Study of FLAs in the area of Climate Action, Resource Efficiency and Raw materials

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Summary and Conclusions

The Review of Forward-looking Activities (FLAs) undertaken in recent years at national, European and international level in this area, indicates that while the H2020 proposals on climate action, resource efficiency and raw materials aim to address a highly relevant set of themes, H2020's proposed *approach and the mechanisms for implementation* need to be better specified, to ensure that an effective framework for addressing the grand societal challenges is put in place.

1. **The H2020 Climate Action challenge needs to be better integrated with other grand societal challenges.** It is currently presented largely as a set of stand-alone themes. Greater effort needs to be invested in defining the meta-framework and approach. In particular it should show that the climate challenge interfaces and connects with other grand societal challenges, including health and security among others. There needs to be more attention given to processes to explore, allow and support cross-challenge integration. Climate change risks/threats and opportunities need to be addressed in conjunction with other threats across the wider policy spectrum. H2020 needs to implement effective joined-up approaches and, where required, to introduce deeper changes in governance.

2. **Given the pivotal role of human behaviour in addressing climate change, the people dimension, relating to social and human aspects of climate change, needs to be given more central importance in H2020.** In this respect there is a need to re-frame global environmental change issues fundamentally as social and human challenges, rather than primarily physical environment concerns. An integrated nature-society perspective is recommended for driving the co-evolutionary transition to a post-carbon society. Linear efforts to manage ecosystems focused on one variable (environmental or economic) need to be replaced by more adaptive approaches integrating human, environmental and economic interactions. Increasingly 'soft' aspects such as values and beliefs which influence human behaviour towards the environment, climate and scarce resources, are being recognised as key determinants of human impacts on climate change. H2020 needs to factor in ethics, culture, religion and human rights as important drivers of climate change.

3. **For both climate change and resource issues the international dimension requires more dedicated attention and prominence.** Climate change impacts from outside Europe can be equal or greater in their consequences for Europe than direct impacts from within Europe. These relate among others to, increased migration due to harsh climate conditions and/or extreme events, the disruption of business and trade links and diplomatic relations, and security (access to critical infrastructures including ports and research facilities).[1] Recognition of these aspects of climate change need to be factored into H2020 in order that appropriate attention is given in H2020 initiatives. For resources Europe is vulnerable to external supply shocks which are highly interactive with climate change. On the one hand climate driven extreme events could lead to instability and disruption of resources and on the other hand eco-innovation is itself dependent on certain critical metals. Robust research and innovation strategies are required to mitigate these threats.

4. **More attention needs to be given to the innovation dimension in meeting the Challenge.** The innovation dimension is particularly important for driving the transition to a post-carbon

[1] Foresight International Dimensions of Climate Change (2011)
Final Project Report, The Government Office for Science, London

society. This needs to take account of the fact that the "challenge posed by the need to control human-centred global warming demands innovation of a far higher systems order than any preceding 'technological paradigm' in the world's industrial history"[2] as we move into a post-hydrocarbon landscape. The research dimension continues to have a predominant role in H2020 and a more balanced approach is needed, assigning equal priority to mechanisms to stimulate eco-innovation and social innovation. Measures to support innovation that should be given more prominence include demand-side policies and giving attention to the *regional* and urban dimension and the complementary use of structural funds to build and/or address gaps in capacity and critical mass through smart specialisation.

5. **Proactive measures are needed to promote interdisciplinary approaches to the challenge.** H2020 is well-positioned to spearhead a more proactive policy aimed at strengthening the European research and innovation framework for tackling climate change by building a sound common foundation for interdisciplinary and transdisciplinary research (natural, human and social sciences). This is implied in the H2020 objectives and approach, and work is underway to promote RD4SD[3]. However it would be useful if this goal is specified and appropriate mechanisms and incentives are put in place, to encourage this and take it forward.

6. **The science-policy interface will be particularly critical as a disruptive path is likely to drive a need for continual research-based advice on these issues at a policy-making level.** H2020 needs to encourage initiatives and projects to address this dimension in a more robust way by anticipating policy needs and designing the work plan and related measures accordingly. The FLAs highlight the uncertainty due to the geopolitical and economic landscape and climate research, emphasizing the need for ongoing investments in foresight in the area of climate change – not only at the design phase of H2020 but also over its lifetime as disruptions in the context, new feeds of information and research results and new technologies may require a re-thinking of approaches and the need to consult with stakeholders to create awareness of new opportunities or threats. In order to render the H2020 approach more robust, it is therefore important that forward-looking activity (horizon scanning, forecasting and foresight) is factored into H2020 as an ongoing activity, tracking disruptions and addressing in particular opportunities for social and environmental innovations, through effective engagement of experts and non experts and to align policies and strategies at different levels.

The detailed findings are presented in the main part of this report. In the final section, the report identifies challenges which are disruptive to H2020, adjustments to H2020 themes and missing issues in H2020.

[3] RD4SD (Research and Development for Sustainable Development) Expert Group Report and FP7 Project Vision RD4SD

Introduction

This Report has been prepared in response to the invitation for a study on Climate Action, Resource Efficiency and Raw Materials, in support of the work of the European Forum for Forward-Looking Activities. The aim of this Study is to develop mechanisms for ensuring that Horizon 2020 takes account of a wide range and fuller set of challenges for the area under review. The scope of the study was broadly defined by the societal challenge in this area as set out in the proposal for Horizon 2020, summarised by the objective:

> "The specific objective is to achieve a resource efficient and climate change resilient economy that meets the needs of a growing global population within the natural limits of the planet's natural resources. Activities will contribute to increasing European competitiveness and improving well being, whilst assuring environmental integrity and sustainability and the availability of raw materials, keeping average global warming below 2 °C and enabling ecosystems and society to adapt to climate change."

As noted in the Technical specifications, the areas of energy and food security were only covered insofar as they present issues of coordination and synergy with Climate action.

The key questions addressed in this report are:

- Identification of the main challenges and sub-challenges in respect of the area;
- Comparison of these challenges with the announced broad lines of activities under Horizon 2020;
- Assessment of the extent to which these challenges are disruptive for the assumptions or proposals of Horizon 2020;
- Identification of any adjustments to the themes in the light of this; and
- Whether any important challenges or issues are missing from the announced broad lines of activities.

The study also assesses the scope for a focus within the Climate action societal challenge on the cross-cutting areas of substitution of raw materials and of inducing behavioural change in society.

1. Approach

Work focused on a review of key Forward-looking Activities with a view to identifying insights relevant to the questions set out in Section 2. The need for this approach was already identified by the Stakeholder Workshops on Horizon 2020. These emphasised the importance foresight approaches to shape long term strategies for the area and indicated the critical importance of focussing not only on technological innovation but also societal innovation and societal change. They also noted that resource efficiency needed to be balanced with considerations of biodiversity and environmental protection.

