, transport, socio-cultural system, knowledge base, labour market, etc. This will imply, for example, moving the current 'smart city' concept beyond technology.
    iii. Developing new assessment methodologies to evaluate the true degree of eco-innovation through life cycle methods. This will require strengthening data management systems and the creation of new systemic design tools, through collaboration between industry and the research community. The outcome should be a set of new tools that are able to evaluate the true eco-impact of innovations.
    iv. Understanding better the influence of innovations on the local environment and on local resources, especially in the case of the Arctic.

Details of these actions are elaborated in the Road Map included as Annex I to this report.

17. The plenary discussion on this priority area emphasised the need to strengthen risk assessment methods and especially to operationalise the idea of acceptable risk in relation to innovations. There was also a concern that not enough attention had been paid to the gap between making an innovation in this area and bringing it to the level where end users can adopt it. There was an issue of communication of innovations (this applies to all sub-groups). We need to consider incentives for innovators to fill this gap and study successes and failures in the process of going from the innovation to the user and then to the market.

<u>Priorities in the Area of Climate Services</u>

18. The objective here is to strengthen significantly the global market for climate services, designed to provide cutting-edge customised information services and adaptation solutions to a range of end-users in the business domain, the public decision-making domain and to individuals, making the EU a world leader in this sector. The group attributes to the term 'climate services' a broad meaning, which covers the transformation of climate-related data into customised products, their subsequent application and outreach and strong links with social sciences and humanities. Climate-related data in this context goes beyond the physical climate data, aiming to represent the Human Earth System with its various connectivities between physical, chemical, biology, social, economic systems.

19. Figure 1 represents schematically our broad view of Climate Services. Climate System Science explicitly goes beyond the physical realm as described above. The social science aspects are crucial. The links between natural and human/economic systems provide

important drivers for market development from both business and decision making perspectives. This creates the "service demand" which represents a strong feedback to future model development. The key features related to the figure are the following:

i. "Climate system science" can, and does provide lots of raw data, and also processed information aimed at end users, but without much expert knowledge of the requirements of these users. These components already exist but require continuing investment in development and improvement.
ii. End users have access to large databases (such as CMIP5) but lack expert knowledge in using that raw data. Users are much more than just business and local governments – national and international level policy makers (i.e. mitigation as well as adaptation) are also users.
iii. There is a requirement, and emerging activity, to bridge this gap – shown here as "consultancy services" which might be through large data providers, but should also include many smaller services (e.g. SMEs) with local or sector-specific expertise. These consultancies will draw on information including, but not limited to, downscaled regional output and output from impacts models. There is a R&I requirement here for cross-disciplinary expertise in both the data and the user needs.
iv. "Climate Services" is much more than just this consultancy area – it has to encompass the whole spectrum and includes the components of science which provide the information to start with. It is also vital to ensure that the service demand side gets a strong role. The services have to reflect societal needs both related to business activities and to public decision making. This requires effort in the initial phase of development in order to reveal user needs, to clarify legal issues and other critical market framing issues.
v. While Copernicus will support operational running of an eventual service there is a clear and central role for continued investment in R&I through H2020.

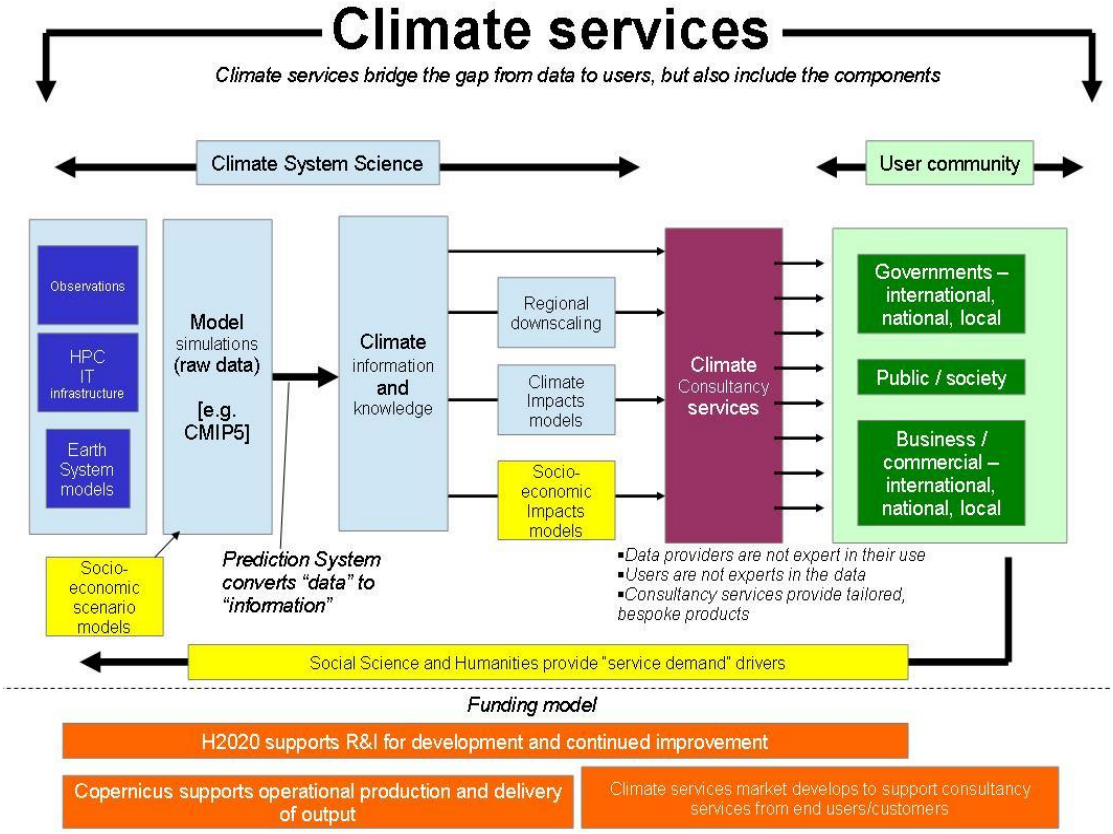

Figure 1: The Essence of Climate Services

20. The plenary discussion on climate services noted that other initiatives were also engaged in the same field (notably the Copernicus programme and Joint Programming Initiatives) and coordination with them is essential if H2020 is to provide genuine value added. There is a clear distinction between continued requirement for R&I to develop and improve underpinning components and the need for operational support of data provision.

