SYSTEMIC RESEARCH AND INNOVATION IN THE FIELDS OF CLIMATE ACTION, ENVIRONMENT, RESOURCE EFFICIENCY AND RAW MATERIALS

LESSONS FROM PRACTICAL EXPERIENCE

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What to find in this policy brief?

Key messages  2
I  Introduction  4
II  Examples of systemic innovation approaches  6
III  Lessons for future R&I policies in the EU  9

This project has received funding from the European Union’s Seventh Framework Programme for research, technological development and demonstration under grant agreement no 308680.
Key messages

Climate action, environment, resource efficiency and raw materials are priority challenges for the future of the European Union. The EU aims to stimulate systemic research and innovation (R&I) in these areas by bringing them together under one of the seven ‘Societal Challenges’ under the European R&I programme Horizon 2020.

This policy brief discusses the lessons that can be found for future systemic approaches based on 40 case studies from inside and outside the EU. The main findings are that:

I Stimulating innovation at a systemic level can take many different forms. Although only a limited number of cases build on social innovation alone, there are more examples where technological and social innovation go hand in hand.

II There are several examples of systemic R&I approaches that involve the integration of knowledge and expertise from actors who are new to the process, such as citizens and businesses. Bringing together stakeholders from various backgrounds and disciplines often leads to mutual learning and an increased awareness of the wider societal consequences of the solutions being researched.

III Inspiring overarching policy visions and targets, particularly on a regional and local level, can contribute to mobilising stakeholders towards achieving systemic change. Jobs, economic growth and development are some of the concepts that can unite stakeholders, as well as – on a local level – fossil free and self-sufficiency energy targets.

IV Bringing together stakeholders representing different policy fields can help prevent bureaucratic overlaps in the stimulation of R&I, which improves cost-efficiency. This bringing together of stakeholders also helps address inconsistent policy frameworks, subsidies and taxes.

V Integrated tools, such as life cycle management approaches, that show the wider societal benefits of proposed sectoral solutions can provide insights that help to motivate systemic change.

VI Care should be taken to fully exploit the potential of systemic R&I by assuring sufficient monitoring and adequate governance of any approaches that are utilised to encourage it.

RECREATE is a 5-year project running from 2013 to 2018, funded by the European Commission. It is carried out by a consortium consisting of 16 key partners from European research and industry and is led by the Joint Institute for Innovation Policy (JIIP). The overall objective of the project is to support the development of the European Union’s research and innovation funding programme Horizon 2020, with a specific focus on the part Societal Challenge 5: Climate Action, Environment, Resource Efficiency and Raw Materials.

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Dear Reader,

We are very pleased to present you with number five of our RECREATE Policy Briefs. These documents translate the key outcomes of the project into policy-relevant messages. After four Policy Briefs that were dedicated to the Evidence-Based Narratives (EBNs) which we develop in RECREATE, this edition is linked to a different task. More concretely, it summarises the key conclusions of a stocktaking exercise in which we explored R&I policies around the world and at different governance levels that explicitly link the fields of Climate Action, Environment, Resource Efficiency and/or Raw Materials in a systemic way. In other words, we looked for policies and measures which try to group some (or all) of these fields in the same way as so-called “Societal Challenge 5” of the Horizon 2020 programme does.

Some interesting lessons, conclusions and recommendations can be drawn from the 40 cases that we have looked at. One aspect is that often, such systemic R&I approaches include not only different disciplines but also new types of actors, such as citizens and businesses. This is linked to the fact that often these do not only aim at technological innovation but also at social innovation. Hence, we see that there are several dimensions in which research and innovation can be transformed. It goes without saying that there is quite a potential in such new approaches, in multiple ways.

Yet while integrating different fields of research can have a number of benefits, it is of course not a goal in itself. Additionally, and this is a lesson from our very own project as well, one should always be aware that the grouping of R&I fields as it is made in Societal Challenge 5 is also just a small part of a system the limits of which could be widened and reconfigured endlessly. To name just one example, it often turns out quite difficult to separate the four fields mentioned above from the field of Energy (which is not included in Societal Challenge 5). Hence, whether something is really ‘systemic’ always depends on the specific case and could well lead to philosophical debates, which is not what we want to do here, though.