In practical terms the approach involved three main but overlapping parts:

a. Identification of FLAs relevant to the area;
b. Review of these FLAs to identify key insights emerging;

c. Comparison of these insights with the proposed Horizon 2020 actions in order to address the key study questions.

The FLAs identified as relevant and reviewed in this section are listed in Box 1.

Box 1: The list of FLAs reviewed

a. FLAs by European and international agencies

EEA	State and Outlook of Environment 2010 Report; BLOSSOM
ESF	LESC Science Position Paper 2009 http://www.esf.org/fileadmin/links/LESC/Appendix05_LESC_Science_Position_Paper.pdf
ESF/COST	RESCUE Foresight Initiative 2012
ICSU	Scenarios 2031,Strategic Plan (2012-2017) http://www.icsu.org/publications/reports-and-reviews/icsu-foresight-analysis/download-report-1
WBCSD	Vision 2050
WEF	Mining and Metals Scenarios to 2030 (2010)

b. A systematic examination of foresight and horizon scanning databases

EU	EFP Briefs
UK	Horizon Scans – Sigma and Defra
EU	FP7 Farhorizon and iKnow

c. A review of selected national foresights of wider European relevance

Finland : Foresight on long-term climate and energy policy
http://vnk.fi/julkaisut/listaus/julkaisu/fi.jsp?oid=273275

UK: Foresight International Dimensions of Climate Change (2011)
Final Project Report, The Government Office for Science, London

Sweden : Policy Brief on Metals in Low Carbon Economy
Swedish Environment Institute

The Netherlands: Rare Earth Elements and Strategic Mineral Policy,
The Hague Centre for Strategic Studies and TNO, Report No 2010-02
Authors: Jaako Koroshy, Rem Korteweg and Marjolein de Ridder.

Part 1: Review of FLAs

2. Overview of the FLAs

The review of FLAs provides a deliberately diverse range of activities, yet the outputs and content converge to provide a number of common insights. It is however important to highlight

at the outset that the report is not comparing similar processes and/or products. Indeed, the FLAs vary in terms of :

- *Scope*, with some activities having a full focus on climate action and/or resource effficiency and raw materials, while in others there is a partial focus on one or all of these themes
- *Content*, with a mix of forward-looking and strategy documents.
- *End results,* with some activities developing scenarios, a vision, a set of recommendations or specific actions (or some mix of these).

The scenarios, visions and forward-looking strategies generally tend to reflect, as one would expect, the profile and remit of the organisation commissioning the FLA. For the activities under review, there were in some cases a stronger emphasis on a particular aspect(s) of concern, including international science, business opportunities, international cooperation and governance depending on the organisation profile and the thematic focus of the activity.

3. The Analysis

In the review of activities in the area of climate action in particular, the key impression is one of a dichotomy of *certainties and uncertainties* (or levels of certainty and uncertainty) in current and future trends and drivers. Indeed the prospects and outlook for climate and environment are mixed, with growing vulnerabilities counterbalanced by an enhanced potential for improving the resilience to pre-empt and combat risks. On the one hand, there is a level of certainty that population growth and continuation on current paths of growth and development if unchecked, will contribute to growth in industry and urbanisation and lead to accelerated rates of deterioration in ecosystems and quality of life. On the other hand, the degree and extent of uncertainty has in recent years become more pronounced, with unstable governance systems and the onset of economic, financial, political and social crises which impact significantly on the global response to the climate challenge.

The certainty of a relatively stable climate over the last 10000 years, is now in question[4], with increasing levels of greenhouse gas emissions and global warming. More importantly it is evident that there is a growing incidence of extreme weather events, ranging from floods and tsunamis to heatwaves and droughts. Indeed, several studies express concern at the increased uncertainty due to unprecedented change and complexity, and the spread of risk and vulnerability round the world as a result of growing interconnectedness. "Sudden breakdowns in one area or geographical region can transmit large-scale failures through a whole network of economies, via contagion, feedbacks and other amplifications".[5]

Another dimension of uncertainty is tied to the targeting of research and innovation investments and outcomes in this area, including smart specialistion in niche areas, together with the

[4] EEA State of the Environment and Outlook Report 2010

[5] EEA The European Environment - State and Outlook 2010

scientific uncertainty relating to climate research and the unforeseen impacts of new technologies. The policy and governance dimension, building and managing the interconnection and linkages with other related challenges and the global drivers of change, provide additional insights into the level of complexity involved in identifying the key priorities and the appropriate policies and measures for action. The emphasis on interconnections between the different driving elements internal to the climate challenge, as well as the impacts and pressures of other challenges on the climate challenge emerges strongly in the analysis of FLAs. The cross-challenge linkages are a key factor to contend with and require new approaches - "the interconnectedness of issues such as water, food and energy – relationships that must be considered in an integrated and holistic way, with tradeoffs that must be understood and addressed". [6]

The WEF Rare Minerals and Scenarios 2030 identifies a number of critical uncertainties, relating to drivers which are highly uncertain and can wield tremendous impact. These include geo-economic and geo-political landscape (relating to location of economic power, the role of markets, stability within and between states) together with the economic and environmental outlooks. The depletion of certain resources, in particular, non-renewable resources, is a consequence but will also create impacts, on the negative side potentially leading to conflicts and on the positive side driving innovations in resource efficiency. For example, the fact that low carbon technologies are reliant on rare metals, may hinder large scale deployment of these technologies[7] and slow the transition to the post-carbon economy. The Farhorizon Critical Mineral and Metals Synthesis Report (2011) also highlights the need for the EU to pursue win-win cooperation with developing countries by assisting them to develop resources.

The blurred line between certainty and uncertainty, particularly in the eyes of the public, compounded by the information overload with constant feeds of new information based on research activity and significant findings, together with the way information on current and future prospects is presented, and made public, are one dimension of the complexity of this challenge. The Horizon Scans, in particular the ongoing watch for new information, have potential on the one hand to add to the certainty, yet the implications of the new information and its knock-on effects in related areas, together with questions as to whether and how the new information will be used, can lead to uncertainty over outcomes. Indeed the Horizon Scans highlight the rapid rate at which new trends and drivers (physical and social), together with new insights and understandings, and new approaches worldwide are emerging, and can be tracked and made available. This points to the fact that policy approaches are becoming more prone to redundancy within a shorter space of time and this influences the timeliness of policy approaches and the extent to which they can be based on up to date and reliable information.

