European Environment Agency

Report of the EEA Scientific Committee seminar on knowledge for sustainability transitions

Copenhagen, 18 May 2016

Acknowledgements

This report is based upon presentations and discussions that took place at a seminar of the European Environment Agency's (EEA) Scientific Committee, held on 18 May 2016 in Copenhagen. Seminar participants included:

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Contents

Key messages from the seminar

What types of knowledge are needed to support sustainability transitions?

Transitions are enormously complex and uncertain processes of societal change. They cannot be managed in a top-down manner. However, supported with diverse, transdisciplinary and co-produced knowledge, societies have opportunities to catalyse and steer transition processes towards long-term sustainability goals. This implies the need for knowledge plurality — embracing diverse disciplinary perspectives alongside lay, local, traditional, institutional, political and ethical knowledge.

Frameworks for understanding transitions and related knowledge needs

During the seminar, several frameworks were proposed for structuring knowledge for transitions:

- The **multi-level perspective** explains (socio-technical) transitions in terms of interactions between niche innovations, the socio-technical regime and the broader economic, political and cultural landscape. By implication, achieving transitions requires knowledge that can influence these three levels and their interactions.
- According to **Mintzberg** (Mintzberg et al., 2005), effective strategies for addressing complex problems rely on three kinds of knowledge: goal-oriented knowledge drawing on visions, targets and cost-benefit calculations; deliberate knowledge, explaining what is feasible or legitimate; and emergent knowledge, based on experimenting and learning.
- O'Brien and Sygna identify **three spheres of transformation**: the practical (behaviours and technical responses); the political (systems and structures); and the personal (beliefs, values, worldviews and paradigms). Changes in the personal sphere have the greatest transformative potential but are also particularly hard to achieve.

Seen against these frameworks, each of the analytical perspectives addressed during the seminar can make useful contributions to the knowledge base for sustainability transitions.

Integrated assessment models

IAMs can provide **powerful messages to policymakers, in particular in clarifying the urgency of action**. They enable researchers to develop environmentally and technologically feasible visions for reconfiguring societal systems, pathways for achieving transitions, associated cost-benefit calculations, and information about trade-offs. In the context of Germany's Energiewende, for example, modelled scenarios have played an indispensable role in supporting the adoption of science-based policy in recent decades. Even ministries have created 'light' scenarios to help identify areas for future policy.

At the same time, **IAMs have a variety of major limitations**. Their inability to reflect or anticipate the role of governance, actors and social interactions, or abrupt technological or behavioural shifts, significantly limits their accuracy. Despite their popularity, there is often a translation gap between the messages from modelling exercises and policy action, perhaps reflecting the fact that factual evidence alone may be insufficient to motivate change in established systems. Scenario-based approaches may also have limitations for developing national transition strategies because they tend to focus attention on technological responses with clearly defined economic costs, and undervalue other important measures.

Socio-technical analysis

Socio-technical analysis of transitions employs largely social scientific and historical approaches to explain how political, social and cultural forces obstruct or facilitate systemic change. In terms of providing knowledge for transitions, its value lies particularly in **explaining the feasibility and legitimacy of system innovation, and highlighting the struggles, competition and resistance** inherent in changing technologies, social networks and institutions.

Socio-technical analysis points towards **different types of 'instrumental knowledge' that can help in steering transition processes**. These include information on the internal momentum of niche innovations; techno-economic issues such as price-performance ratios and market share; socio-cognitive issues such as beliefs and visions; and governance aspects such as the reliability of policy and the stability of the existing regime. System innovations and transitions are perceived as very different from 'business as usual', implying the need to extend beyond environmental policy's focus on regulations and price instruments to embrace also a focus on innovation policy.

Socio-ecological analysis

The socio-ecological perspective on transformations to sustainability is particularly valuable in **linking the natural sciences to narratives on values and worldviews**, using conceptual frameworks such as planetary boundaries and the Anthropocene. Transdisciplinary research is seen as essential in bringing the analysis of systems and behaviour in global environmental change research together with social science's focus on experience and culture. Only by combining these perspectives is it possible to determine how to transform at the needed scope, scale, speed and depth; how to transform in a manner that is equitable, ethical and sustainable; how individual change relates to systems change; and where power, politics and human agency fits in.

Transformative activities can be grouped into three domains: practical, political and personal. The EEA focuses its efforts primarily on the political domain, generating knowledge to support changes in rules, regulations and incentives. However, it is important to recognise that major sustainability issues such as climate change are not merely technical but also adaptive challenges. Addressing **values, beliefs and worldviews is essential for achieving sustainability transformations and may exert greater leverage** on system change than activities focusing on the practical and political domains. For example, the successes in Germany's Energiewende owe much to the emergence of a cross-party consensus and the support of 80% of the population. Similarly, changing values are an important aspect of Norway's electric vehicle success story. It is **therefore important to consider how the EEA can connect better to the personal sphere**.

Practice-based knowledge

Practice-based knowledge can contribute in several important ways to supporting sustainability transitions. For example, case studies can:

- **Provide evidence about what works and what does not**, based on analysis of initiatives and experiments at the micro scale. For example, comparative studies could be particularly useful in analysing the role of public policy and regulations in hindering or supporting innovation and transition processes.

- **Illustrate and communicate difficult and abstract transitions concepts** in ways that non-experts can readily understand. For example, the Norwegian electrical vehicle case example illustrated many important themes from transitions theory, including the role of policymakers in creating niches for innovation and stimulating transitions; the importance of a policy mix rather than a single measure; the potential for radical innovations to have unintended consequences (e.g. impacts on values); the trade-offs inherent in systemic change (e.g. distributional impacts); and the lack of a single 'silver bullet' technological solution.
- **Engage people's feelings and influence their beliefs and values**. The sociologist Robert Putnam, for example, has greatly increased the impact of his work by breaking with the neutral and impersonal tone of much social scientific analysis and making it intensely personal. Motivating action requires a good story and the power of case studies to engage people emotionally has been significantly underestimated and undervalued.

Scientists clearly face important challenges in developing practice-based knowledge, notably the **difficulty handling and interpreting large amounts of qualitative and quantitative data, and risks inherent in attempts to generalise from individual case studies**. Such concerns are legitimate and point to the need for frameworks and processes to assess experiments and learn from them. At the same time, if scientific rigour is pushed too far it risks dismissing what practice-based knowledge can offer. Although randomised control cannot be achieved in the same way as in the natural sciences, **policy-relevant messages can be extracted from comparisons of case studies**.

The mass of **new knowledge emerging in cities** provides a potentially rich source of practice-based knowledge to support transitions**.** Indeed, cities themselves are increasingly being recognised as knowledge innovators, with the potential to reconfigure core systems rapidly. Projects such as ARTS provide lots of interesting lessons about transitions and their governance, for example showing how initiatives can be expanded or replicated; the role of ICT platforms and networks in supporting scaling; the importance of funding from the EU and other sources; and the value of particular local government personnel and support mechanisms. A planned database listing initiatives and lessons learned from FP7 projects such as PATHWAYS, TESS and ARTS could provide a valuable resource for the EEA as it seeks to develop practice-based knowledge.

What role should the EEA have in creating knowledge for transitions?