21. The subgroup identified a number of actions that should be included in any future programme. These are listed here and further elaborated in the Road Map, attached as Annex II:
    i. Observations and monitoring. Combine global *in situ* monitoring networks with satellite observations and models and other data related to climate system change.
    ii. Modelling. Climate services built on today's state-of-the-art climate system understanding will be useful for only a short-time period without a strong effort in improving and regularly updating the fundamental understanding of the climate system. Continued R&I investment in development and improvement of climate-system and socio-economic models is vital to enable Europe to stay at the forefront of climate services.
    iii. Use of infrastructure and technology. Climate services will require extensive, adequate, dedicated HPC and IT infrastructure for storage and dissemination.
    iv. Adding value. Enhance the global environmental change information and outreach capacity that considers societal behaviour and human decision-making. At present there is a dis-connect between supply and demand for climate services so that what is supplied does not match what is demanded and potential demand for

services is not fully developed. The Commission will need to work with business and local government as well as education providers in this endeavour[2].

22. There will be demand for initialised near-term predictions as well as scenario-based long term predictions. R&I is required to make improvements in both, and also to combine both in a seamless manner at intermediate timescales. Climate services output will be both deterministic and probabilistic in nature, depending on the type of service considered and the question addressed. R&I is required into how to extract useful forecasts from model output, how to evaluate such output and how to communicate and use it. Regional downscaling of climate, mechanisms of climate variability and its impacts and risks of extreme events will become increasingly important to end users.

23. Uncertainty related to climate services is a major factor that needs to be specified. Framing of outputs in probabilistic terms is fundamental for development of risk-based decision making on mitigation and adaptation. European decision makers and businesses are currently lacking access to a consistent, authoritative set of high-resolution climate projections linked to impacts, and socioeconomic information for Europe. There is therefore a need to develop science to underpin a climate service prediction system for the European region. In the first instance the prediction system could be based on the current generation of models to produce a probabilistic set of high-resolution projections, covering timescales from seasons to decades. R&I is also required to develop the next generation system, at higher resolution, incorporating additional improvements in initialisation techniques, process representation and earth system components.

24. As the demand for services grows, users will want some guarantee that the private sector provider is using the latest information and is qualified to supply the relevant information. There may therefore be a need for certification of private suppliers, which the EC could help up to structure, working with private associations. At the same time the private sector is likely to develop financial instruments that are related to climate mitigation, an extension of the growing "green bonds" market. Again H2020 could help develop the criteria under which a bond may be considered as supporting low carbon investment.

25. Overall the AG felt there was potential for the EU to lead in the provision of climate services at the global level. This would require, however, strong cross-disciplinary teams as well as effective interaction with stakeholders. Some certification system to guarantee quality may be necessary. Capacity building on bridging the gap between disciplines is needed on the supply and demand side. This could be done through:
    i. Providing general knowledge to the demand side on diverse climate-related information and modelling, taking account of different time scales for different uses[3].

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[2] To better quantify and understand the demand for climate services a market survey should be carried out on what are the areas where climate services are (and will be) needed by the business and other communities. This should stimulate the service developments for the future across the various sectors.

[3] Weather services are closely related to user needs, and the feedback on the value of more accuracy is straightforward. We can learn from looking at the weather service customers, and transfer the lessons to other services.

ii. Demonstrating the added-value for developing markets and businesses of networking, information sharing, open access, and transparency.
iii. Mapping stakeholder interests related to different planning issues and business creation and to achieve leadership by including the private sector, governments, insurance, and Public Private Partnership needs.
iv. A crucial aspect of the capacity building is to identify and target the right actors/ people on the right position, who are knowledgeable how to deal with the climate service information, including dealing with uncertainties & serve as quality multipliers to the respective sectors.

Priorities in the Area of Nature Based Solutions

26. The objective of this area is to position Europe as world leader in innovation through nature-based (i.e. inspired by, using, copying from or assisted by nature) solutions for improving society's economic, social and environmental resilience, particularly in urban areas, and to foster the uptake of these solutions, notably by contributing to the development of a global market for nature-based solutions.

27. The rationale is that human societies are on a trajectory where the planetary supply of natural resources and services ultimately cannot meet demand. Thus the overall challenge is to bring and maintain the human demand for resources and services within the global and, in some cases, regional supply constraints. Nature, itself, is resource efficient and can inspire or support innovation that contributes to meeting this global challenge. Ultimately, the continued development of human societies is dependent on meeting this challenge. The EU, therefore, will benefit from investment in nature-based solutions across all sectors. In addition, all other societies will increasingly be looking for these solutions, creating a global market.

28. Long term and lasting solutions should be modelled on those found in nature but "solutions" based on nature are not by definition good. Certain criteria must be met for such solutions to help society meet the challenge of maintaining demand for natural resources and services within global supply. These are:
    i. Built-in resilience – providing the ability to bounce back after perturbation. This can imply, for example, not putting all eggs in one basket, avoiding undesirable lock-ins.
    ii. Designing systems that are reversible where possible, that are locally attuned (in a geographical but also a social sense) and energy and resource efficient.
    iii. Designing them in ways that takes account of the larger, system context and that maintain or augment natural capital where possible.

29. In the discussion that followed the AG reemphasised the point that nature based solutions were not necessarily the best solutions: we need to define the goals clearly and have some way of evaluating the results of different solutions in a comprehensive way. In that regard a system of evaluation that included accounting for the externalities associated with different ways of providing goods and services would be socially desirable and would give nature based solutions a fair chance to prove their worth. The AG also felt that lessons could be learnt from how early societies used such solutions. Furthermore the links to other countries and their search for such approaches needs to be emphasised.

30. Under the rubric of nature based solutions there was also a discussion of cultural heritage and its links to the environment. Europe is especially rich in assets under this category, which is also an important economic sector through its contributions to tourism and employment that can be implemented in a (generally) low impact environmental way. The sector is, however, under some threat through both social and climatic changes that need to be better understood and addressed. Development of some brownfield sites as centres of our cultural heritage, the reopening and sustainable exploitation of closed sources of traditional materials to supply heritage-compatible repair materials and the revitalization of the vanishing skills and professions needed for qualified intervention in heritage assets are all important potential sources of green growth in the future.

31. A Road Map describing the actions needed under this area is included at the end of the report as Annex III. It sets out seven priorities, namely:
    i. Ways of doing research
    ii. Regulations to account for damage to nature through economic activities by internalising externalities
    iii. Research to promote the uptake of nature based solutions
    iv. Awareness communication and networking
    v. Capacity Building
    vi. Identifying and promoting nature based solutions to other societal challenges, such as health, transport, energy and food
    vii. Identifying and promoting nature based solutions to other sub-groups within societal challenge 5, such as climate change, buildings and cultural heritage, water and waste management and ecosystem restoration.