Ongoing research updates climate trends and drivers[8] with some key points shown in Box 2 b

Box 2: Climate Trends and Drivers

- Sophisticated simulations predict future warming up to 3 degrees celsius by 2050
- Arctic methane on the up

[6] World Business Council for Sustainable Development – Vision 2050
[7] SEI Policy Brief - Metals in a Low-Carbon Economy: Resource Scarcity, Climate Change and Business in a Finite World
[8] UK Horizon Scans DEFRA

- Release and transboundary impact of persistent organic pollutants due to global warming
- Migration of prodigal plankton species could cause catastrophic effects on the Atlantic food web, fish stocks and fisheries industries
- 'Missing' heat – new research has found that the Earth's deep oceans absorb vast quantities of heat, possibly buffering the short-term warming an increase in greenhouse emissions may have on surface temperatures. Researchers caution that the ocean is not a permanent heat sink and buffering affects are cyclical.
- Dramatic rise in groundwater abstraction contributing to sea level rise
- Temperate climates will prove attractive to mobile invasive species as global temperatures rise
- Ageing population will lead to increase in pharmaceutical residues
- 'Eco-cycology' business encourage consumers to return damaged unused goods

A short review of current relevant climate trends and drivers indicates a broad and diverse range of information, including changes in the natural environment, detection of deterioration in ecosystems, prediction of future changes, emergence of new technologies, as well as the interconnections and cross-impacts with social, demographic, economic and business developments and trends. These need to be monitored, analysed, brought together and assimilated, and then factored in as 'live feeds' into policies and strategies.

This joined-up approach has been adopted by ICSU in its strategic plan[9] which is aimed at strengthening international science, with a view, in particular, to understanding global environmental change. The strategy identifies five Grand Challenges which reflect a 'process' or 'lifecycle' approach, and are based on integrating natural and social sciences and humanities. These are:

1) "Forecasting: improve the usefulness of forecasts of future environmental conditions and their consequences for people.
2) Observing: develop, enhance and integrate the observation systems needed to manage global and regional environmental change.
3) Confining: determine how to anticipate, recognize, avoid and adapt to abrupt global environmental change.
4) Responding: determine what institutional, economic and behavioural changes can enable effective steps towards global sustainability.
5) Innovating: encourage innovation (coupled with sound mechanisms for evaluation) in developing technological, policy and social responses to achieve global sustainability." (ICSU Strategic Plan II, 2012-17 pages 17-18)

[9] ICSU Strategic Plan II, 2012-2017

This certainty-uncertainty dichotomy affects the whole chain from the production of new knowledge, to the way it is presented to policy makers and the public and the way knowledge is translated into new products, processes and services. Forward-looking activities are influenced by and reflect an appreciation of this complexity but further work is needed to develop appropriate tools to cope with the challenge of multi-level interconnected procceses of change, spanning the natural and human/social spheres. Certain FLAs start by distinguishing between the predetermined elements, such as population growth and changing demographics, urbanisation, industrialisation, growing incidence of natural disasters and extreme weather events and depletion of resources, from the uncertainties. These include the instability of infrastructure, border, law and security worldwide especially in already vulnerable regions, the geopolitical and geoeconomic landscape and outlook, the environmental outlook, technological uncertainty, and social disruption and change (lifestyle and consumption patterns). The long-term scales, the impact of tipping points, and inherent structural uncertainty combined with constant flow of new knowledge are key aspects to contend with.

To add to the uncertainty and highlight the potential for major disruptions occurring in future scenarios (particularly over long-term time horizons), the FLAs and horizon scans flag a range of potential disruptions and wild cards. These include resource wars, long-term economic depression worldwide, combined natural and man-made disasters, influx of climate and conflict migrants.The level of uncertainty and the potential for disruption highlight the need for more joined-up policy-making to manage the interconnection between challenges and between challenges and sub-challenges. There is a need to factor in more strongly:

- Challenges on a scale, speed, interconnectedness, and impact that are unprecedented.
- Complexity and cross impacts at different levels from other challenges
- Climate impacts from outside into Europe – risks and consequences.

The review of recommended actions in FLAs highlights the fact that the devil is in the detail and the national and intergovernmental FLAs provide a level of granularity in specifying a set of specific actions to be followed up. These include regulatory and governance measures, follow-up foresight activity, assessment of policy options and impacts:

- foresight for social and environmental innovations
- explore regulatory frameworks to support eco-innovation
- explore introduction of natural resource taxation
- develop information and calculation systems for estimating raw material and waste flows and their environmental impacts
- the role of public procurement in the commercialisation of sustainable technology
- assessment of climate policy from perspective of sustainable development;
- assessment of economic and employment impacts of climate policy; legislative impacts

- innovation in national and local policies to reshape demand patterns
- governance of new technologies, substances and materials
- advanced “cradle to cradle” metals and minerals stewardship, basing decisions about resource use on a product’s footprint along the value chain throughout its life cycle.

Part 2: Relevance for Horizon 2020

In the next section of the Report, the key disruptions are extracted from the analysis and presented, together with themes in Horizon 2020 which require adjustment and/or elaboration as well as missing issues which require attention.

Challenges disruptive to H2020

The review of forward-looking activities and strategy documents, identified a number of challenges which could prove disruptive to the climate action part of Horizon 2020. A shortlist, starting with the challenges considered likely to have the highest impact, is presented below:

Factoring in policy and governance

- The geo-political, geo-economic and social landscape and outlook uncertainty are obvious concerns which may be assumed to remain as constant unstable factors to contend with in Horizon 2020. However the implications of a small change in the context, could have major repercussions, potentially positive or negative, throughout the system. It is recommended that these elements are addressed through relevant research and innovation activity, foresight, awareness-raising and dialogue with business and social partners, in order to improve the robustness of the approach.
- As indicated in the analysis, the level of complexity due to the interconnectedness of challenges (relating to climate) is proceeding on a scale, speed, and impact which is unprecedented. This requires dedicated responses by giving priority to interdisciplinary research and in particular research into complex systems, by connecting individual research efforts and avoiding stand-alone projects, and by linking research and innovation actions more coherently. More importantly the linkages between the climate and related sub- and meta-challenges need to be configured, better understood and addressed in a more systematic way.

Vulnerability and access to resources

- Europe’s vulnerability to external supply shocks could emerge as a core concern in the near future, particularly in times of political, financial, economic and social instability outside Europe and within. The impact of climate change can contribute to this instability due to the impact of extreme events, droughts, pandemics and as a

consequence increased cross-border movement of people. Horizon 2020 needs to give more prominence and attention to this potentially highly disruptive challenge in the resource efficiency and raw materials. There needs to be a greater sense of urgency in gearing Horizon 2020 to address this challenge

- Worldwide access to certain scarce resources if contested or subject to instability and conflict in future, could have detrimental effects on the development and production of low carbon technologies. This needs to be given priority attention in H2020, since the EU drive to effect a transition to the post-carbon economy is dependent on certain rare metals and resources and progress could therefore be hampered/delayed.

Coping with risks, complexity and uncertainty

- The uncertainty (or certainty) surrounding climate research could emerge in time as a more disruptive factor, due to growing complexity in the field, and this could affect the extent to which the results of this research are accepted and used as the basis for policy and action. Efforts to strengthen the science-policy and science-society interface could help in this respect.