Possible roles for the EEA

During his opening remarks, Hans Bruyninckx proposed four potential roles for the EEA in supporting transitions and related knowledge development:

- **convenor** of actors from different research and governance communities to facilitate the integration of different forms of knowledge;
- **translator** across disciplines and from complex scientific theory into the language of policy;
- **networker**, helping to link transition initiatives and research projects and thereby helping scale local practices;
- **analyst** of specific topics of particular importance for transition processes.

Many of the subsequent suggestions for the EEA's role in creating knowledge for transitions corresponded to one or more of those categories:

- The EEA has an important **leadership role**, particularly in terms of framing sustainability issues and creating spaces for research and policy to connect. In particular, the EEA could provide a **platform function**, bringing together different kinds of actors, including the Organisation for Economic Co-operation and Development the International Energy Agency and national environment ministries.
- The EEA could also seek to connect with and convene **young researchers**, since they are often the scientists least locked in by disciplinary and other conventions, as well as having different consumption patterns and values to previous generations.
- Domain-specific institutions such as the International Energy Agency might be better equipped than the EEA to analyse specific systems in detail and develop **'instrumental' knowledge** to inform system change. However, EEA work on issues such as lock-ins in the energy system and environmental pressures across the European food system suggested that the EEA could have a role in analysing particular aspects of core systems.
- The EEA might be best positioned to focus on '**agenda setting**': framing topics, raising the awareness and understanding of policymakers, and stimulating debate in the European Parliament, the European Commission and national environment ministries.
- At the same time, there is a clear need for translators and aggregators to **synthesise and share multidisciplinary knowledge** and to create **actionable knowledge from grassroots initiatives and experiments**. The EEA could perform exactly that role, intermediating both between science and policy, and among initiatives.
- The findings of EU-funded research projects are often neglected. There is a need for better **knowledge management systems** to ensure that available research (including research generated under Horizon 2020 and its predecessors, as well as 'grey literature' such as EEA reports) is used to the full.
- If reconfiguring its knowledge in a more practice-oriented direction, the EEA could seek to **engage with grassroots initiatives** directly or via projects like ARTS, which have analysed large numbers of case studies and identified policy-relevant lessons. An EEA study providing an overview of the findings of such projects could be valuable.
- Ongoing EEA work with the Eionet also points to the potential for the EEA to **gather practice-based knowledge from its European network** to strengthen its analysis of transitions — both illustrating theory and practice, and potentially motivating action.
- **Diverse forms of knowledge** are needed to support transitions. The EEA could consider developing knowledge on human competencies, social organisation and the ways that different types of information influence individual choices. Another important area is exploring how EU regulations hinder experimentation and diffusion, and how new regulations could promote them.
- In undertaking its analysis, the EEA should recognise **'reasonable evidence', rather than 'certain evidence'**, as the appropriate basis for analysing, assessing and governing transitions.

Priorities for the EEA in coming years

Moving towards a more solutions-oriented knowledge base implies the need to develop new knowledge. However, such adjustments do not imply that established science, focused on the environment's state, trends, drivers and pressures, is now redundant. The **EEA clearly needs to continue its core environmental monitoring and reporting work**, partly because of its legal obligations to do so but also because such knowledge, in combination with foresight, is crucial to support transition processes. For example, raising awareness about the challenges Europe faces can help disrupt dominant societal systems, while the 'horizon scanning and alarm' function of science is crucial for identifying the risks and opportunities inherent in technological innovation.

The EEA also needs to consider how to **target and communicate its knowledge creation**. For the EEA, the political sphere provides the most opportunities for catalysing and steering transformation. However, the EEA should consider how to connect better to the personal sphere, which could imply a need to communicate to different worldviews, using different voices and framings. To maximise its influence, **the EEA should seek to develop knowledge targeted at actors that can change systems**, particularly actors that are not getting much attention. Against those criteria, the city level looks like an excellent focus for knowledge development.

Finally, in **building towards SOER 2020**, the EEA could seek to structure its analysis using the three levels of the multi-level perspective. For example, at the niche level the EEA could explore what is happening, what can be learned and how societies can accelerate change. At the regime level, analysis could explore lock-ins, feedbacks and opportunities to destabilise the dominant system. At the landscape level, EEA analysis of global megatrends and planetary boundaries could draw attention to the unsustainability of prevailing systems of production and consumption, thereby contributing to pressures on the dominant regimes.

In analysing transitions initiatives and their impacts, SOER 2020 could include a systemic assessment of solutions. Such an assessment could not be comprehensive but could provide some initial insights into trade-offs, rebound effects and distributional impacts. SOER 2020 could also seek to emphasise the EEA's role as an **agenda setter and intermediary** — translating and communicating transitions theory and research for policy audiences, and articulating policy demands to science.

1 Background

On 18 May 2016, the European Environment Agency (EEA) Scientific Committee held a seminar on 'knowledge for sustainability transitions' at the EEA headquarters in Copenhagen, Denmark.

Sustainability transitions and new knowledge needs are central themes in the EEA's Multi-Annual Work Programme 2014–2018 (EEA, 2014), which emphasises the systemic nature of Europe's environmental challenges and the need for an expanded knowledge base to respond effectively. These topics are also explored in some detail in the EEA's five-yearly flagship report, *The European environment — state and outlook 2015* (SOER 2015).

Based on a comprehensive review of the European environment's state, trends and outlook, SOER 2015 concluded that if Europe is to achieve its 2050 vision of 'living well within environmental limits' (EU, 2013), it must fundamentally transform its core societal systems, in particular those related to food, energy, mobility and the built environment (EEA, 2015). Moreover, achieving such transitions will require profound changes in dominant practices, policies and thinking, which will in turn demand new knowledge.

As noted in SOER 2015, there are gaps between established monitoring, data and indicators and the knowledge required to support transitions. This is particularly apparent in relation to issues such as planetary boundaries, systemic risks and tipping points, the impacts of global megatrends, and the interrelationships between economic development, environmental change, and human health and well-being.

For the EEA, responding to these gaps will partly require a shift in emphasis, extending knowledge of existing environmental problems to include a greater focus on solutions. This of course begs the question: how can a more solutions-oriented knowledge base be developed and what would it look like?

It has been widely argued that comprehending the systemic challenges that we face and potential pathways towards sustainability will require that knowledge be developed in a more transdisciplinary and co-creative way (e.g. IGBP et al., 2001; ESF-COST, 2011; Future Earth, 2014; Hackmann et al., 2014; Nature, 2015).

These two themes were likewise emphasised in the EEA Scientific Committee's recent note on knowledge for transitions, which stressed the need to 'bring together natural, social and political scientists, economists and legal experts' and 'incorporation of stakeholders throughout the process, in accordance with the principles of co-production' (EEASC, 2015).

The Scientific Committee also echoed SOER 2015's call for a greater use of foresight methods to identify visions and pathways towards sustainability, as well as highlighting the importance of experimentation in knowledge approaches to produce new insights.

Several factors suggest that the EEA may be well positioned to bring together evidence from experiments across Europe, and to develop transdisciplinary, co-creative knowledge to support policy and decision-making. These factors include the EEA's established network of partners across Europe, its thematic (rather than disciplinary) focus, and its role as an intermediary at the science-policy interface.