<u>Priorities in the Area of Sustainable Supply of Raw Materials</u>

32. The overall objective of this area is to ensure the sustainable supply of non-energy and non-agricultural raw material to the EU. The sub-group noted at the outset that there were a number of parallel initiatives in this area such as the EIP on Raw Materials, ETPs (e.g. ETP SMR), ERA-MIN, and PPPs. It was important that efforts, knowledge, tools and research infrastructures were coordinated between them to avoid duplication and to maximise the impacts of H2020.

33. The EU is currently highly dependent on imports of raw materials that are crucial for a strong European industrial base, an essential building block of the EU's growth and competitiveness. In order to secure a sustainable supply from EU and non-EU sources, Europe is therefore confronted with a number of challenges along the entire raw materials value chain composed of exploration, extraction, processing/ refining, recycling as well as substitution. This involves managing raw material resource flows effectively both from primary and secondary sources (see Figure 2).

34. Europe's mineral potential is under-explored both with regard to subsurface (particularly deeper than 150 meters) and at sea in the EU Member States exclusive economic zones. The higher costs for deeper exploration, time delays in permitting, and the technological and economic feasibility of mine development are challenges to be tackled.

35. The long term vision is to tap the full potential of primary and secondary raw materials and to boost the innovation capacity of the EU raw materials sector, turning it into a strong sustainable pillar of the EU economy and an attractive industry, whilst addressing

societal challenges and increasing benefits for society. This can only be done by gaining relevant knowledge about raw materials in Europe. It also requires that stakeholders, including the relevant authorities, raw materials and downstream industries, research communities and society work towards the same objectives.

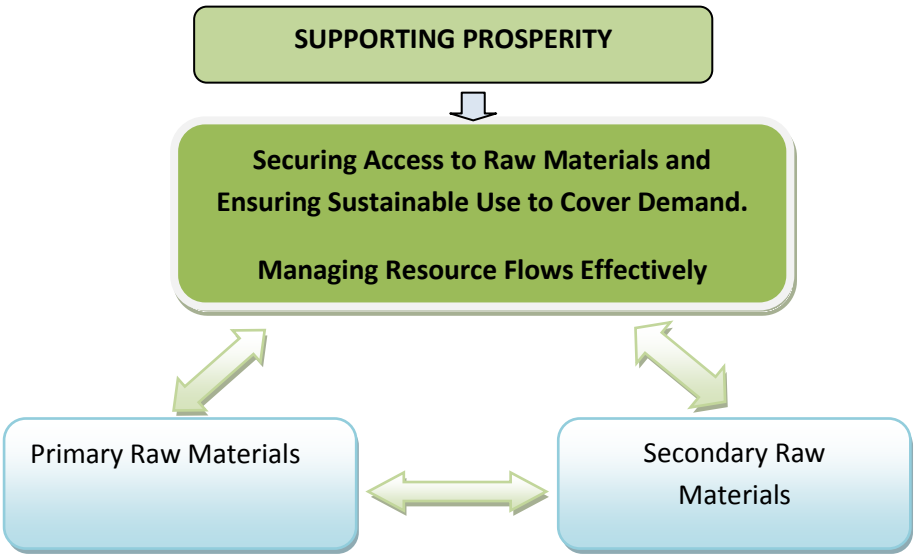

Figure 2: Raw Materials

36. The subgroup vision and rationale is based on the review of this area in the Strategic Implementation Plan (SIP) of the European Innovation Partnership (EIP). It identifies seven priority areas for action, with several sub-areas under each priority area. The first three (i, ii, iii) fall under the broad category of the technology pillar, the next three (iv, v, vi) under the category of non-technology pillar and item (vii) under the category of international cooperation:

i. Raw materials research and innovation coordination
    1. Improving R&D&I coordination in the EU
ii. Technologies for primary and secondary raw materials production
    2. Exploration
    3. Innovative extraction of raw materials
    4. Processing and refining of raw materials
    5. Recycling of raw materials from products, buildings and infrastructure
iii. Substitution of raw materials
    6. Materials for green energy technologies
    7. Materials for electronic devices
    8. Materials under extreme conditions
    9. Applications using materials in large quantities
iv. Improving Europe's raw material framework conditions
    1. Development of a material policies framework
    2. Access to mineral potential in the EU
    3. Better public awareness, acceptance and trust
v. Improving Europe's waste management framework conditions and excellence
    4. Innovation in product design for optimised use of (critical) raw materials and increased quality of recycling

5. Optimised waste flows for recycling
6. Prevention of illegal shipments of waste
7. Optimised materials recovery

vi. Improving Europe's knowledge base and skills relating to raw material flows
8. Creation of an EU raw materials database
9. Creation of a possible EIT knowledge and innovation community
10. Optimised raw materials flows along value chains

vii. Strengthened international cooperation in this area with respect to.
1. Technology development and adoption
2. Raw materials governance and dialogue
3. Health safety and the environment
4. Skills, education and knowledge.
5. Investment activities

In order to avoid any duplication and to give credit to the substantial stakeholder consultation that was carried out for the EIP the Road Map elaborating on these areas has taken into account the EIP's SIP and is included at the end of the report as Annex IV.

37. If successful, this program of action will result in a number of improvements in access to raw materials, sustainable management of resources within the economy and world-leading innovations both in technology and business practices. It should also result in changes in consumer behaviour that are more consistent with the sustainable use of our raw materials.

38. Other issues that were highlighted in the discussion on raw materials included: (a) the importance of addressing skill shortages along the whole value chain, especially in the area of mining and mineral processing, (b) environmental and societal problems related to waste management (e.g. tailings); and (c) the importance of timber as a raw material, which needed to be covered somewhere in the program.

<u>Priorities in the Integrating Social Sciences and Humanities (SSH) Across the Priority Areas</u>

39. The societal challenge of climate action, environment, resource efficiency and raw materials implies a strong movement of adaptation in society. SSH expertise will be particularly necessary to understand what this implies and to accompany change. There are a number of ways in which SSH could play a role in the design of actions on the four priority areas. In addition there are some issues that cut across the four strategic areas and that may "fall between the cracks" if not addressed specifically.

Systemic eco-innovation:

40. Social science research needs to be mobilized at all the levels presented in the roadmap. For instance, "multi-stakeholderism" requires research on governance models to understand how very different actors with very different methods and practices can work together.