- The increasing effects and impacts of climate change, both in Europe and worldwide, if enhanced, can engender significant risks to European industry and business and our quality of life. Indeed climate change needs to be considered as potentially a risk multiplier and more attention needs to be given to safeguarding EU business and security interests from a range of risks which could be caused by climate change.

Adjustments to H2020 Themes

In comparing the Horizon 2020 themes with those identified in the Forward-looking activities, certain themes are mentioned in H2020 but are not framed in a comprehensive way and/or addressed in sufficient detail. It is important to note that the documents reviewed vary in their level of granularity, with national strategies and policy briefs generally tending to go into more detail than international vision and scenario reports. However, it is useful to give an indication of possible other ways of re-framing issues and provide a level of detail which could assist the re-framing. Once again the more important theme adjustments have been discussed first in the list which follows:

Enhancing the people dimension and transdisciplinary research

- The research agenda as currently elaborated in Horizon 2020, continues to reflect a primarily natural sciences emphasis, with the selection, presentation and treatment of themes based on natural science disciplines. Whilst the strengthening of individual disciplines relevant to climate research is important, there needs to be a stronger effort to develop cross-disciplinary approaches as well as addressing the whole policy cycle. In general, there is a need in H2020 to re-frame global climate and environmental change issues fundamentally as social and human challenges, rather than solely as physical

environmental issues.[10] The 'people' dimension needs to emerge more strongly in addressing the societal challenges in H2020.

- H2020 is well-positioned to spearhead a more proactive policy aimed at strengthening the European research and innovation framework for tackling climate change by building a sound common foundation for interdisciplinary or transdisciplinary research (natural, human and social sciences). This is implied in the H2020 objectives and approach, and work is underway to promote RD4SD[11]. However it would be useful if this goal is specified and appropriate mechanisms and incentives are put in place, to encourage this and take it forward.

Towards more joined-up approaches

- While there is reference to the international dimension of climate change in H2020, the range of potential international impacts needs to be elaborated together with the interconnection with other policy areas. These relate to among others, increased migration due to harsh climate conditions and/or extreme events, the disruption of business and trade links and diplomatic relations, and security (access to critical infrastructures including ports and research facilities).[12]

- H2020 could benefit from a shift to a process approach in its design, reflecting comprehensive and balanced attention to different aspects of the policy cycle from forward looking activities (including horizon scanning, forecasting and foresight) to observation, confining, policy responses and innovative action.

- The climate action and resource efficiency themes in H2020 need to connect more clearly with a range of sectoral policy domains in order that there can be a comprehensive and coherent integration of environmental considerations therein. Particularly important are the cross-sectoral themes and those areas which could fall in the gaps between sectors.

Links to industry and policy

- While H2020 addresses the theme of eco-innovation and social innovation, the proposed approach for stimulating both needs to be further elaborated and there needs to be a stronger emphasis on stimulating the use of demand-side policies and measures at European, national, local and organisational level to address climate change. In particular the use of innovative public procurement and other innovation-friendly instruments needs to be given priority in EU projects and initiatives. The review of FLAs indicates that certain member states including Finland and UK are leading in this respect and could be

[10] ESF/COST - RESCUE Foresight Initiative 2012

[11] RD4SD (Research and Development for Sustainable Development) Expert Group Report and FP7 Project entitled Vision RD4SD

[12] Foresight International Dimensions of Climate Change (2011)
Final Project Report, The Government Office for Science, London

used as references for EU-wide policies and to promote mutual learning between member states.

- In addressing the climate change challenge, the science-policy interface is particularly critical, and greater attention needs to be given in H2020 to encourage initiatives and projects to address this dimension in a more robust way by designing the work plan and related measures accordingly.

Important Issues Missing in H2020

In this final section, attention turns to major gaps/omissions in the Horizon 2020 design and approach, as currently formulated. The first set of concerns relate to the meta approach and the broader links with other grand societal challenges, and the need to enhance the profile, ambition and thereby the impact of the H2020 programme. The second set of issues relate to ways of capitalising on investments in H2020 projects by ensuring more effective use of the results for policy development and in developing new projects and initiatives. The third set of concerns relate to the means for ensuring more effective implementation. All three are considered important and require an appropriate investment of resources.

The meta approach

- The H2020 Climate Action challenge as currently defined, reflects primary emphasis on a set of stand-alone themes and greater effort needs to be invested in defining the meta-framework and approach, i.e. how the climate challenge interfaces and connects with other grand societal challenges, e.g. health, security, ICT, among others. There needs to be more attention given to processes to explore, allow and support cross-challenge integration. Climate change risks/threats and opportunities need to be addressed in conjunction with other threats across the wider policy spectrum. As noted in a recent report to ERAB, this may require major re-thinking in governance structures. "Generally the challenges are of a highly complex systemic nature crossing a range of different policy areas…. A challenge therefore almost always faces fragmentation of policy making. Overcoming these problems at national and international levels requires deep and often difficult changes in governance."[13] This aspect needs to be clearly elaborated in H2020 and the interconnections defined and addressed.

- Several forward-looking studies point to the fact that climate change impacts from outside Europe are likely to have as significant consequences as direct impacts of climate change orginating from within Europe. Recognition of these dual aspects of climate change need to be factored into H2020 in order that appropriate attention is given to both aspects in H2020 initiatives as well as to how they interconnect and the likely consequences.

[13] EC DG RTD Study to assist the European Research Area 'Board: Investing in Research and Innovation for Grand Challenges, Joint Institute for Innovation Policy January 2012 Authors: Jos Leijten, Maurits Butter, Johanna Kohl, Miriam Leis and Daniel Gehrt

- Increasingly 'soft' aspects such as values and beliefs which influence human behaviour towards the environment, climate and scarce resources, are being recognised as key determinants of human impacts on climate change. H2020 needs to factor in ethics, culture, religion and human rights as important drivers of climate change. This links to the previous point recommending a stronger core emphasis on the people dimension in H2020. It is important that these soft aspects are not addressed solely through add-on requirement to projects but are given more serious attention.

Capitalising more effectively on investments in H2020 projects

- Previous experience with the Framework Programme reflects a multitude of diverse largely stand-alone initiatives and projects. In order to develop a more coherent picture of climate change developments and to capitalise on the use of results across projects , it is important to create a framework for contextualising research activity and to avoid the development of silos and work in isolation. Apart from clustering projects, there is a need to build working links between projects by redesigning the way projects are implemented in H2020.

- It is important that information and results developed through the climate change and resource efficiency projects in H2020 are oriented to feed into a dynamic, adaptive and integrated information and decision-support system on climate change issues.[14] This can be used as reference for EU and member state policies and for H2020 projects.

- The outreach to a wider audience of policy-makers, researchers (mature and young), schools, local communities needs to be given higher priority. This requires stronger core efforts to make public and accessible the research results of H2020 projects. This can be done by using internet and social networking tools to create awareness, facilitate contacts to this knowledge base for different audiences.