Yet it is also clear that there exist a variety of barriers to creating and using the needed knowledge — both in general and at the EEA. These include:

- **academic barriers**, for example problems securing funding for transdisciplinary research and in terms of career development;
- **conceptual barriers**, such as problems integrating knowledge grounded in contrasting epistemologies and ontologies;
- **systemic barriers**, such as lock-ins to particular ways of producing and using knowledge (e.g. arising from established educational, organisational or communication practices, or from conflicts of interest linked to funding and employment opportunities);
- **practical barriers**, such as limitations in the necessary skills and resources within institutions to create transdisciplinary, co-created knowledge, or difficulties extracting policy-relevant messages from analysis at very different spatial scales.

These barriers suggest that developing the knowledge to support sustainability transitions will, in some senses, require transitions in knowledge systems — at the EEA and elsewhere.

1.1 Objectives of the seminar

The overarching aim of the seminar was for participants to engage in a discussion on knowledge for transitions, which would help the European Environment Agency (EEA) and its partners in DG Research and Innovation in focusing knowledge developments in this area.

The seminar aimed to explore a number of key questions, including:

- What sorts of knowledge are needed to inform the governance of transitions and transformations (and what sorts of perspectives are currently underrepresented)?
- Bearing in mind the various barriers to transdisciplinarity and co-creation, how should countries seek to develop and use knowledge for transitions?
- What role should the EEA have in creating and communicating knowledge for transitions to inform EU policy?
- How can the EEA best use its specific resources (e.g. a large network, strong links to policy but fairly limited finances and personnel)?
- How can Horizon 2020 support the development of knowledge for transitions?

1.2 Organisation of the seminar

As set out in the agenda (see Annex), the seminar was organised into two sessions.

Session 1, '**evidence from theory**', explored what knowledge could be taken from three scientific perspectives on systemic change: integrated assessment modelling, socio-technical transitions and socio-ecological transformations. It addressed questions such as:

- What types of knowledge does each perspective offer?
- What sorts of spatial and temporal scales does it primarily address?
- Why are transitions so difficult according to each perspective?

- What are the strengths and weaknesses of each perspective in explaining systemic challenges and how transformations might be achieved?
- How effective is each perspective in influencing policy and how could this influence be strengthened?
- In what ways could H2020 support the development of transdisciplinary, co-created knowledge for transitions?

Following presentations and discussions on the three perspectives, the co-chairs mediated a longer discussion addressing the theme of 'scientific knowledge on sustainability transitions – implications for policy and support needs from H2020'.

Session 2, **'evidence from practice'** addressed the knowledge that can be taken from on-the-ground transitions activities and experiments, involving different actors, scales and societal systems. It included three presentations addressing energy sector transitions at the broad systemic scale; grassroots initiatives in urban settings, and largely private-sector led innovation in the mobility sector. The presentations and subsequent discussions addressed issues such as:

- What kind of evidence can be taken from local initiatives that are relevant to knowledge and policy guidance at the European scale?
- To what extent are experiments (e.g. in policy innovation) occurring across Europe?
- (How) is transitions knowledge and analysis contributing to the emergence and development of niche initiatives?
- In what ways is EU policy and funding influencing the emergence and development of niche initiatives?
- How can local practices be expanded, replicated or lifted to higher policy domains?
- In what ways are local niche activities contributing to systemic change and long-term sustainability goals (and is it possible to quantify those systemic effects?)
- What risks and uncertainties are associated with upscaling of niche practices?
- How can H2020 support the development of knowledge (for transitions) deriving from practice?

Following the presentations, a respondent provided some reflections on the diversity of actions under way across Europe, the links between local actions and systemic change, and the implications for creating policy-relevant knowledge. This provided an introduction to the subsequent discussion on 'knowledge from on-the-ground initiatives — implications for policy and support needs from H2020'.

2 Introductory presentations

2.1 Opening remarks by the Chair of the Scientific Committee

Sybille van den Hove, Chair of the EEA Scientific Committee, welcomed participants and gave an introductory presentation addressing the knowledge needed to support sustainability transitions; the need for interdisciplinarity in knowledge development; and the shift towards more systemic perspectives.

She commenced by observing that **the shift towards a new 'science of solutions' did not imply that established science — focused on environmental states, trends, drivers and pressures — was now redundant**. Both sciences were needed, alongside a science that scanned for emerging issues, because transformations would trigger unexpected trade-offs. Technological innovations in particular always brought surprises, so **the 'horizon scanning and alarm' function of science was crucial to identify both risks and opportunities**.

In addressing the question 'how can a more solutions-oriented knowledge base be developed and what would it look like?" it was important to acknowledge that comprehending and addressing systemic issues in core socio-ecological systems would require systemic forms of knowledge. That implied the need for concerted efforts to:

- deliver **transdisciplinary** research;
- develop more holistic approaches to **knowledge and policy**, encompassing both ecosystem and social resilience (EEASC, 2015);
- embrace **knowledge plurality**, bringing together scientific, lay, local, traditional, institutional, political and ethical knowledge;
- go beyond data and knowledge to include a focus on **competencies**.

Globally, vast numbers of innovative solutions were being devised and tested but links between such initiatives were often weak or absent. As a result, activities lacked adequate support; knowledge about what works and what does not was lost; initiatives failed to cross-fertilise and exploit potential synergies; and solutions were not assessed in a systemic manner. Bridging between initiatives was therefore crucial and could be achieved by all sorts of state or non-state actors. Scientific and assessment communities had a special role in undertaking comparative systemic assessment of solutions in the complex social-ecological systems in which they were embedded.

The EEA was shifting from problem-focused integrated environmental assessments towards more solutions-oriented integrated sustainability assessments (as described in the work of Jill Jäger). Integrated sustainability assessments were framed in relation to a long-term vision, enabling greater understanding of options and pathways for transitions.

For the EEA, this shift in assessment approaches implied going beyond knowledge on the state of environmental policies to using more systemic knowledge. It was essential to explore potential solutions with an **experimental, reflexive and adaptive** mind set. That included the need for experimentation in producing and sharing knowledge, including EEA assessments. To contribute knowledge for transitions, scientists needed to adopt a much more reflexive attitude towards their work, to contextualise it, and to share it.