41. The relations between social innovation and eco-innovation would benefit from the involvement of historians of technology or anthropologists specialized in material culture - they have developed a lot of research on the links between technology and culture. For example in the case of Artic resources geographers, historians, economists, anthropologists, specialists of international relations, lawyers, etc. could analyse the

geopolitical consequences of different development through their impacts on populations, the claims to sovereignty, etc.

42. More specifically SSH has a contribution to make through the following disciplines :
    i. *Economics:* to work out the advantages, the way to share costs and benefits, etc., internalise externalities and account for natural and social capital.
    ii. *Sociology/anthropology/management studies:* enable different work cultures to collaborate. Different industrial branches will have to work together. This may be accepted on paper but comes up with difficulties due to different rhythms, different management structures, etc. SMEs will need particular support.
    iii. *Sociology/anthropology/psychology*: understand the change from a consumption-centred economy ("more and bigger is better") to a more sustainable model. For instance, identity-building processes (owning a big car…) will change (e.g. to sharing rather than owning), as will leisure activities.
    iv. *Anthropology, geography, history:* what can be learned from countries/societies that recycle(d) massively ? Gender is probably an important factor (domestic practices, possibly different attitudes to thriftiness, etc).

Climate Services

43. Climate services provide information and predictions about the climatic trends but, as noted, also need to provide a comprehensible analysis of how society can and does react to major climate events. Expertise in the social, economic and political impact of climate change has to be a major dimension of climate services, analysing geo-political changes; migration and poverty induced by climate and sea-level change; the situation of small countries/populations that have few resources to face climate change (Pacific islands, Arctic); etc. In other words Europe should offer climate services centred on the social dimensions of climate change as well as on the physical ones. It should provide a sort of observatory of how the world is evolving, with geopolitics, migration, poverty, etc. being monitored. Getting a global understanding of what is happening will be very important.

44. The following disciplines within SSH can make the following contributions that are important
    i. *Sociology, anthropology:* Society will need to learn from new events. This learning process will have to be as efficient as possible. Examples are studies on Katrina in the US but also the 1999 storms in Europe, e.g. on how populations managed before the arrival of help from outside. Another example is a study on the way public decision makers in the Bordeaux area use satellite pictures to try to handle future rise in sea-level.
    ii. *Geography, political sciences, history:* how does climate change affect political and economic power balances in the world? How will governance issues in the "new" Arctic and Antarctic areas be handled?
    iii. *Communication sciences:* how can a massive amount of new information on climate be communicated efficiently? How can it be linked to end-users needs and constraints? What role do the media play in disseminating knowledge?
    iv. *Psychology, cognition sciences:* how is satellite information, GIS maps understood and used by non-specialists?

45. In terms of content the subgroup had noted that the demand for climate services will need to be built up through capacity building. This will, however, need to focus in particular on the role of socioeconomic data, where the following issues need to be addressed:

i. Potential users of climate services should be included in an assessment of needs and markets, including current users of "weather information".
ii. Attention should be paid on how the ownership of a service platform can be structured in a way where data is open source, and business creates tools and custom designed products.
iii. A mainstreaming approach should be developed, where climate services are related to other planning issues and GIS based information. This could for example be with respect to sustainable cities, energy, transportation, water systems, and other regional planning issues.
iv. A link to new and already existing data beyond the traditional scope of climate information could be made. Socioeconomic information and planning data are very important here, and Eurostat and other statistical offices are key partners.
v. A protocol for consistent cross country data systems and at EU level should be set up, where cross boarder/regional data can be generated in a consistent way.
vi. An approach for handling risks and uncertainties related to climate services needs to be elaborated. This should address:
    a. How can the uncertainty be communicated
    b. Approaches for decision making given uncertainty, different decision rules
    c. Considerations of consumer and the private sector preferences given uncertainty and ambiguity.
vii. Consideration of legal issues in relation to:
    a. Uncertainties of potential damages in relation to investments and insurance. Examples of these are adaptation measures and design standards, private houses, infrastructure.
    b. Who are going to carry the losses, when climate information do not show up to be a good forecast.
    c. Private sector responsibility versus the public sector.

ii. Collection of experiences with similar data service platforms, which can be used to develop climate services (satellite information, weather services, environmental data, water systems).

Nature-based Solutions

46. SSH disciplines have the following important contributions to make to this priority area:
    i. *Anthropology, sociology:* on understanding attitudes to "Nature" as well as on understanding the changes that nature-based solutions will bring in consumers' practices. Gender and cultural backgrounds are important in contributing to attitudes.
    ii. *Geography, history, urban studies:* on understanding how cities evolve. Poverty is a very important dimension to take into account, as well as gendered modes of appropriation of the city. How will small and large-scale communities integrate?
    iii. *Economics:* for the economic viability of "nature-based solutions" based on a full social costing of different alternatives. Attention to socially responsible solutions (participant, cooperative, grassroots initiatives) is particularly necessary. People could be considered part of Nature, with more attention paid to well-being and happiness as opposed to narrow income-based measures.

47. If the social dimensions are not taken into account there is a risk of imposing "one size fits all" solutions. "Best" strategies may be different in different places and for different communities. The big challenge is to find nature – and culture – based solutions, so as not

to be only technology driven. Here again, history of technology and anthropology of material culture can be mobilized.

Sustainable Supply of Raw Materials

48. The social dimensions of this priority area need to be taken on board at many of the stages identified in the programme outlined above. This is especially the case for recycling and factors determining its effectiveness.

49. The SSH disciplines are relevant to this priority area in the following ways:
    i. *Anthropology, geography, history, language studies:* All these disciplines are needed to understand the geopolitical issues at stake (at government but also NGO and citizen level) and to develop collaboration in a responsible and sustainable manner with the countries that produce raw materials.
    ii. *Anthropology, sociology, psychology:* to understand citizens', business's and industries recycling practices. An example: ethnographic studies on recycling in Cairo show traditional system is more efficient than the system introduced by large international companies.
    iii. Geopolitics is a major element of the raw materials question.
    iv. Social points of view are also essential: relations with other countries, "acceptability" of mining sites – see the shale gas controversy, etc.