Ensuring effective implementation

- Several FLAs demonstrate and highlight the need for ongoing investments in foresight in the area of climate change – not only at the design phase of H2020 but also over its lifetime as disruptions in the context, new feeds of information and research results and new technologies may require a re-thinking of approaches and the need to consult with stakeholders to create awareness of new opportunities or threats. It is important that foresight is factored into H2020 as an ongoing activity addressing in particular opportunities for social and environmental innovations

- It is important that forecasting and modelling activity in the area of climate change is appropriately supplemented with participatory approaches.

[14] Recommendation of the ESF/COST - RESCUE Foresight Initiative 2012

Concluding Remarks

This Report has identified salient themes and issues emerging from FLAs in the area under review as a means for informing the expanding focus of Horizon 2020, in terms of the scope, rationale and positioning and also in terms of the robustness to disruptions, the interconnection with other challenges, and the governance and implementation details. The reframing of climate issues, to give a more central role to the human dimension, and to factor in the international dimension, emerge as key recommendations.

The need for maintaining a watch on key developments (emerging trends and context) and new information (emerging from research and innovation) needs to be accepted as an ongoing commitment. Analysing the information and understanding its significance for policy and action, requires investment in ongoing foresight activity tailored to specific policy needs, and involving different configurations of stakeholders. An inbuilt process approach, which addresses horizon scanning, policy development, action, research and innovation and evalution, is particularly recommended.

Annex 1: Short Reviews of the FLAs

This section features relevant extracts from the select list of FLAs, focusing on rationale and key challenges, disruptions and/or wild cards and key results and/or recommended actions.

a. FLAs by European and international agencies

FLA	Rationale and Key Challenges	Disruptions / Wild Cards	Key Results/Recommended Actions
EEA State and Outlook of Environment 2010 Report; BLOSSOM	Unprecedented change, interconnected risks, increased vulnerabilities; fast environmental change leading to new challenges on scale, speed and interconnectedness which is unprecedented. Many of the immediate impacts lie outside Europe's direct influence, they have significant consequences and will create potential risks for the resilience and sustainable development of the European economy and society	Sudden breakdowns in one area or geographical region can transmit large-scale failures through a whole network of economies, via contagion, feedbacks and other amplifications.	Better implementation and further strengthening of current environmental priorities in climate change; nature and biodiversity; natural resource use and waste; environment, health and quality of life. Whilst these remain important priorities, managing the links between them will be paramount. Improving monitoring and enforcement of sectoral and environmental policies will ensure that environmental outcomes are achieved, give regulatory stability and support more effective governance. • Dedicated management of natural capital and ecosystem services. Increasing resource efficiency and resilience emerge as key integrating concepts for dealing with environmental priorities, and for the many sectoral interests that depend on them. • Coherent integration of environmental considerations across the many sectoral policy domains can help increase the efficiency with which natural resources are used and thus help greening the economy by reducing common pressures on the environment that originate from multiple sources and economic activities. Coherence will also lead to broad measures of progress rather than just against individual targets. • Transformation to a green economy that addresses the long‑term viability of natural capital within Europe and reduced dependency on it outside Europe.
ESF Science Position Paper – LESC (Standing Committee for Life, Earth and Environmental sciences) Strategic Science Position Paper: The View Ahead (2009)	Mankind is facing some major challenges related to the natural environment. Atmospheric concentrations of greenhouse gases are increasing, leading to changes in the energy balance of our planet and resultant warming of the climate, the oceans and the Earth's surface. The speed of these processes is such that most ecosystems cannot adapt and major turnovers are to be expected. The present challenge is to mitigate the impacts and to adapt to	Extreme geological events affecting the environment on a very short timescale. Why do some volcanoes yield clear precursory signs in the lead up to an eruption, whereas others erupt without warning? Monitoring our planet will provide constraints to models that could help policy-makers to take action for mitigating natural hazards. Improved understanding of active	Science and society - The development of transdisciplinary approaches, based on an active dialogue with decision-makers and other stakeholders, is not an easy task. Interdisciplinary science is essential to distinguish between the natural variability of elemental cycles and the anthropogenic perturbations of those cycles, as both are part of the Earth system. Similarly, human responses to global change are not simple. Their study requires contributions from natural and physical sciences and social and human sciences. Overall, the extensive knowledge base that scientific research has created should contribute to

	environmental crises on local, regional, and global scales. Efficient strategies have to be found and need to be rapidly implemented.	processes, better dating techniques and proper evaluations of uncertainty will lead to better interpretations of the geological record and, therefore, more precise future provisions.	the development of sustainable responses. Natural, social and human sciences need to improve their ability and capacity to work together so as to respond to the pressing societal and policy needs.
Responses to Environmental and Societal Challenges for our Unstable Earth (RESCUE), ESF Forward Look – ESF-COST 'Frontier of Science' joint initiative. European Science Foundation, Strasbourg (FR) and European Cooperation in Science and Technology, Brussels (BE). ISBN: 978-2-918428-56-5. 60 p.	Many global change issues are by now well identified and to a certain extent individually understood. But it is their multiple combination at local and global levels that brings about a series of major and complex problems. Such complexity cannot be addressed by the traditional disciplinary scientific approach. An integrated knowledge base and a new set of common practices are required to address these issues. The tackling of the global change challenges must also be of wide societal and individual concern. For this to happen, a deeper and more open dialogue, and integrated cooperation between the research community, policy-makers, society and ultimately private individuals are required.	Reframing the way global environmental issues are approached will require new questions, new approaches and new ways of thinking in research. For instance, to re-shape human activities related to environmental change, there is a need to understand the roles of culture, values and behaviour in generating global change. This means analysing how problems and solutions are framed at different levels by different actors. It means examining the interplay between institutions and individuals, and under-standing how these interactions can block or drive societal change. Transforming society will require people to question deeply-held values and assumptions, a process that can be supported by research.	RESCUE proposes an innovative vision of how to support the transitions towards sustainability with education and research, built on an open knowledge system, where knowledge is generated from multiple sources (some of which are scientific) and shared at every stage of its development. Problems are defined by society as a whole, not just by scientists. Changes are required in: • The research framework • Transdisciplinarity and new approaches • The production of knowledge • Education and sustainability learning • Institutions that support the knowledge system Recommendations • Build an institutional framework for an open knowledge system • Re-organise research so disciplines share knowledge and practices, and, from the onset, work together with each other and with stakeholders • Initiate long-term integrated demonstration projects • Develop sustainability education and learning in an innovative, open knowledge system • Respond to the challenges and opportunities created by the internet for an open knowledge system ready for transitions towards sustainability • Create a dynamic, adaptive and integrated information and decision-support system on global change issues.
ICSU (2011). ICSU Foresight Analysis Report 1: International science in 2031 – exploratory scenarios. International Council for Science, Paris	The purpose of this project was to explore how international science might develop over the coming two decades in a changing economic, social, political and environmental context. ICSU has used this foresight process to test its role and mission and to guide long-term strategic choices aimed at strengthening international science for the benefit of society. What will be the key drivers influencing international science in the next 20 years? How can international science collaboration be supported to help science progress and benefit society in the next 20 years?	Economic, political and social developments over the next twenty years represent a major area of uncertainty yet they set the arena for international science. As the world struggles to overcome the global economic crisis, a multi-polar system is emerging. The balance of power is shifting towards the East but we do not know exactly how, or on what time scale, this will affect the established world order. The evolution in the roles of different international players, including non-state actors, remains to be seen. Future directions will be, to a	4 scenarios are developed - the first selected scenario axis is based on the Key Driver: State Sovereignty, Regionalism and Globalism. At one end of this axis, countries have a nationally oriented outlook and they tend to look inward and address issues unilaterally. At the other end, countries have a global outlook and favour international cooperation and problem-solving. The axis has a continuum from 'global' to 'national' outlooks. The second selected axis is based on the Key Driver 'Science and Society'. At one end of this axis, science acts fairly independently from society. At the other end, science is highly engaged with society. The axis represents a continuum from 'engaged' to 'detached'. Scenario 1: The triumph of globalism (global-engaged) Scenario 2: Science supplying national needs (national-engaged) Scenario 3: Science for sale in a global market