On behalf of the entire RECREATE consortium, we wish you a good read and look forward to your feedback. If you would like to find out more about the project, please visit our website www.recreate-net.eu or send an email to info@recreate-net.eu.

Kind regards,
Robbert Fisher
Project Coordinator
Systemic research and innovation in the fields of climate action, environment, resource efficiency and raw materials

Lessons from practical experience

This policy brief discusses the potential benefits of stimulating integrated and systemic R&I in the fields of climate action, environment, raw materials and resource efficiency based on a total of 40 case studies covering policy and programmes within and outside the EU. Several key lessons are drawn.

I Introduction

Climate change, environment, resource efficiency and raw materials are no longer research areas that can only be addressed from a single discipline perspective. Solutions in these fields contribute to a more sustainable future of the European Union and require integrated research and innovation on a systemic level. This includes exploiting synergies and feedback loops between the areas (Figure 1) as well as integrating within existing and foreseen developments and trends in society. Therefore, one of the ‘Societal Challenges’ that the EU Horizon 2020 Programme aims to address (‘SC 5’) intends to stimulate systemic and integrated solutions in these fields.

RECREATE has examined 40 case studies of integrated approaches to climate change, resources and raw materials in countries inside and outside the European Union (Figure 2). The case studies were selected to reflect the wide variety of approaches that are applied and also on the basis of the availability of empirical evidence regarding success factors and barriers for integration.

Systemic Innovation

“Systemic innovation is understood as innovation that aims at responding to a societal challenge by obtaining a system-wide transformation through affecting the system’s economic, social and environmental dimensions as well their interactions. This implies a trans-disciplinary perspective that integrates technology, business models and economic organisation, finance, governance and regulation as well as skills and social innovation”. (European Commission, Horizon 2020 Work Programme 2016–2017)
### Figure 2: RECREATE Case-Studies for Stimulation of Systemic and Integrated R&I; cases in italics are used in this policy brief

| Case 1 | Climate futures for Tasmania Case Study – Climate Change Adaptation Good practice / Australia |
| Case 11 | Hai Basin Integrated Water and Environment Management Project / China |
| Case 21 | Forward-looking projects of the High-Tech Strategy / Germany |
| Case 31 | Restoring mined sand dunes at KwaZulu-Natal / South Africa |

| Case 2 | Multi-level adaptation to Climate Change Good Practice Case – Great Barrier Reef / Australia |
| Case 12 | National Program to Abate the Climate Change Impacts in the CR / Czech Republic |
| Case 22 | FONA Research for sustainable development / Germany |
| Case 32 | Action Plan for Energy Saving and Efficiency 2008-2012 / Spain |

| Case 3 | Science for a Sustainable Development “SSD” / Belgium |
| Case 13 | ALFA Programme / Czech Republic |
| Case 23 | National Climate Initiative (NCI) / Germany |
| Case 33 | National Adaptation Plan to Climate Change / Spain |

| Case 4 | Flanders in action / Belgium |
| Case 14 | Danish Climate Change Act / Denmark |
| Case 24 | National Mission for Enhanced Energy Efficiency / India |
| Case 34 | Basque Plan to combat Climate Change 2008–2012 / Spain |

| Case 5 | Marshall Plan 2 Green, Wallonia / Belgium |
| Case 15 | Ringkøbing-Skjern Energi 2020 / Denmark |
| Case 25 | The Sustainable Urban Transport Project (SUTP): The example of Pimpri-Chinchwad BRT / India |
| Case 35 | The Energy Strategy 3E2020 / Spain |

| Case 6 | Luz para todos – Universal Access to and Use of Electric Power / Brazil |
| Case 16 | Elaboration of Estonia’s Draft National Climate Change Adaptation Strategy (NAS) and Action Plan / Estonia |
| Case 26 | The National and Local Climate Change Adaptation Plan of Korea / Korea |
| Case 36 | Swedish Research and Innovation Strategy for a Bio-based Economy / Sweden |