<u>Cross Cutting Areas</u>

50. The subgroup working on this area felt that there were important societal challenges that were not covered in the four priority areas. In particular they noted:
    i. The links between this societal challenge and that of Health, Demographic Change and Wellbeing. Certainly climate services will be concerned with these issues but so will assessments of innovations in all the other areas – how safe are they from a health perspective and how can they contribute to our health and wellbeing?
    ii. Where are challenges food and water covered? In part they will be addressed under climate services but there are issues relating to these that are not climatic.
    iii. Where do we address specific sector level challenges, such as those to the building industry? They will come up in sustainable raw materials and climate services but problems of change in the industry will involve other social problems as well.
    iv. Migration is a cross cutting topic. It comes up in climate services but it is wider than that and perhaps merits consideration on its own.
    viii. The impacts of geopolitics for climate change and resources may need to be addressed outside the ambit of these priority areas. More generally the impacts of climate change in regions outside the EU may have consequences for Europe's ability to adapt and sustain growth and these have to be understood and planned for.
    v. The role and potential of cultural heritage, which is covered under nature-based solutions but has links to other sectors as well.

Appendix: Meetings of the AG and Members of the Group

The AG has met so far on four occasions (4th October 2013, 11th December 2013, 29th - 30th January 2014 and March 13th 2014).
The names of the 31 members of the AG are given below.

Name	Country
Prof. Almut ARNETH	Germany
Dr Nikolaos ARVANITIDIS	Sweden
Prof. Manuel BARANGE	UK
Dr Danilo BONATO	Italy
Dr David BRESCH	Switzerland
Ms Laura BURKE (Chair)	Ireland
Dr Suzanne DE CHEVEIGNE	France
Dr Mark DOHERTY	Ireland
Prof. Eeva FURMAN	Finland
Prof. Kirsten HALSNÆS	Denmark
Dr Corina HEBESTREIT (Vice Chair)	Belgium
Mr Chris JONES	UK
Dr Ewa KOCHANSKA	Poland
Mr Stefan KUHN	Germany
Dr Hab. Joanna KULCZYCKA	Poland
Mme Anne LAPERROUZE	France
Prof. Michal V. MAREK	Czech Republic
Prof. Anil MARKANDYA (Rapporteur)	Spain
Prof. Beatriz MORALES-NIN	Spain
Dr Antonio NAVARRA	Italy
Ms Ana NEVES	Portugal
Dr Enrique PLAYAN	Spain
Mr Lars-Otto REIERSEN	Norway
Prof. Katherine RICHARDSON	Denmark
Dr Aurela SHTIZA	Belgium
Mr Hervé SUTY	Belgium
Prof. Dr Erja TURUNEN	Finland
Dr Sybille VAN DEN HOVE	Spain
Dr Saskia VAN DEN MUIJSENBERG	Netherlands
Prof. Shearer WEST	Belgium
Prof. Dr Roko ZARNIC	Slovenia

Annex I: Road Map for Systemic Eco-innovation

Objective: To position Europe as the continent that realises a closed loop circular economy, enhancing its industrial competitiveness through resource productivity (higher added value per unit of resource) and continuously improving its leading position for resource efficient products and services on the world market

Actions	Stakeholders	Expected Outcome/Impact
Systemic level		
Creation of new research models for "Multistakeholderism" (New models of governance, new business models, self-organising of companies towards integrated value networks, introduction of new stakeholders… Comparison of framework conditions. Sociology/anthropology/management approaches enabling different work cultures to collaborate. Different industrial branches will have to work together	The entire value chain; All relevant stakeholders (importance of industrial participation (including SME's), economic and social sciences). Both dimensions should be covered: integration on equal footing of different stakeholders as well as bringing different disciplines together.	Collaborative approaches, getting away from "silos"
Interaction between market, regulations and social behaviour should be understood better. How to design, influence and accelerate formation of eco-efficient markets.	All relevant stakeholders	New systemic input and balance, clearer picture of the contribution of each element.
To find ways to introduce social innovation to eco-innovations and vice versa. E.g. to understand how energy, food, water and social systems interact with each other. How to understand and learn from sub-systems (e.g. cities) and end-users? How to influence on market uptake? Actions are needed through sociology/anthropology/psychology approaches to understand the change from a consumption-centred economy to a	All relevant stakeholders	New understanding how different interfaces influence each other

more sustainable model.		
Case level		
Development of systemic approaches for energy efficiency, water efficiency and waste refinery (for instance in the urban environment) towards circular economies	Public authorities, citizens, industry A wide range of research actors (technology, economics, societal, environment, energy, etc.)	Decreased total use costs through well balanced systems Better services to citizens
Understanding interactions between various sub-systems related to eco-innovation, such as energy, water, material flows, transport, socio-cultural system, knowledge base, labour market. Moving current 'smart city' concept beyond technology.	Public authorities, citizens, industry Research widely (technology, economics, societal, environment, energy, etc.)	Better services to citizens, new business opportunities for industry
Creation of new assessment methodologies to evaluate eco-innovation through value chain and life cycle. Stronger interface to energy. How to manage data and create new systemic design tools. (From assessment of already made decisions towards influence of design. In all levels)	For industry made by research community	Validate tools which can be used to quantify and evaluate eco-impact. This should have influence on policy making and also for business practices and decisions making of industry.
Develop skilled people to address these societal challenges in a systemic and cross discipline manner.	Policy makers, industry, new generations;	Carry out an assessment to identify skill gaps and define strategy to fill them.
Understanding influence of local environment for larger systems. Case artic dimension ⇨ systemic understanding of pros and cons for use of artic resources	Geographers, historians, economists, anthropologists, specialists of international relations, lawyers, etc. could analyze the geopolitical consequences, the impact on populations, the claims to sovereignty, etc.	Tools for deeper understanding and decisions making in a systemic level.

Global level		
Making Europe a global best practice for circular economy	EU policy makers; International partners, Industry; Society; Other concerned stakeholders	Assess needs; Recognise collaboration opportunities; Understand correct level of actions;
To adopt good practices in global level via systemic approach	EU policy makers; International partners, Industry; Society; Other concerned stakeholders	Cross learning through global excellence

Annex II: Road Map for Climate Services

Objective: To create a European market for climate services designed to provide cutting-edge customised information services and adaptation solutions to a range of end-users, both in the business to business domain, in the public decision-making domain and to consumers, making the EU a world leader in this sector.