		large extent, determined by economic developments, which are highly uncertain. Rapid globalization and increasing interdependence of all aspects of society further complicate the picture.	(global-detached) Scenario 4: Rise of aggressive nationalism (national-detached).
ICSU (2011). ICSU Strategic Plan II, 2012-2017. International Council for Science, Paris.ICSU Strategic Plan	The five grand challenges to be addressed are: 1.Forecasting - improving the usefulness of forecasts of future environmental conditions and their consequences for people 2. Observing: develop, enhance and integrate the observation systems needed to manage global and regional environmental change. 3. Confining: determine how to anticipate, recognize, avoid and adapt to abrupt global environmental change. 4. Responding: determine what institutional, economic and behavioural changes can enable effective steps towards global sustainability. 5. Innovating: encourage innovation (coupled with sound mechanisms for evaluation) in developing technological, policy and social responses to achieve global sustainability. Three major cross-cut ting challenges have emerged: 1.Integrating regional and global activities and bridging the gap to the less developed 2. Integrating disciplinary perspectives 3. Structure–function issues	International governance and policy-making mechanisms are evolving rapidly. At the intergovernmental level, a plethora of new multi-lateral and regional fora have developed as impor tant venues for policy debate. Multi-stakeholder networks are also having an effect on policy making in certain areas. Moreover, ICSU it self is no longer the only body that can justifiably claim to represent the global science community. Many global assessment and research programmes are managed separately: This despite the reality that many global challenges are interdependent. This often reflects a lack of co-ordination in the science policy sphere.	In order to address the Grand Challenges, a major new decadal initiative will be launched. This will build on the existing global change programmes and other relevant activities and will have a particular focus at the regional level. The aim is to deliver the knowledge that is necessary to implement policy and/or technology solutions that can lead to a sustainable future at multiple scales – local to global. 3 main programmes: Research coordination and planning – to organize excellent international interdisciplinary research in selected priority areas of importance to society. Programmes include: Global Earth Observing Systems, Disaster Risk, Ecosystem Change, Exploring New Horizons and Future Directions including New Scientific Horizons and Foresight (to explore future directions for international science and to help ICSU position itself strategically and for members to explore their future international positions). Science and policy - to ensure that science is integrated into policy development and governance at the international and national level and that relevant policies take into account both scientific knowledge and the needs of science. Universality of science - to promote the freedom and responsibilities of scientists and access to data and information as a critical contribution to strengthening the global science community. science education, science-society, capacity for science.
WBCSD Vision 2050	In 2050, some 30% more people (round 9 million) will be living on this planet. For business, the good news is that this growth will deliver billions of new consumers who want homes and cars and television sets. The bad news is that shrinking resources and potentially changing climates will limit the ability of all 9 billion to attain or maintain the consumptive lifestyle commensurate with wealth in today's affluent markets.29 global companies representing 14 industries tackled this dilemma and developed a vision, based on dialogues in 20 countries with companies as well as experts, of a world on-track toward sustainability by 2050. Vision 2050 addresses three	Radical policy and lifestyle changes; Disagreement on values; Unintended consequences of new technologies, new revolutions in nanomaterials and bioengineering. There are many questions about how these new technologies should be managed. The urgent need for solutions to sustainability problems will put tremendous pressure on science for fast development and early release, with all the risks that implies.	The critical Pathway to connect to a sustainable future includes: • Addressing the development needs of billions of people, enabling education and economic empowerment, particularly of women, and developing radically more eco-efficient solutions,lifestyles and behavior • Incorporating cost of externalities, starting with carbon,ecosystem services and water • Doubling of agricultural output without increasing the amount of land or water used • Halting deforestation and increasing yields from plantedforests • Halving carbon emissions worldwide (based on 2005 levels) by 2050, with greenhouse gas emissions peaking around 2020 through a shift to low-carbon energy systems and highly improved demand-side energy efficiency • universal access to lowcarbon mobility • Delivering 4-10fold improvement in the use of resources and materials. For further exploration:

	questions: What does a sustainable world look like? How can we realize it? What are the roles business can play in ensuring more rapid progress toward that world?		1.New business opportunities derived from Vision 2050 for decade ahead. 2.New external relations priorities, derived from a review of business opportunities and an analysis of what is required by government and other stakeholders to realize these business opportunities. 3.New risks to monitor and address, based on the actions of other stakeholders and on critical and pertinent risks from the risks and wild card analysis.
WEF Mining and Metals Scenarios to 2030 (2010)	This FLA is the outcome of a year-long process which brought together over 200 leaders from the private sector, government, academia and international and non-governmental organizations in a strategic dialogue structured by scenario planning methodology to consider the following central question: "How will the environment for the global mining and metals sector look in 2030?" Key aims were to : • stimulate dialogue between the public and private sectors and civil society regarding the future of the mining and metals sector • deepen insight into the complex context in which the sector operates by bringing together multi-disciplinary and multi-stakeholder perspectives • strengthen the mining and metals community by providing a non-threatening context in which diverse stakeholders with conflicting worldviews are encouraged to share their perspectives and develop mutual understanding, and • provide useful tools to improve strategic decision-making, and identify strategies for collaborative action.	Eight critical uncertainties were identified where the range of possible outcomes is wide and their impact on the sector is significant. They have been categorized into four areas: geo-economic landscape, geopolitical landscape, economic outlook and environmental outlook. Will Asia dominate the geo-economic landscape or will economic power be spread across regions? Will cross-border flows be more open or more closed? Will markets be free or controlled? Will the geopolitical landscape be stable or unstable? Will there be ideological convergence or divergence between regions? Will change be more predictably cyclical or more extreme and unpredictable? Will average global GDP grow rapidly or stagnate? Will the response to climate change be decisive and ambitious or reactive and incremental?	3 Main scenarios develop: 1. Green Trade Alliance -In 2030, the world is divided and countries are defined economically by whether or not they belong to the Green Trade Alliance (GTA), to promote "environmental sustainability without compromising competitiveness." GTA countries, including some industrialised, resource-rich and developing countries, have experienced a period of accelerating innovation and lifestyle changes. 2.Rebased Globalism -In 2030, the world is more interconnected, complex and multipolar. Power comes from control of resources as well as possession of capital, with resource-rich countries playing by their own rules. Civil society has gained power. 3. Resource security - In 2030, the era of globalisation is a distant memory as nations prioritise narrow self-interest. They hoard domestic resources, enter cartels based on regional and ideological alliances and resource blocs, and engage in neo-colonialism and import substitution strategies. Further work: Generating strategic options – reflect on collaborative approaches which contribute towards the sustainability of global mining and metals sector. Opportunity for country deep dives using the scenarios for discussions at national and local level)