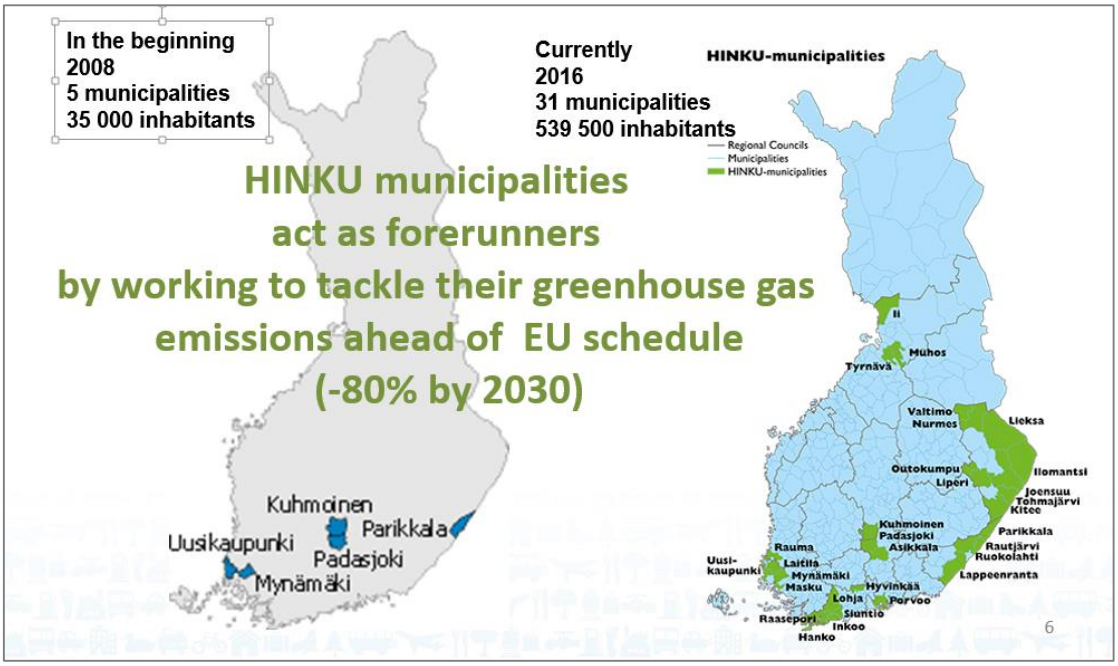
2.2 Knowledge for transitions: some initial reflections

Per Mickwitz, co-chair of the seminar, gave a presentation on 'knowledge for transitions: some initial reflections', which addressed two issues: the knowledge needed to support sustainability transitions; and the EEA's potential role in providing that knowledge.

He explained that, in addressing these issues, he would draw on his experience as a member of the EEA Scientific Committee but also his roles as a research director at the Finnish Environment Institute (SYKE) and as the chair of the Strategic Research Council of Finland. In those roles, he frequently faced the difficult challenge of balancing a focus on long-term visions and goals against the need to produce analysis that was immediately relevant.

Experience in Finland illustrated the **importance of experimentation** for developing solutions-oriented knowledge, but also the need for mechanisms to assess experiments and learn from them. In Finland, a group of 31 'HINKU' municipalities had committed to tackle their greenhouse gas emissions ahead of schedule, targeting an 80% reduction by 2030 (Figure 2.1). An online database enabled the municipalities to share valuable information on the initiatives under way at the municipal level and at smaller scales, including data on emissions reductions and payback periods for investments.

Figure 2.1 HINKU municipalities: vision and experiments



Source: presentation by Per Mickwitz

It was important for the EEA and its network to reflect on the kinds of mechanisms that could be developed at the European scale to support the development and use of actionable knowledge of the sort exemplified by the HINKU case. For example, one area where comparative studies could prove particularly useful was in analysing the **role of public policy and regulations in hindering or supporting innovation and transition processes** more broadly.

Interdisciplinary research was essential for developing the knowledge for transitions but it presented some challenges. Finland's Strategic Research Council distributed EUR 50 million

annually to fund research annually but identifying good projects and assembling appropriate panels to assess proposals was difficult. In contrast, the Council had achieved greater success in financing research that could have an impact. **Central to this success was the requirement that research plans include an 'interaction plan'** aimed at coordinating interactions between researchers and potential users of the knowledge throughout the research process — including co-planning, co-production of knowledge and collaboration after the research had ended.

In concluding, he noted that SOER 2015 stated the need for transitions very clearly and that there was now **a need to create knowledge that could promote and help direct public policy and private activities**. The current workshop provided an opportunity to reflect on what role the EEA should play in creating such knowledge. He suggested four potential challenges of the EEA and the EU for developing knowledge in the 2015–2020 timeframe:

- **sharing knowledge about experiments**, assessments of experiments and frameworks for learning;
- **synthesising and sharing multidisciplinary knowledge** on the sustainability challenges of emerging paths / niches;
- **analysing how EU regulations hindered experimentation and diffusion**, and how new regulations could promote them;
- ensuring that **financing (e.g. under Horizon 2020) was targeted at multidisciplinary research** on relevant topics for transitions, and made use of that research more likely.

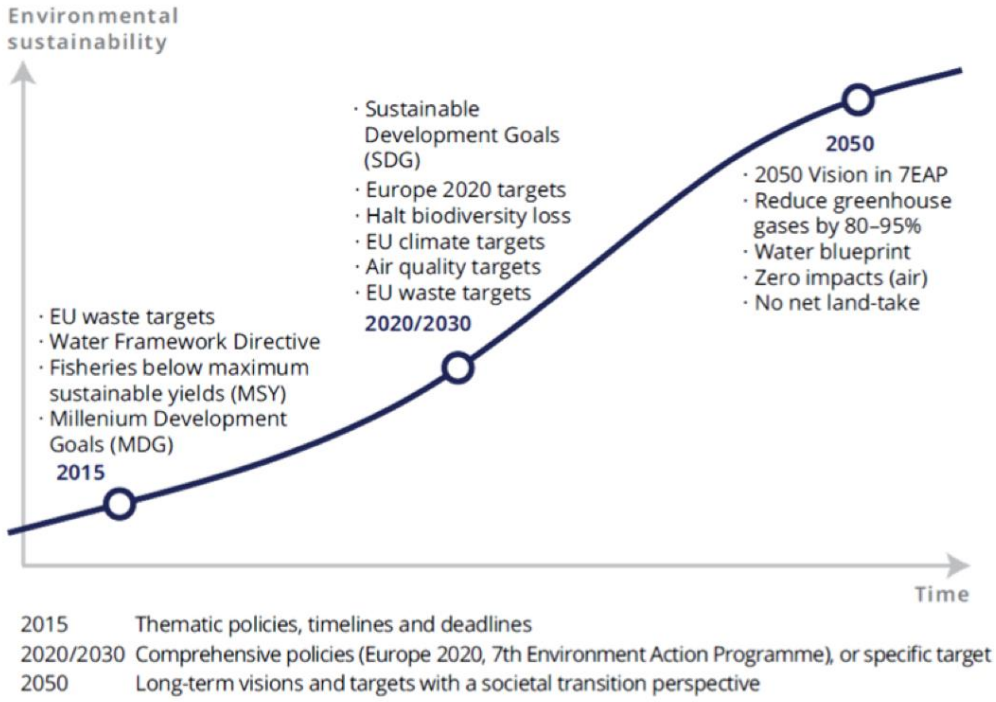
2.3 The EEA, the EU and knowledge for transitions

Hans Bruyninckx, Executive Director of the European Environment Agency and co-chair of the seminar, gave a presentation on 'the EEA, the EU and knowledge for transitions'. He began by setting out Europe's unique policy framework, which provided a long-term perspective, linking actions today to 2050 sustainability targets and visions in 2050 (Figure 2.2). Pursuant to that framing, the EEA reported on day-to-day implementation of the EU's environmental *acquis* but also related its work to Europe's 2020, 2030 and 2050 agendas.

The EEA recognised two themes as being particularly important for comprehending and addressing Europe's long-term sustainability challenges. First, the notion that environmental limits created the boundary conditions within which the societal systems could operate sustainably. Second, the idea that society's activities should be reframed in terms of core systems. The systemic nature of Europe's environmental challenges and the need for new knowledge to support transitions in core societal systems were central themes in the EEA's Multiannual Work Programme 2014–2018.