Actions	Stakeholders	Expected Outcome/Impact
Combine global and regional data from in situ and remote monitoring networks, with impact data, socio-economic and land use information, and other sources of data and knowledge at local level (including traditional knowledge). This involves coordinating discussions between suppliers and users of climate data in agriculture, forestry, marine, industry, insurance etc., as well as the modelling community.	Suppliers and users of data. Research, governments, business communities. Statistical services.	Framework for facilitating data provision and access, enhanced use of multiple data streams → test models; data-assimilation into models; develop localised adaptation options; assess potential of success for mitigation options.
Continuing development of underpinning models and modelling techniques. Improved incorporation of observational data into modelling systems: applications in model evaluation and constraints.	Research community, developers and users of models and users of model output; decision makers, business	Improved realism and reliability of models. Enhanced trust in their projections
Identify the main modelling gaps and deficiencies in understanding the linkages between the climate, biogeochemical, economic, social and health system models and support work to fill these gaps. The research community will need to discuss the issues with policy and business user communities and the outcome should be a prioritisation of the modelling needs and actions to address them.	Research community; policy makers/institution, business	Prioritisation of modelling needs, emphasising the interactions and feedbacks (and action to improve on these)

Develop a prediction system to produce an authoritative set of high resolution, probabilistic projections for Europe linking climate, impacts, and socioeconomic information. Continued R&I into improved resolution, process representation and initialisation of predictions. Database on agreed global climate variables (beyond T and P...), agreed common format and required resolutions (space, time) (for seasonal to decadal to longer time frames).	Governments, research and business Engage with WMO, and WCRP/CMIP	Improved capacity to produce probabilistic predictions from model output. Availability and documentation of database of authoritative model projections in standardised, defined formats with quantified uncertainties and probabilities, at high resolution.
Use of infrastructure and technology. Numerical modelling is the main tool to deliver climate information both via analysis of observation and/or numerical forecasts and scenarios. Sufficient resources therefore should be dedicated to the development of models and analysis techniques to fully exploit research infrastructure and computing advances that will occur in the coming years to decades.	Model developers and data suppliers. Engage with ESFRI.	More efficient models, faster availability of outputs, more reliable and faster access to data etc.
Develop suitable methodologies for downscaling global ESM understanding to regional and local levels for building reliable regional circulation models, impact models, economic models, sectoral models, social and health system models, etc.	Research community; policy makers/institution, business	Testing of different methodological approaches, assess outcome vs. suitable observations and identify most suitable way forward
Knowledge creation and capacity building for decision making and climate proofing existing and future assets under uncertainty, targeting both private sector and government, including behavioural issues and response capacity.	EC, business (marketing), teaching (schools, universities), policymakers, local administrators	Engage with public and private sector, encourage better integration between natural, economic, social sciences; show opportunities for using climate services to develop e.g., mitigation/adaptation options.
Aid developing a future enlarged market for climate services, identify untapped potential, and how it can be stimulated recognizing gaps in knowledge and uncertainties	EC, business, research community	Identify service development track from where we are today to where we aim to be tomorrow; development of opportunities for various sectors

Develop the demand for climate services through the demonstration of potential capabilities on specific applications of high economic potential and societal added value – to launch a competitive bid for expressions of interest in order to identify possible sectors in which to invest with priority	Climate services users	Successful case studies may stir the diffusion of climate services to other business sectors

Annex III: Road Map for Nature-based solutions

Objective: to position Europe as world leader in innovation through and with nature- 'naturetech'- for improving society's economic, social and environmental resilience, particularly in urban areas, and create a global market for nature based solutions

Actions	Stakeholders	Expected Outcome/Impact
1 Ways of doing Research The way calls are formulated and evaluated should reflect the inter- and trans-disciplinary nature of nature based solutions.	Evaluation committee that is interdisciplinary-wired and understands what biomimicry, biomimetics, bionics etc. is	Removal of barriers for inter and transdisciplinary R&I. Allow for out of the box and systemic projects and solutions to be selected.
Every project and topic should include a multi-dimensional assessment of (both benefits and risks). The Life's Principles framework can help with this		
Participatory approaches to research, innovation and deployment. Facilitate the process of connecting people with ideas, skills etc. Build from the bottom up, online, offline. Eg living labs etc.		Foster cooperative relations and accelerate innovation
Enabling upscaling and downscaling of solutions. Benchmark, replicate and transpose what works - evolve to survive		
Need for pre-normative research. Research to promote standards, regulations etc.		
* Set aside at least 25% of research funds on researching the risks/negative side effects (ideally by 'neutral' group).		Holistic approach to innovation
2 Regulations Internalisation of external effects. Revisit subsidies (perverse and virtuous).	DG Energy, other relevant DGs	Better ways to compare NBS with current solutions

3 Research Research mechanisms to promote the uptake of nature-based solutions		
4 Awareness, Communication and Networking Agree on rationale, definition and criteria what is NBS?		
Make the aspect of this priority more visible in a dynamic way. Need to communicate and build awareness. Eg dedicated TED platform, dynamic forum, congress, etc. Share success stories	Entrepreneurs, inventors, researchers, taxonomists	
Facilitate Biology to Design process. Many biologists and taxonomists have deep knowledge and understanding of biological/ecological phenomena, which could interest companies. Abstract the biological knowledge.	Biologists, taxonomists, academia, research institutions, natural history museums	
Organise event for Private Investor clubs and connect with start ups that need financial support to go to market. Connect them to H2020 supported initiatives – bridge different phases Set aside money for match making activities – connect investors and entrepreneurs	Research, entrepreneur, investors, foundations (donations), DG	
5 Capacity building Horizon2020 We need to look at embedding nature-based solutions in education to develop the necessary workforce and uptake of nature-based innovation by business and governments. Focus on bridging silos in higher education: eg biology and business or biology and design. Capacity building (with Marie Curie, Erasmusplus)	Formal and informal education, business	
6 Framing conditions Nature-based solutions (NBS) should find a place under the 'other'	DG's, EC	More focused investment and R&I activities

Societal Challenges too. Nature-based/inspired solutions can help address health-related, food-related, energy-related, green transport, etc.		
Nature-based solutions as theme for SME instrument	SME instrument program	
7 Potential priority areas for Challenge 5: • NBS for low carbon, resource efficient, green, circular economy. • NBS for mitigation and adaptation for climate change. • NBS for cities, buildings, cultural landscape and heritage. • NBS for water-related challenges. • NBS for decontamination, waste treatment, ecosystem restoration. • NBS for social innovation – services, organizational challenges, behaviour change. • NBS to support economic activities in nature-protected areas; support Natura2000-friendly jobs. Nature as model, measure and mentor		

Annex IV: Road Map for Raw Materials (based on the EIP's SIP)

Objective: Ensuring the sustainable supply of non-energy and non-agricultural raw materials