| Case 7 | Climate-Smart Development – Integrated Solid Waste Management in Brazil / Brazil |
| Case 17 | Finland’s Climate Change Adaptation Research Programme (ISTO) / Finland |
| Case 27 | Alternative Fuel Bus Fleet in Suceava / Romania |
| Case 37 | Energy Solutions for smart cities and communities: Växjö / Sweden |

| Case 8 | Programme “World Class Mining Companies”/ Chile |
| Case 18 | Regional strategy for climate and energy, Pirkanmaa / Finland |
| Case 28 | Cost- and energy efficient heating systems based on granular biomass pellets / Romania |
| Case 38 | Climate Action Plan / USA |

| Case 9 | New sources for water resources for small and medium-sized mining / Chile |
| Case 19 | National climate change adaptation plan / France |
| Case 29 | National Water Resource Strategy (NWRS2) – Examples of implementation / South Africa |
| Case 39 | Energy Efficiency and Conservation Block Grant (EECBG) Program / USA |

| Case 10 | National S&T Supporting Program / China |
| Case 20 | Programme “Investments in the Future” / France |
| Case 30 | Renewable Energy Independent Power Producer Programme (REIPPPP) / South Africa |
| Case 40 | Green Jobs Strategy and the Energy Plan of Arlington County, Virginia / USA |
II Examples of systemic innovation approaches

Systemic innovation in the fields of climate action, environment, resources and raw materials can be stimulated at various policy levels, varying from national to regional and local level. The following five cases (summarised in Figure 2), illustrate some very different integrated approaches to research and innovation in Germany, Brazil, Belgium, Sweden and Denmark.

2.1 Integration on a national level

Integrating climate action, environment, resources and raw materials research and innovation on a national level can take place under the umbrella of a ‘high-tech strategy’, as the German case illustrates. The common denominator in this case is ‘high-tech’, which helps bringing together interests from various ministries, economic sectors and policy areas.

The National High-Tech Strategy (Germany)²

The High-Tech Strategy was launched in Germany in 2006, and revised in 2014. It shows how horizontal coordination between ministries and vertically between different political levels (federal and regional level) can promote systemic innovations in R&I. It was coordinated by the BMBF (Ministry for Research and Education), 11 different governmental departments (inter alia, the Ministries for Agriculture; Economics and Technology; Environment; Health; Mobility; Research and Education). These groups joined forces to design an integrated strategy for the German government. The strategy can be considered as integrated R&I because it focuses on priority tasks requiring an integrated view on technologies, business models, institutional organisation, lifestyles and skills. The priority tasks encompass inter alia ‘digital economy and society’, ‘sustainable economy and energy’, and ‘intelligent mobility’.

The strategy aims to strengthen innovation in Germany and attract R&I intensive companies to the country. This is supported by a high-level advisory body, the High-Tech Forum, which comprises of 20 high-level representatives from academia, industry and civil society.³ The Forum provides guidance and recommendations for implementing and advancing the High-Tech Strategy, for example in relation to a Green Economy. The High-Tech strategy has also created links between various R&I activities and policy topics across government departments as well as with the German Länder (States; to integrate, where possible, national and subnational research programmes and measures) and with European institutions (e.g. in the context of Horizon2020 or through portals such as “International Cooperation” aimed at creating links to international partners via international cooperation opportunities.

The strategy’s integrated approach has received international recognition as well as broad support from the scientific community and the private sector in Germany. Furthermore, evaluation reports found the strategy to be effective in raising Germany’s position among European innovation regions and in strengthening innovation in Germany among research clusters, e.g. via an increase in the number of patents for innovations filed to the European patent office (e.g. Germany leading with more than 1,000 patented innovations from the electro mobility South-West technology cluster).⁴

National systemic approaches to R&I can vary from implementing integrated high-tech strategies to the application of integrated tools for the analysis of wider systemic benefits of specific sectoral innovations.