While the SOER 2015 had provided a compelling account of the environmental and socio-economic challenges that necessitated sustainability transitions, **there was a need for SOER 2020 to shift from a focus on problems to include more on solutions**. That implied exploring the **knowledge, competencies and governance approaches** needed to support transitions.

Figure 2.2 The long-term EU policy context



Source: EEA (2015).

Several factors suggested that the EEA was well positioned to develop transdisciplinary, co-creative knowledge to support transitions. These included its established networks and cooperation, its topic focus and experience working across disciplines, and its role as an intermediary at the science-policy interface. However, the EEA clearly also faced barriers to creating the needed knowledge, including the disciplinary constraints of academic communities, methodological challenges combining different forms of knowledge, and lock-ins to particular routines of generating and using knowledge for decision-making. Those barriers suggested that creating knowledge for transitions would require fundamental changes in knowledge systems.

The EEA's core role as a network organisation at the policy-science interface pointed towards a number of key roles in supporting the development of knowledge for transitions. First, as a **convener** of actors from the different research and governance communities, with the aim of facilitating the integration of different forms of knowledge. Second, as a **translator** both across disciplines and from complex academic theory into the language of policy. Third, as a **networker**, helping in linking or replicating local innovations, or 'scaling up' local practices to higher institutional or policy levels. Fourth, as an **analyst** of specific aspects of systems of particular importance for transition processes.

In keeping with this broad range of potential roles, the EEA was engaged in a variety of activities to develop knowledge for transitions. Those included a report setting out the different academic perspectives on sustainability transitions and transformations; reports on key aspects of transitions (e.g. energy sector lock-ins and the use of foresight in policy); new processes of knowledge development and sharing within the EEA's country network; and research into the implications of planetary boundaries and global megatrends at the European and national levels.

Finally, the EEA had also started building towards SOER 2020, exploring how to frame it, what elements to retain from SOER 2015 and where to innovate. It was hoped that the current seminar would make a significant contribution to that planning work.

Discussion

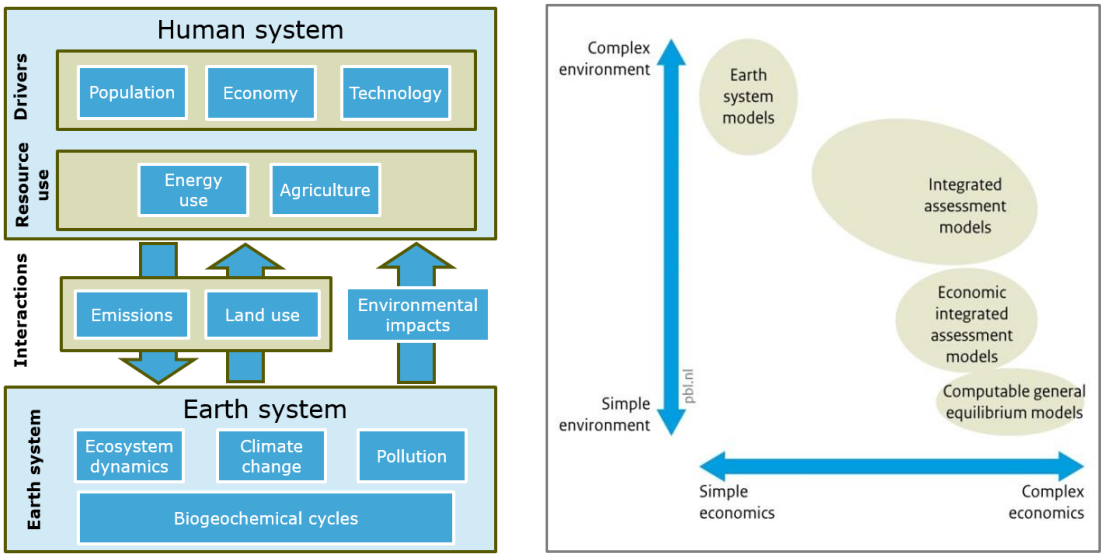
During the discussion, one Scientific Committee member said that the concept of socio-ecological systems deserved careful consideration. Historically, analysis at the EEA and elsewhere had not adequately reflected the social dimension of environmental challenges. Economic analysis framed problems in terms of economic costs and benefits but alternative academic perspectives, such as anthropology, questioned the validity of this framing. **Without an understanding of social organisation of people, it would be hard to grasp the challenges and potential solutions**. Responding, another Committee member suggested that much **more data on the environment's economic value was needed** because it held the key to influencing the decision-making of financial and political institutions around the world.

3 Session 1: Evidence from theory — modelling, transitions and transformations

3.1 Sustainability transitions: the role of quantitative systems modelling

Andries Hof, Netherlands Environmental Assessment Agency (PBL), gave a presentation on integrated assessment models (IAMs), explaining their characteristics, focus, insights and limitations. He explained that IAMs varied in their complexity but shared a focus on three core dimensions: the human system, the earth system, and their interactions (Figure 3.1, left). In combining environmental and socio-economic complexity, they differed from earth system models, which focused on the physical environment; economic integrated assessment models, which calculated the social costs of carbon; and computable general equilibrium models, which focused on welfare and employment effects (Figure 3.1, right). There was often confusion about the different types of models, including in the academic literature.

Figure 3.1 Core characteristics of integrated assessment models (left) and comparison to other types of global models (right)



Source: Van Vuuren (2015)

IAMs focused on long-term and complex sustainability issues, where major transitions were required. For example, an IAM might explore how production and consumption could be organised globally to feed 9 billion people while preserving biodiversity and avoiding dangerous climate change. Such challenges constituted 'wicked problems' — offering no single solution, linked to beliefs and values, and characterised by the inertia, uncertainty and feedbacks inherent in complex systems.

In response to such challenges, **IAMs offered a quantitative, policy-focused approach to mapping out possible futures — indicating difficulties, synergies and trade-offs, as well as exploring uncertainty and the boundaries of possible futures**. For example, IAMs had been used to expose the inertia inherent in the energy system and alternative pathways to creating a sustainable system. They could illustrate the emissions reduction pathways and the peak emission dates required in different world regions in order to achieve climate

change mitigation targets. They could also provide valuable insights into the role of new technologies in influencing the cost and ease of achieving transitions.

In summary, IAMs provided a variety of **valuable insights into transition processes**. For example, they could illustrate the challenges and trade-offs involved in achieving multiple long-term sustainability goals simultaneously; describe potential (technological) pathways towards sustainable systems; and convey the effects of delaying action or the implications of limiting availability of technological options. On the other hand**, IAMs provided limited insights into softer aspects of transitions**, such as the role of **governance, actors, processes and social interactions**.

Discussion

The ensuing discussion focused largely on **opportunities to address the shortcomings of integrated assessment modelling and the influence of IAMs on policy**. The following observations were made:

- Modelling had a high status in the policy world, particularly in supporting the articulation of climate plans and budgets, but it was questionable whether the limitations of modelling in reflecting social interactions and processes could be overcome.
- Although the EEA could benefit from the modelling capacity available, there appeared to be **a translation gap between the messages from the models and policy action**, for example in terms of the expansion of renewable energy technologies in the Netherlands.
- Models had been **unable to anticipate dramatic technological shifts** in the past, such as the impact of mobile phone technology on financial services in Africa. It would be useful to reflect on how modelling could be adapted to address such shifts, in view of the need for societies to achieve radical transitions in coming decades.