Actions	Stakeholders	Expected Outcome/Impact
- **Co-ordination and Support Actions to help developing technology, non-technology and international co-operation policies; as well as preparatory Research and Innovation (R&I) actions to mobilize the community and create strong consortia. (SIP Ref. I.A; II.A; II.B; III.1; III.2; III.3; III.4)**		
I.1 Improving R&D&I coordination in the EU To strengthen coordination of the research initiatives (such as Horizon 2020, ERA-MIN, PPPs and ETPs), efforts, knowledge, tools and research infrastructures.	**Potential players:** EU, Member States, industry and academia.	The success of the proposed actions would maximise the impact of the other actions in the Technology pillar; Improve the understanding of the Raw materials Research and Innovation needs and initiatives by the wider society in the EU.
II.A Priority Area: Improving Europe's raw materials framework conditions		
II.1: Minerals Policy Framework To provide a stable and competitive supply of raw materials from EU sources while promoting good governance and facilitating public acceptance.	**Potential players:** EU, MS, industry, academia, local communities.	The successful implementation should promote, by good governance, the investment into minerals sector, and consequently increase sustainable minerals supply from EU sources.
II.2: Access to Mineral Potential in the EU To foster access to mineral deposits, improve the regulatory framework.	**Potential players:** EU, MS (mining and planning authorities or agencies, geological surveys), industry, academia.	Successful implementation of this action should allow prudent use of existing and future minerals reserves and resources.
II.3: Public Awareness, Acceptance and Trust Increase at first the public awareness of the benefits and potential costs of the raw materials supply, secondly obtain its acceptance and finally gaining the trust for the activities of the sector.	**Potential players:** Industry MS, EU, academia, local community, NGOs	The successful implementation of this action should contribute to increasing knowledge and building trust in the resource companies and enhance acceptance of their activities.

- **II.B Priority Area: Improving Europe's waste management framework conditions and excellence**		
II.4: Product design for optimised use of (critical) raw materials and increased quality of recycling To minimise critical and other raw materials needed in products to perform particular functions, support product life extension and maximise the amount of materials recycled/reused through the development of new design strategies for various product ranges.	**Potential players:** EU, MS, industry, academia, standardisation bodies, NGOs	The full potential of the circular economy is estimated at 540 billion Euro (USD 700 billion) in materials savings alone. These actions are expected to increase raw materials recovery for collected e-waste and increase the recovery levels of critical raw materials, e.g. rare earth metals, indium, tantalum, from currently less than 1%.
II.5: Optimised waste flows for increased recycling To boost the quality and quantity of collected waste/end-of-life products, in particular those containing technology/critical metals and minerals in significant quantities – and improve the life-cycle management of products, thereby preventing losses of valuable raw materials and to then ensure their high quality treatment and recycling.	**Potential players:** EU, CEN/CENELEC, MS, industry, academia, NGOs	There is a potential to further increase collection rates by about 10 million tons of paper, currently disposed of by landfill (or incineration) and up to 15 million m3 of used wood annually.
II.6: Prevention of illegal shipments of waste To prevent illegal shipments of waste from the EU to non-EU countries, thereby preventing losses of valuable raw materials, competition.	**Potential players:** EU, MS, IMPEL-TFS, Basel Convention Secretariat, customs authorities of Member States, industry, academia, customs/environmental authorities in key third countries, CEN/CENELEC	The actions should lead to a significant reduction of illegal waste shipments from current estimated levels of around 20-25%.
II.7: Optimised material recovery To improve the quality of recycled material by developing standards for e-waste recycling and encouraging the transition from waste to secondary raw materials.	**Potential players:** CENELEC, EU, national standardisation bodies, industry	Not estimated
- **II.C Priority Area: Knowledge, skills and raw materials flows**		
II.8: European Union Raw Materials Knowledge Base The European Union Raw Materials Knowledge Base (EURMKB) will provide EU level data and information on raw materials from different sources in a harmonized and standardized	**Potential players:** EU, MS (mining authorities, geological surveys, forest authorities), industry, academia, non-EU MS, international	Successful implementation of this action should give guidance to EU and Member States policy and decision making on EU, MS level as well as in industry; informing also on

way, encouraging activities of the raw materials sector.	organizations	strategic issues and providing foresight needed for decision making (policy, industry).
II.9: Possible EIT Knowledge and Innovation Community(KIC) To boost excellence in the raw materials sector, a network of research, education & training centres on sustainable raw materials could be created as an EIT Knowledge and Innovation Community, which also involves the business community & bases on education, entrepreneurship & technology innovation).	**Potential players:** EU, MS, industry, academia, research institutes	Successful implementation of this action will maximise resource efficiency by intelligent use of research and technology along the entire production chain and by optimizing interactions along the entire raw materials value chain; increase the number of highly qualified professionals in the raw materials sector; directly promote innovative products and services through the business community.
II.10: Optimised raw materials flows along value chains The objective of this action area is to enhance the conditions of the raw materials value chain in order to optimise raw materials flows along value chains and improve the combined use of primary and secondary raw materials without the loss of quality through improved cooperation of actors along different value chains.	**Potential players:** EU, MS, industry, forest/wood-based value chain actors, national / regional industrial symbiosis networks, academia	Interdisciplinary and transnational cooperation will boost raw material sector in the EU. Specifically on wood, the action will allow matching the supply and demand of wood for the EU industry, while creating greater added value to the economy and more jobs compared to direct energy use of material.
- **III. INTERNATIONAL COOPERATION PILLAR**		
III.1: Technology Shortening the implementation time of new technologies; utilising synergies between the EU and its partners in a dialogue on all relevant technologies with the aim to improve the environmental performance of the whole supply chain and information , as well as capacity building and to support pro-sustainable development strategies to develop national/regional minerals industries.	**Potential players:** USA, Japan, Latin America, Canada, Australia, South Africa	Successful implementation of this action should increase the knowledge and use of most advanced, economically effective and innovative technologies in the whole value chain of raw materials, from exploration, through extraction, processing and production to recycling and substitution; Facilitate the exchange of information for better design of the raw material flows.
III.2: Global Raw Materials Governance and Dialogues This action area covers economically-important raw materials in	**Potential players:** International associations, G20, European	A more balanced situation on the world trade market in raw materials, elimination of barriers to trade or trade bans. This would benefit the economic stability, especially the