A second example of an integrated approach at the national level in an emerging economy is the Brazilian integrated solid waste management strategy. In this case, integration is only aimed for in one sector. The primary instrument in the systemic approach here is the use of life-cycle analysis as an integrated tool to show which broader societal benefits would result from more integrated societal solutions. Life-cycle analysis is part of the National Solid Waste Policy that was implemented in 2010. This approach has already shown a number of successes.
Integrated solid waste management strategy (Brazil)
The current approach to solid waste management in Brazil results in 58 percent of waste going to landfills and the remainder to dumps. The majority of sanitary landfills flare the methane produced by the decaying waste, while open dumps simply allow the methane to vent to the atmosphere. A 2014 World Bank simulation looked at the benefits of an integrated waste management strategy aimed at improved organic waste treatment through innovative anaerobic digestion and composting technologies. This simulation found that at $1–2 billion investment per year through to 2030 in Brazil could result in significant improvements in resource efficiency, 158–315 Mt less CO₂ emissions, 44,000–110,000 jobs created, 2,500–4,900 avoided premature deaths from air pollution and 550,000–1.1 million tons crops saved. These benefits emerged from an integrated life-cycle assessment approach that considers every step in the waste value chain, from generation in the household through to final disposal, and considers what is needed to effectively manage waste as a resource. Such life-cycle assessments are part of the Solid Waste Management Legislation implemented in Brazil in 2010. While the law has not yet gone into full effect, many cities in Brazil have made significant progress on waste management in recent years. Rio de Janeiro has improved its landfills and its recycling rates. Cities such as São Paulo and Curitiba have increased recycling rates and practices, and their laws have helped to pave the way for the national mandate. However, other aspects of the new Brazilian system are preventing the fruits of integrated management approaches from being reaped. In particular the issues of the allocation of costs to the various parties in the reverse logistics system set up still need to be solved.

Figure 3: Waste management in Brazil

2.2 Integration on a regional level
An example of systemic integration on a regional level is the “Marshall Plan Green” in Wallonia, Belgium. Here, a region characterised for many years by high unemployment and increasingly outdated energy-intensive industry was mobilised by a politically driven, integrated green investment strategy.

The ‘Marshall Plan 2’ in Wallonia (Belgium)
In 2009 the so-called “Plan Marshall 2 Vert” – the Green Marshall Plan 2, was implemented. The plan is a regional green investment strategy that also includes investments in climate and resources. Previous sustainable development initiatives in Wallonia (such as the Future Contract since 1999 and the Marshall Plan since 2005) did not result in major shifts towards green investment. After significant gains by the Walloon Green party at the June 2009 regional elections the party used its newly gained power in a coalition government with Socialists and Centre-Democrats to make the 2005 Marshall Plan “green-er”. The new regional government formulated the Green Marshall Plan 2 that was implemented between 2006 and 2009. Sustainable development in a broad sense, including an integrated approach to climate and resources, was underpinned as a cross-cutting aspect of the plan, and was made part of the government’s main socioeconomic strategy. This resulted in public visibility, political support, significant budgets for R&I and high-level administrative monitoring. Other results include a new ‘centre of competitiveness’ for promising environmental technologies, particularly focusing on start-ups, spin-offs, very small enterprises (VSEs) and SMEs in industries in the environmental sector and also on training in professions within these areas of activity. Green business clusters (Eco Construction, Cap 2020, Tweed and Waste) were also set up in Wallonia. In 2016 the European Commission selected Wallonia as one of six European regions to be supported more actively to develop green chemistry, circular economy and biomass projects. This has to counterbalance to the ongoing closures of heavy industry in Wallonia, such as Caterpillar in 2016.

Integrated approaches at a regional level can benefit from green investment strategies.
2.3 Integration on a local level

At the local level, systemic integration of climate and resources R&I can bring together various actors and unleash new inspiration and energy for all stakeholders. Setting an inspiring and ambitious local goal within a limited timeframe, such as becoming a fossil free or self-sufficient energy community is often a focal point of such efforts. The integration efforts are subsequently fine-tuned to optimise achieving this target, as the examples of Växjö in Sweden and Ringkøbing-Skjern in Denmark show.