Responding, Hof noted that modelling approaches had been criticised in recent times because they had anticipated the use of particular technologies, such as carbon capture and storage (CCS), which had not become widespread. In general, it was not yet clear how IAMs should deal with crucial technologies whose viability was not yet clear. **Behavioural shifts such as dietary change, which could be very influential, were not yet represented in the models**. The usefulness of the results of modelling exercises was also questionable beyond the time horizon of 20–30 years. On the other hand, IAMs could have an important role in assessing environmental impacts, such as potential impacts of biofuel targets on ecosystems or the effect of European policy choices on other world regions.

Hof agreed that there might be a gap in transmitting knowledge from IAMs into policy. He further suggesting that, in **highlighting the technical feasibility of technological change, IAMs potentially sent the wrong message to policymakers** and society more broadly about the challenges ahead. However, local circumstances, such as the availability of cheap fossil fuel resources, were also likely to influence the influence of modelling results on policy.

Summarising, the co-chair noted that models provided particularly powerful messages to policymakers. Those included messages about the urgency of action to address emissions and about the very strong assumptions being made about technological advances, notably CCS. Solid knowledge was essential for influencing policy. In generating such knowledge about core systems, such as energy, it was important that assessment not be confined by national boundaries but extend the focus to broader scales.

3.2 Transitions in socio-technical systems: innovation and technology

Frank Geels, University of Manchester and speaking on behalf of the Sustainability Transitions Reseearch Network (STRN), gave a presentation on transitions in socio-technical systems. He explained that, whereas the preceding presentation on modelling had focused on the cost-efficient pathways from the present to a sustainable future, **socio-technical analysis put greater emphasis on the political, social and cultural barriers on the way**.

Addressing persistent environmental problems required **system innovation**, including changes in technologies but also in social networks and institutions — both regulatory institutions and mind sets and values. It was therefore also about learning, power struggles, societal debates and cultural meanings.

For example, reconfiguring the electricity system would require new technologies such as solar and wind energy but it would also require other changes such as new business models, better energy storage, grid extensions, and demand-side measures such as smart meters. In academia there was a tendency to focus on individual measures but system innovation required that they all be considered concurrently.

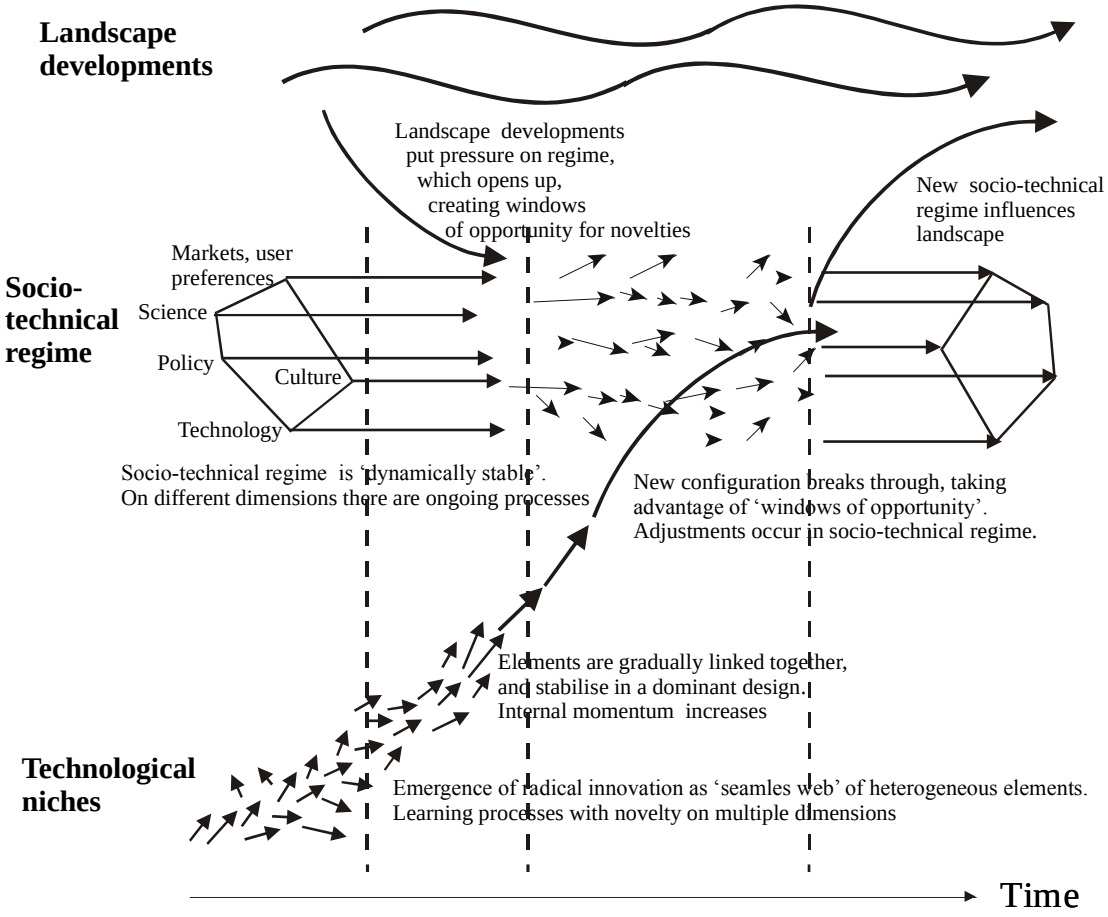
In the mobility system, there was a tendency to focus on alternative power sources, such as new fuels or charging infrastructure, rather than other social and technological innovations such as car sharing and smart ticketing, self-driving cars, modal shift and upgrading of local transport systems in cities. In the built environment, the range of innovations included retrofitting, district heating, smart homes, teleworking or teleshopping or creating compact or smart cities.

The conceptual framework used for socio-technical analysis drew on three kinds of literature, all of them quite sociological in character:

- **Evolutionary economics** challenged the focus on equilibrium inherent in mainstream economics, emphasising instead disruption and clashes between entrants and incumbents, as well as lock-ins to existing regimes, path dependence and sunk investments. Radical changes were often initiated in niches where they were protected from the pressures of the dominant regime.
- **Sociology of innovation** regarded innovation as a social process, involving multiple actors in processes of contest or struggle.
- **Institutional theory** highlighted the ways that formal and informal institutions constrained choices and the power struggle inherent in efforts to change belief systems and mind sets.

The three analytical perspectives were combined in the multi-level perspective (Figure 3.2). The existing system or regime was structured and locked in by user preferences, policies, technologies, cultural norms and so on. Transitions in the socio-technical regime resulted from a combination of pressures from the broader landscape, which could destabilise the regime, and diverse experimentation at the niche level, which occasionally solidified into a dominant design. **Empirical analysis of Europe's core socio-technical systems suggested that there was clear movement in the electricity and mobility systems but limited evidence of transitions so far in the heating and food systems**.

Figure 3.2 The multi-level perspective on transitions



Source: Geels (2002).

Turning to the knowledge needed to support transitions, Geels said that there was a need for much more **reflexive and systemic knowledge**. System innovations and transitions were very different from 'business as usual', implying that knowledge development needed to extend beyond environmental policy's focus on regulations and price instruments to embrace also innovation policy. There was also a need for a high level of political will.