b. A systematic examination of foresight and horizon scanning databases

FLA	Rationale and Key Challenges	Disruptions / Wild Cards	Key Results/Recommended Actions

EU European Foresight Platform Brief 213 Material Efficiency and Resource Conservation (MaRess) Project - German Foresight	The extraction and exploitation of resources, the associated emissions and the disposal of waste are polluting the environment. A strategy for increasing resource efficiency is increasingly becoming a key priority in national and international politics. The MaRess project aimed at advancing knowledge with respect to central questions of resource conservation, especially the increase of resource efficiency with a focus on material efficiency. Therefore, the most interesting technologies, products and strategies for increasing re-source efficiency were identified in a broad, multi-staged, expert-driven process.	The increasing scarcity of resources and the high and fluctuating prices of raw materials can lead to major economic and social dislocations, combined with a growing risk of conflicts over raw materials. Competitive disadvantages arising from the inefficient use of resources endanger the development of businesses and jobs.	Relevant fields of action proposed include: Cross-sectional technologies and enabling technologies: "Door openers" for resource efficient applications Integrating resource efficiency into product development Consideration of resource efficiency criteria in product development processes Resource efficiency potential of implementing light-weight construction using new materials Resource efficiency potential of high-strength steel Resource efficiency-oriented business models: product-service systems require rethinking Resource efficiency potentials of new forms of "using instead of possessing" in assembly facilities Resource efficiency potential of production on demand The analyses also demonstrate the need to make greater use of or develop suitable arrangements (such as networks) to involve industrial partners at an early stage. Existing networks (MaRess) need to be strengthened and other consortia established (e.g. with a stronger focus on sector-specific topics). Only a few University departments and specialist areas offer programmes in the field of resource efficiency. The setting up of a Virtual Resource University to provide university training from innovation to implementation.
EU European Foresight Platform Brief 181 Breakthrough Technologies to secure the supply of critical minerals and metals in the EU economy	This FLA was part of Farhorizon, an EU FP7 Blue Skies Project aimed at piloting, developing and testing in real situations a foresight methodology designed to bring together key stakeholders to explore longer term challenges and to build a shared vision that could guide the development of the relevant European research agenda. Although essential to many sectors in the EU economy, development of this sector has been neglected due to low commodity prices, rendering the EU dependent on imports. The aims of the exercise were: To identify the key challenges for raw materials supply in Europe; To identify breakthrough technologies or other innovations that could transform the picture, including substitution, new sources, ways to change demand and new applications; and To define in broad terms the research and innovation strategies needed to develop and make use of such technologies. .	Demand for these minerals and metals is likely to increase dramatically from rapidly growing, highly populated, emerging countries, such as China. Strong competition for access to natural resources, including mineral resources vital to any economy, is likely to accelerate further in the coming years with possible severe environmental and social impacts. The EU economy is more than any other exposed to these issues, as it produces very little of the minerals it consumes, and almost none of the critical minerals it needs to develop its green technologies. The creation of a new R&I context in Europe is essential, not only to reduce the EU's dependence on imported minerals and metals, but also to chart the road ahead, to develop a win/ win cooperation with developing countries and to	Policy recommendations were summarised in terms of four necessary Key Actions: Key Action 1: Establish an integrated strategy for the area and support it with continuity of funding. Research in the area needs to be clearly linked to creating the right conditions for successful innovation. Key Action 2: Move from Stop-Go to a lasting approach with three central aspects for a research, technology and innovation programme. Support up to now has been project-based and provided limited support on a stop and go basis, where continuous policies and knowledge development would be necessary. Key Action 3: Increase the flow of trained people. A supply of trained people is a significant constraint. The lack of investment in research and teaching in this area over the past 20 years has depleted the availability of expertise to undertake the necessary research and teaching. Key Action 4: Governance issues are critical. The area goes beyond the competence and capability of individual Member States and is inherently European. Even current European initiatives are dependent on action - rare metals are behind all the proposed Innovation Partnerships. Collaboration beyond Europe is also necessary but a collective voice is more likely to be heard. There are also opportunities to exert a positive influence to halt environmentally damaging or politically dangerous approaches in other parts of the world, notably in

		stimulate EU competitiveness in technology, products and service providers to the global economy	Africa and parts of the CIS. The momentum from the Raw Materials Initiative needs to be carried forward into H2020 and the EU's innovation and wider policies including those in the ACP/EU domain.
UK Horizon Scans Example from Sigma Scan: Dangerous Climate and Tipping Points	Evidence from models, theory and records of past climate indicates that the climate system can change abruptly if it passes so-called 'tipping points' - critical thresholds at which a small change induces a large response in the climate system. Tipping points cannot be quantified as yet however if 'tipping points' are passed, the effects would be virtually irreversible over timescales of hundreds or even thousands of years.	Potential climate tipping points include: • rapid melting of the Greenland Ice Sheet • collapse of the West Antarctic Ice Sheet • abrupt retreat of Arctic summer sea-ice • shut-down of the over-turning circulation in the Atlantic Ocean • dieback of the Amazon rainforest • rapid release of methane from permafrost or 'methane hydrates'. • sudden changes to marine ecosystems resulting from ocean acidification	Inhibitors: International efforts towards mitigating greenhouse gas emissions Development of renewable energy and carbon capture and storage technologies Improvements in the efficiency of energy use derived from fossil fuels Development of low carbon economies Public awareness and support for limiting climate change Aerosol emissions from major volcanic activity

c. A review of selected national foresights of wider European relevance

FLA	Rationale and Key Challenges	Disruptions / Wild Cards	Key Results/Recommended Actions