The SESAC programme in Växjö (Sweden)\textsuperscript{11}

The “Sustainable Energy Systems in Advanced Cities” (SESAC) programme in Växjö takes energy as the basis for an integrated approach to resource efficiency and climate action. It aims to accelerate innovation in renewable energy solutions and advance energy efficiency by integrating various routes for energy supply and demand reduction in new sustainable building concepts. The aim is to make Växjö independent from fossil fuels by 2030, with the help of citizens and businesses. In Växjö the relevant stakeholders are stimulated to work together and integrate different energy-technologies that also reduce emissions and contribute to resource efficiency (e.g. district cooling, high rise wooden houses, district heating supply for the domestic hot water and bioenergy). The knowledge gained from the SESAC programme has led to the establishment of several new green, innovative companies and to an innovative cross-financing model that helps finance new projects and initiatives that contribute to achieving the Växjö 2030 goal. It has also fed into the new local energy plan for the City and has inspired a new way of public tendering that favours the fulfillment of energy performance requirements for buildings. The SESAC programme is part of a wider political aim to green the city that has led to Växjö being called ‘the greenest city in Europe’.\textsuperscript{12}

Energi 2020 (Denmark)

The idea that research and innovation can benefit from tapping into local ideas, innovation potentials and support is also shown in the case of Ringkøbing-Skjern (Denmark). In 2008 the municipal council in this community passed an ambitious integrated planning strategy entitled “Energi 2020”. It combines climate action (i.e. mitigation by CO\textsubscript{2} reduction from non-fossil energies), improvement of resource efficiency (i.e. energy savings in buildings and transportation, utilisation of local bi-products) and substitution of non-renewable raw materials used for energy production (i.e. for wind, sun, hydrogen, and biogas). The overall aim of the strategy is to become self-sufficient in energy production, reliant solely on renewable energy by 2020. The key element of the strategy is its focus on the knowledge and innovation capacities of local actors: local entrepreneurs, scientists, NGOs, local politicians and planners employed in the municipality. As such, most energy projects are driven by local citizens where the municipality supports with network, consultancy and financial support. The plan is highly supported by the local community and by 2015, a degree of self-sufficiency of 56% was reached.\textsuperscript{14}

Local systemic approaches can be promoted by setting inspiring targets that motivate and mobilise a community.

Figure 4: Low energy housing in Växjö, Sweden\textsuperscript{15}
The case studies presented in this paper show that a variety of approaches can be applied to stimulate systemic R&I that integrates climate action, environment, resources and raw materials solutions in a wider societal context. None of these approaches provide a ‘silver bullet’, and the existing merits of single discipline and specialised research approaches in any of these fields should not be neglected. It should also be taken into account that integrated approaches often involve ‘transaction costs’, as they require time and money for stakeholders from various disciplines to get together and understand each other.

Nevertheless, a variety of general lessons for policy makers intending to stimulate systemic and integrated R&I can be learnt from the cases:

- Stimulating innovation at a systemic level can take many different forms. Whereas few cases build on social innovation as such, in some of them technological and social innovation go hand in hand.

- In various cases, systemic R&I approaches involve a process-wise integration of knowledge and expertise of new actors like citizens and business. Bringing together such stakeholders from various backgrounds and disciplines in practice often leads to mutual learning and increased awareness of wider societal consequences of the solutions aimed at.

- Inspiring overarching policy visions and targets, in particular on a regional and local level, can contribute to mobilizing stakeholders for systemic change. Jobs, economic growth, development are some of the concepts that can unite stakeholders, as well as – on a local level – fossil free and self-sufficient energy targets.

- By bringing together stakeholders representing different policy fields, in some cases bureaucratic overlaps in R&I stimulation can be prevented and cost-efficiency of approaches can be improved. This also includes also not consistent policy frameworks, subsidies and taxes.

- Integrated tools that show wider societal benefits of proposed sectoral solutions, such as integrated life cycle management approaches, can provide insights that help to motivate systemic change.

- Care should be taken to fully exploit the potentials of systemic R&I by assuring sufficient monitoring and an adequate governance of such approaches.

With a system-wide transition in Europe and elsewhere still ahead of us, systemic and integrated research and innovation alone cannot provide the one-and-only solution to the societal challenges we are confronted with. However, learning-by-doing and experiments with integration such as the ones examined here can give us an insight into future solutions that will bring about the change that is needed.
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Policy Brief No. 5, February 2017

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Layout
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Berlin, February 2017

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