Transition processes were evolutionary, uncertain and non-linear, engaging actors across society, and associated with struggles, competition and resistance. These characteristics meant that **transitions could not be 'managed' in a normal way. However, the development of 'instrumental' knowledge could help in steering transition processes**. Such knowledge could address the internal momentum of niche innovations, focusing on techno-economic dimensions such as price/performance and market share; socio-cognitive issues such as beliefs and visions; and governance aspects such as the reliability and strength of policy. It could also address the stability of the existing regime, focusing on the extent of lock-ins or cracks in the system that might enable change.

Regarding the EEA's potential role in developing knowledge for transitions, he suggested that **the EEA might be best positioned to focus on 'agenda setting'**: framing the topics, raising the awareness and understanding of policymakers, and stimulating debate in the European Parliament, the European Commission and national environment ministries. In addition, the EEA's work on monitoring environmental trends, combined with foresight, could **raise**

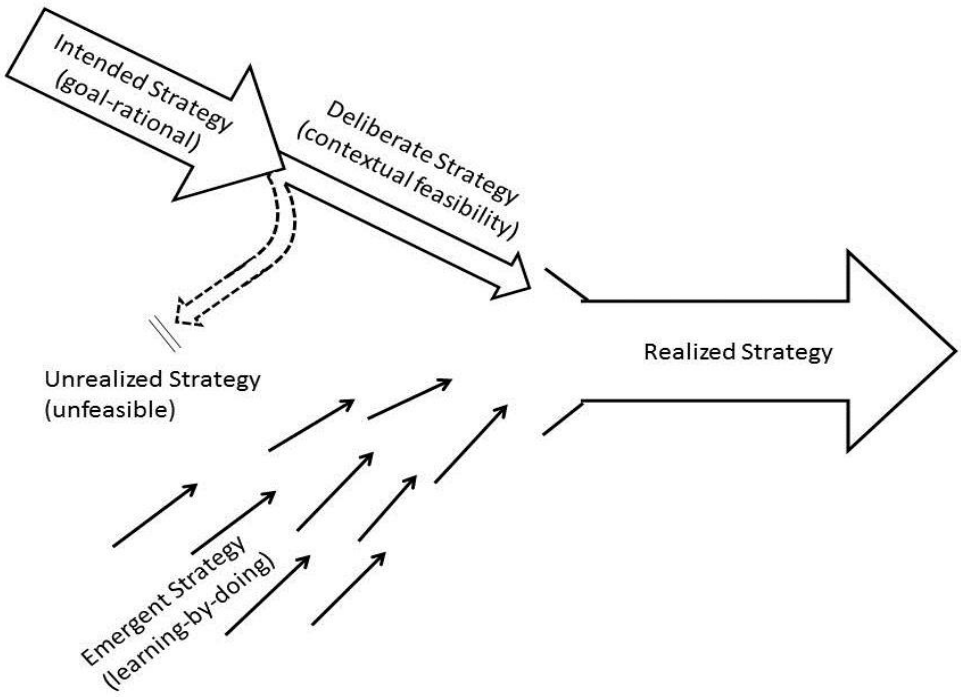
awareness of the need for transitions. In contrast, perhaps **'instrumental knowledge' was best developed by domain-specific institutions**, such as the International Energy Agency, which were better equipped to analyse specific systems in detail.

In building towards SOER 2020, the EEA could initiate its **agenda setting** early in the process and focus on its role as an intermediary. It could provide a **platform function**, convening different kinds of actors, including the OECD, the IEA and national environment ministries. It could help **translate between transitions science and policy**, as it was doing with the ongoing 'transitions knowledge base' project. It could also support knowledge co-production by **articulating policy demands to science**.

In terms of risks and uncertainties, it was important to recognise that failures and dead ends were a major risk for policymakers. In relation to transitions, policymaking should be understood less as top-down 'management' based on targets and cost-benefit analysis, and more as '**goal-oriented modulation**', involving stakeholders, learning and experimentation. Policy needed to be ready to accommodate non-linearity, unexpected outcomes and surprises, such as negative prices in the German energy market. Continuous foresight processes could support flexibility, while on-the-ground projects cold facilitate learning.

Concluding, Geels cited the work of Henry Mintzberg (Figure 3.3), who had argued that in very uncertain, difficult situations effective strategies relied on three kinds of knowledge: **goal-oriented knowledge** drawing on visions, targets and cost-benefits calculation; **deliberate knowledge**, addressing what was politically feasible or legitimate; **emergent knowledge**, based on experimenting and learning what works in practices. Those three types of knowledge helped explicate a variety of policy dilemmas: stability v. flexibility; variety v. focus; work with incumbents v. new entrants; protection v. market selection; waiting for regimes to weaken v. actively destabilising regimes.

Figure 3.3 Governance styles that contribute to effective strategies



Source: Mintzberg et al. (2005)

Discussion

In the ensuing discussion, the following observations were made:

- The presentation resonated with the experience of practitioners in highlighting the need for a more polycentric governance framework. **Social sciences had a key role to play in transformation processes, for example in explaining how political decision-makers can help achieve transitions**.
- The socio-technical analysis suggested instances where regimes had weakened but the incumbents had hidden that reality. As such, the approach could contribute actively to destabilising the regime.
- In Finland, the circular economy concept and the search for new models of economic development had provided a window of opportunity for thinking about issues differently. For example, the prime minister's office has established the 'Experimental Finland' programme of experiments and policy pilots. **Technological and social shifts offered new opportunities to effect system change**. For example, a city bike service in Helsinki had failed a decade ago but had just been relaunched successfully with a mobile service that would have been very complex and expensive to establish until recently.
- History was full of examples of transitions and systemic changes and there was much to be learned from them. The challenge was to understand whether and how such changes could be controlled, and why society persisted in making the same errors and advances.