general, and specifically two types: (1) Critical Raw Materials (CRM) as defined in EU documents; (2) Natural rubber.	Development Bank, South East Asia, Africa (e.g. Ivory Coast and Cameroon), rubber value chain actors, International Rubber Study Group.	high technology sectors using certain raw materials subject to trade distortions, as well as sectors using raw materials that experience technical barriers to trade or uncontrolled and unpredictable trade duties.
III.3: Health, Safety and Environment On the one hand it aims at contributing to improving the health, safety and environmental performance of mining activities worldwide and contribute to development of sustainable mining in partner countries; and on the other hand it endeavours to improve the framework conditions for raw materials supply through dialogue. Furthermore, the aim of this action is to facilitate free and fair trade of metallic and non-metallic raw materials.	**Potential players:** EU, MS, industry, academia, African countries, ICMM (International Council on Mining and Metals), industry including technology suppliers, Basel Convention and its regional centres, UNEP, OECD, national standardisation bodies, CEN/CENELEC, ISO, international study groups on raw materials, academia, NGOs professional organisations (ex: European Federation of geologists)	The successful implementation of this action would trigger positive environmental and social impacts, by improving environmental conditions in mining in the long term, as well as mitigating negative social impacts due to the perception of health and safety in mining sites and the mining value chain.
III.4: Skills, Education and Knowledge First it seeks to increase competence & expertise levels by cooperation with leading educational and research institutions in 3rd countries & improve the availability of workforce skills in mineral resources. Second, it aims to establish an African Mineral Dev. Centre (AMDC) or similar body; third it aims to set up a dialogue on skills & knowledge with Latin American countries engaged in mining; finally it seeks to establish a knowledge based material flows system.	**Potential players:** EU, MS, Universities, Research centres, Industry, International Council on Mining and Metals, regional and international trade associations, ETP SMR, Australia, US, Canada, Japan, China, India, Latin American countries, OECD, UNCTAD, UNIDO, ILO, UNEP and regional offices	The successful implementation of this action should increase of overall knowledge and skills of people working in the sector; through acquaintance of new specific education, improve the technological and economic management in the sector or raw materials, tackling as well industrial development (better mining techniques) as well as environmental protection. In the long term, through better knowledge about raw materials and the mining industry, change the negative perception of people.
I.B Priority Area: Technologies for primary and secondary raw materials production - Demonstrate the feasibility of sustainable production and substitution of raw materials: 10 Pilot actions cross-cutting challenges (SIP I.B; I.C; III.3; III.4)		
I.2: Exploration (i) new cost-effective exploration concepts and technologies and (ii) their interpretation through geo-models in order to find new mineral deposits on the continent and in the seabed, as well as	**Potential players:** EU, MS (including geological surveys), industry (investors, mining industry,	It is anticipated that the same amount of metals and minerals can be extracted at 500 and 1000 m depth as from surface discoveries.

fostering industry investment to mining.	equipment suppliers, academia.	Reduce the industry exploration costs
I.3: Innovative extraction of raw materials The objective of this action area is to enable continental and deep-sea extraction of minerals and extraction of wood in a socially acceptable, environmentally responsible and economically viable way by developing new technological concepts and solutions leading to social acceptance of extraction in the whole Europe and around the world.	**Potential players:** EU, MS, regions and municipalities, industry, academia, research institutes, civil society.	Significantly improve Europe's and also global marine resource base; create numerous new jobs in many regions of the EU; Push Europe to the forefront in the technology areas Reduce both the environmental impact Reduce energy and water consumption and contribute to reduction of land use for mineral raw materials provision; Improve productivity in harvesting and significantly reduce the risk for soil disturbances from forest machines. Facilitate wood mobilisation, enhance the cost-effectiveness of wood supply, and increase the added value of wood products leading to higher competitiveness.
I.4: Processing and refining of raw materials Develop and demonstrate new holistic processing concepts and systems with higher technical, economic, energy and environmental performance and flexibility, versatility and modularity for processing and recovery of different raw materials	**Potential players:** EU, MS, regions and municipalities, industry, academia, research institutes, civil society	The success of this action would unlock a substantial volume of various raw materials from deposits that cannot be economically or environmentally exploited within or outside EU
I.5: Recycling of raw materials from products, buildings and infrastructure Develop and demonstrate cost-effective, resource and energy efficient and environmentally sound solutions for recycling and recovery of valuable raw materials from complex products, buildings and infrastructure, and other waste streams.	**Potential players:** EU, MS, industry, academia, research institutes, civil society	Enabling significantly improved recycling of collected WEEE arising from the new collection targets set out in the 2012 WEEE Directive.
- **I.C Priority Area: Substitution of raw materials**		

I.6: Materials for green technologies To promote a coherent set of specific actions that cover the most important application areas for which CRM are a key component and their substitution will make a substantial difference to the competitiveness of European industry (notably in sectors related to the energy, chemical, and automotive industries).	**Potential players:** The EU and an increasing number of MS have been active in devising a comprehensive policy framework to support the substitution of CRM.	The proposed specific actions should result in reduced CRM content in the application and dependency to mitigate the risk from future bottlenecks in the metal supply-chain in energy technologies.
I.7: Materials for electronic devices A coherent set of specific actions that cover the most important application areas for which CRM are a key component and their substitution will make a substantial difference to the competitiveness of European industry, notably in sectors related to the electronic and lighting industries.	**Potential players:** The EU and an increasing number of MS have been active in devising a comprehensive policy framework to support the substitution of CRM.	The proposed specific actions should result in a reduced dependency on CRM to mitigating the risk from future bottlenecks in the material supply-chain..
I.8: Materials under extreme conditions Promote a coherent set of specific actions that cover the most important application areas for which CRM are a key component and their substitution.	**Potential players:** The EU and an increasing number of MS	Availability of new materials with improved performance under extreme conditions that can have a dramatic impact in many industrial sectors, including the energy, transport, tooling and process industry.
I.9: Applications using materials in large quantities Demonstrate that the substitution of raw materials used in large quantities is feasible in a sustainable and affordable way without loss of functionality, reduce the EU's dependency on import of different raw materials, while exploring new innovative technologies and products, and bringing them to the level of industrial production.	**Potential players:** R&I activities should be industry-driven yet in close cooperation with research based in universities and research centres.	The proposed specific actions should result in reduction of import dependence of rubber used in high-volume applications and diversifying their supply in a sustainable and affordable way, creating a competitive advantage for the EU industry and new jobs; Reduce the use of CRM in alloys and steels produced in large volumes for the automotive, medical, pharmaceutical and energy industry.
- The last pilot actions and identifying the knowledge and technological gaps, improving the societal awareness and skills on raw materials, developing the breakthrough technological concepts and actions oriented to the next R&I Framework Program.(SIP ref. I.B; I.C; II.B; III.3; III.4)		