Government Foresight Report on Long-term Climate and Energy Policy: Towards a Low-carbon Finland 2009	The Report reviews the challenges of long-term climate and energy policy from global and national perspectives. It aims to map out a variety of possible futures and to support preparedness for them by weighing up a number of different lines of action. It includes quantitative targets and sets out concrete guidelines for measures to be taken. Climate change is a challenge to policy both because of its exceptional time span and its scope. Climate change is an issue with major economic, social, political and security dimensions. The severity of impacts is dependent on the adaptive capacity of societies. Building a low carbon society calls for strong and urgent measures at all levels and sectors. The climate perspective needs to be mainstreamed throughout all decision-making and current policies and measures need to be strengthened as well as development of new ones.	In the worst of cases, climate change could even shake the foundations of civilisation. Increasingly subject to extreme and abrupt climate changes - feedback mechanisms in the climate system may accelerate or decelerate warming. There is still uncertainty over some of these feedbacks and they have not been factored into models. Climate policy decisions taken now will have impacts long into the future. There is a need to minimise the risk of extreme, irrevocable and possibly catastrophic changes.	Vision of Low Carbon Finland 2050 - as leader in climate protection it will enhance its international status. The Vision is implemented through targets which are revised based on new scientific information and as international cooperation progresses. A list of measures to promote international cooperation, including efforts to support Europe's leading role in climate policy and transfer of technologies to developing countries. Further work on assessment of the means for reducing green house emissions; scenarios for low carbon and carbon neutral finland; cost-effectiveness of climate policy; how urban structure effects emissions; indirect impacts of climate change transmitted to Finland from rest of the world; a comprehensive estimate of the costs of adaptation; road user charges based on satellite positioning; the role of public procurement in the commercialisation of sustainable technology; development of indicators of sustainable well-being; assessment of climate policy from perspective of sustainable development; assessment of economic and employment impacts of climate policy; legislative impacts.
UK Foresight International Dimensions of Climate Change (2011) Final Project Report, The Government Office for Science, London	The Report addresses 4 key questions: Why are the international dimensions of climate change important for the UK? What are the threats and challenges to the UK from international developments in this warming world? How do the UK's strengths and capabilities help address the challenge of a warming world? How should UK policymakers respond to these threats and opportunities? Challenges identified: International instability could increase as a consequence of climate change. Shifts in the UK's international role and global influence due to geopolitical challenges The financial sector and business may fail to evaluate risks related to climate change Adverse economic impacts could affect overseas resources and infrastructure on which the UK depends. Impacts on global health	The consequences for the UK of climate change occurring in other parts of the world could be as important as climate change directly affecting these shores. Uncertainties in specific areas of climate science, along with the inherent uncertainty of considering the future over several decades, particularly beyond 2040, do not diminish the need for policymakers to take action now. Rather, they imply the need to develop policies which are resilient to future uncertainties by taking a risk-based approach. Acting as a risk multiplier, threats from climate change cannot be treated in isolation, and should be considered alongside threats across the wider policy spectrum.	To address the risks to the UK from climate change impacts overseas, it is crucial that government departments work across existing boundaries between domestic and international policy, and between climate change mitigation and adaptation. ● The long-term nature of climate change combined with the uncertainties that exist in projections(for example, on the pace of change, and regional effects), is acting as a significant barrier to decision-making on climate change policies (and policies affected by climate change) and may lead to inappropriate adaptation or inaction when it is needed most. ● Climate change risks cannot be assessed or treated in isolation from other global threats. The impacts of climate change will need to be factored in across all areas of government policy which have an international dimension. ● While policymakers need to recognise the high degree of uncertainty in climate projections, and future emissions profiles, the challenges of a warming world will arise in one form or another. The uncertainty is not whether the world will experience climate change but how its impacts will be felt. ● There will inevitably be interactions and interdependencies between the impacts of climate change as they develop and the threats and opportunities associated with them. ● Managing the risks associated with climate change will require a high degree of international co-operation. It will be important to strengthen the UK's networks of international influence and to work constructively with business and financial organisations.

Sweden Policy Brief on Metals in Low Carbon Economy Swedish Environment Institute	Low-carbon technologies such as photovoltaics, wind power, and electric and hybrid vehicles are likely to play a key role in climate change mitigation. Yet several of these technologies depend on metals which are becoming scarce and this could hinder large-scale deployment. Most policies treat mineral scarcity as primarily a technological issue, and focus less on the actual supplies.	There is a severe risk of medium- and long-term cumulative supply deficits (CSD) of indium and tellurium; moderate risk of medium-term and severe risk of long-term CSD of neodymium; and limited risk of long-term CSD of cobalt and lithium. Scarce metals production can have significant environmental impacts, which are rarely incorporated into the internal costs of production. However, as environmental regulation becomes stronger and companies seek to reduce their environmental impacts, these trends could further affect the price of scarce materials and the viability of reserves.	Governments view scarcity primarily as a technological issue, and many minerals policies concentrate on technological advancement and environmental sustainability. Such efforts are important, but insufficient, given that our analysis indicates that economic and political risks are likely to significantly contribute to medium- to long-term management difficulties. Governments' long-term strategies should include vigorous efforts to secure mineral supply at the international level through international strategic partnerships (trade agreements, support in international forums, sharing of technology and development aid programmes).
The Netherlands Rare Earth Elements and Strategic Mineral Policy, The Hague Centre for Strategic Studies and TNO, Report No 2010-02 Authors: Jaako Koroshy, Rem Korteweg and Marjolein de Ridder.	The report provides insights into what drives policies on strategic non-fuel mineral resources. Ensuring and safeguarding rare earth metals and other strategic mineral resources is quickly emerging as a strategic policy priority and a number of states are designing and implementing policies aimed at increasing material security. The US, UK and Japan have been selected because these countries are all (a) advanced industrialised economies, which (b) depend on the free global flow of mineral resources for the supply of their economies and (c) have very different policies for strategic non-fuel minerals, both in terms of their strategic concerns and the policy instruments they use.	The analysis shows that the strategic value of non-fuel mineral resources stems from two factors. First, these resources possess properties which make them essential for key applications and technologies in defense, aerospace and green energy technologies. Secondly the supply of these minerals is vulnerable to disruptions. This vulnerability may be due to the absence of a transparent market and limited production or geopolitical tensions associated with the supply or sourcing of these materials from a limited number of countries with a disproportionate share in global production. Domestically-focused initiatives concerning strategic non-fuel minerals are developing today in response to growing resource nationalism in producer states. This creates the risk of a fragmentation of international markets for strategic minerals, which could further fuel security concerns, increase the	Cooperative efforts aimed at an efficient expansion and diversification of the global supply chain should be preferred over narrow policy instruments to establish domestic sources of supply; and should be connected to joint investments in R&D for more frugal resource use, enhanced recycling and the development of effective substitutes.

		potential for geopolitical tensions and inhibit the rapid and efficient expansion of global supplies.	