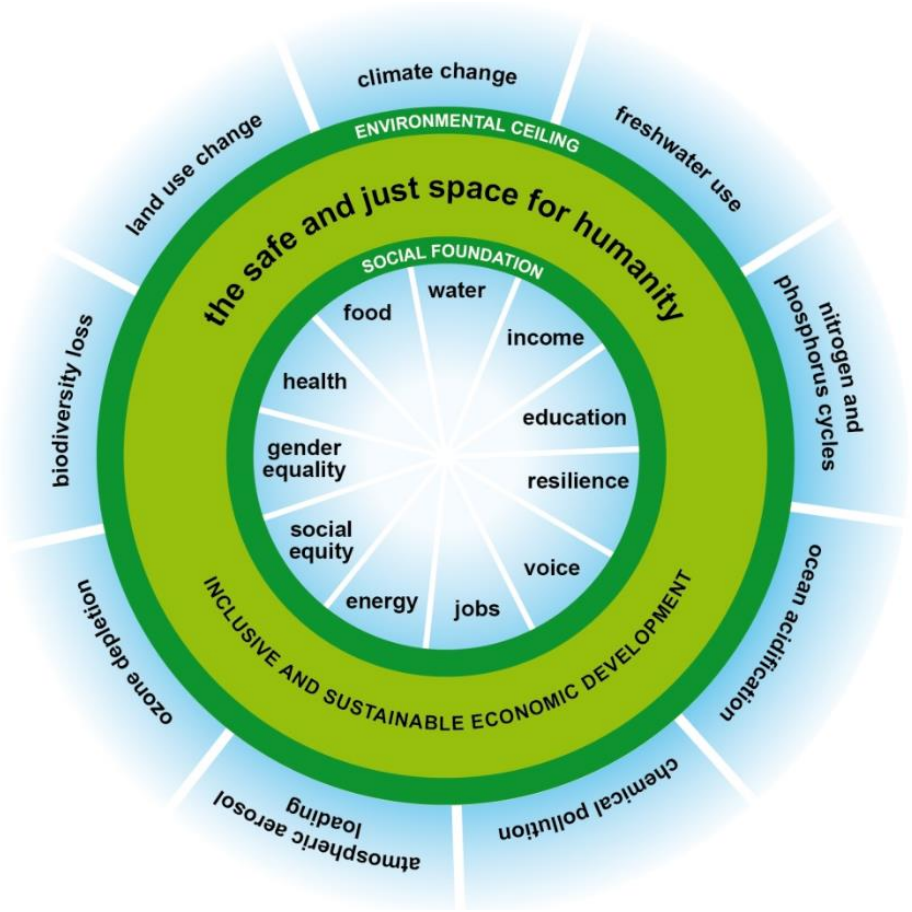
Responding, Geels noted that socio-technical analysis suggested that regimes weakened on multiple dimensions. For example, German energy utilities had underestimated the impacts of new entrants, the financial crisis and the nuclear disaster in Fukushima. He agreed that there was a need to be opportunistic in engaging with political actors and processes, and that there was much to learn from past transitions. Indeed, socio-technical analysis and the multi-level perspective were based on historical case studies. However, in contrast to past transitions, which were created by opportunities, the sustainability transition that were needed today were driven by environmental and socio-economic problems.

3.3 Transformations in socio-ecological systems: adaptation and social change

Karen O'Brien, University of Oslo, gave a presentation on transformations in socio-ecological systems. She recalled that the global environmental change (GEC) community provided the starting point for analysis of socio-ecological systems, particularly in their emphasis on systems thinking and complexity. One valuable contribution from that community was the planetary boundaries concept (Steffen et al., 2015), which provided a useful heuristic conveying environmental limits and humanity's impact on the global ecosystem.

All the discussions at the current seminar were grounded in a recognition that the global community was sure to face huge changes in coming decades — either towards sustainability or in the form of escalating risks. Changes were needed in the next five to ten years that would enable societies to live within planetary boundaries while also securing basic constituents of a good life, such as decent jobs, education and health standards (Figure 3.4).

Figure 3.4 The safe and just space for humanity



Source: Raworth (2012).

Transitions implied a changes from one state to another: from unsustainability to sustainability; from fossil fuel energy to renewable energy; from the high-carbon society to the zero-carbon society; and from inequality and poverty to equity and prosperity.

In the past, the earth systems approach to conceptualising long-term processes of change had emphasised the interdependence of the atmosphere, biosphere and cryosphere, and marginalised the importance of human activities. However, with the emergence of the notion of '**the Anthropocene**', the role of humans as key actors changing the global system had been acknowledged. Correspondingly, the GEC community had sought to reorganise the way that science was done, integrating the natural sciences with social sciences and the humanities. That transition in the knowledge system had not been easy, nor was it complete. But it had already resulted in the creation of a global platform, **Future Earth**, which emphasised integrated research on grand challenges; global partnerships between researchers, funders and users of research; and communication between science and society.

In analysing how to approach change, Heifetz and Laurie (1997) distinguish between **technical problems, which could be diagnosed and solved by knowledge, and adaptive challenges, which centred on beliefs, values, worldviews and paradigms**. Climate change, for example, was not only a technical problem but also as an adaptive challenge.

Adaptive challenges could be identified by several criteria: a persistent gap between aspirations and reality; difficult learning processes (linked to the dynamism, emergence and

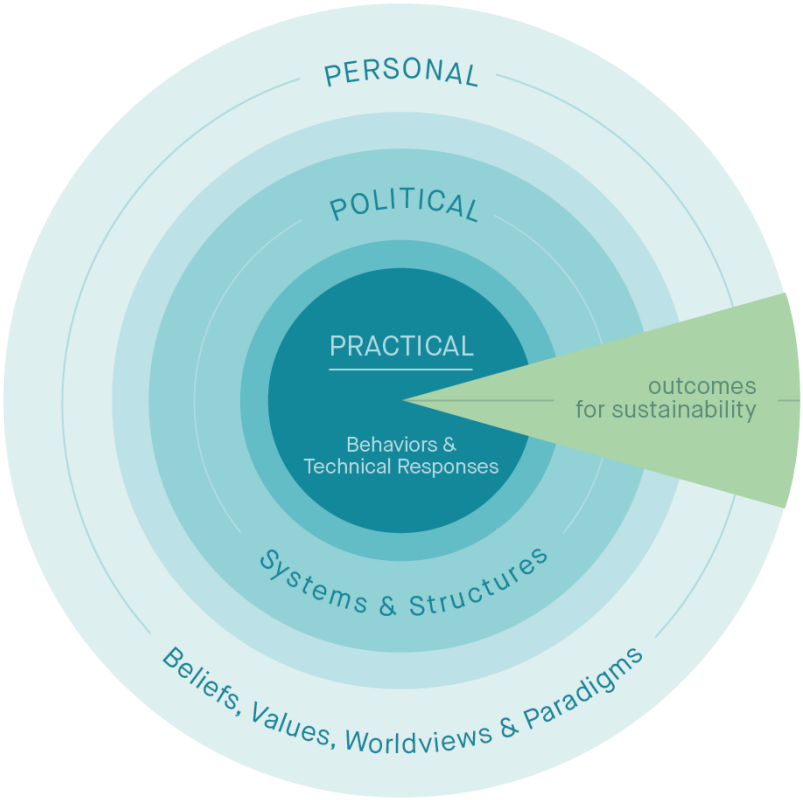
social complexity of the problems); and the need to engage new stakeholders. Engaging with the needed learning processes implied coping with a degree of disequilibrium. But if that distress became excessive then societies tended to treat the issue as a technical problem or to avoid addressing it altogether.

The concept of **'transformation' connoted a physical or qualitative change in form, structure or meaning**. Exploring the idea in more detail raised a number of difficult questions, such as how to transform at the needed scope, scale, speed and depth; how to transform in manner that was equitable, ethical and sustainable; how individual change related to systems change; and where power, politics and human agency fitted in.

Within Future Earth, work under the 'transformations to sustainability' theme aimed to understand transformation processes and options. A major challenge lay in bringing together knowledge on culture, behaviour, experience, systems, which currently remained in distinct silos. Most of GEC research was focused on objective assessments of systems and behaviour, while excluding experience and culture, which were largely the focus of the social sciences. That reality pointed to the need for more integrated research.

Transformative activities could be organised into practical, political and personal spheres (Figure 3.5). In the centre, the practical sphere targeted behaviours and technical responses, via measures such as smart meters and a modal shift from cars to bicycles. Activities in that area were producing some measurable outcomes and results but were not progressing fast enough.

Figure 3.5 Three spheres of transformation



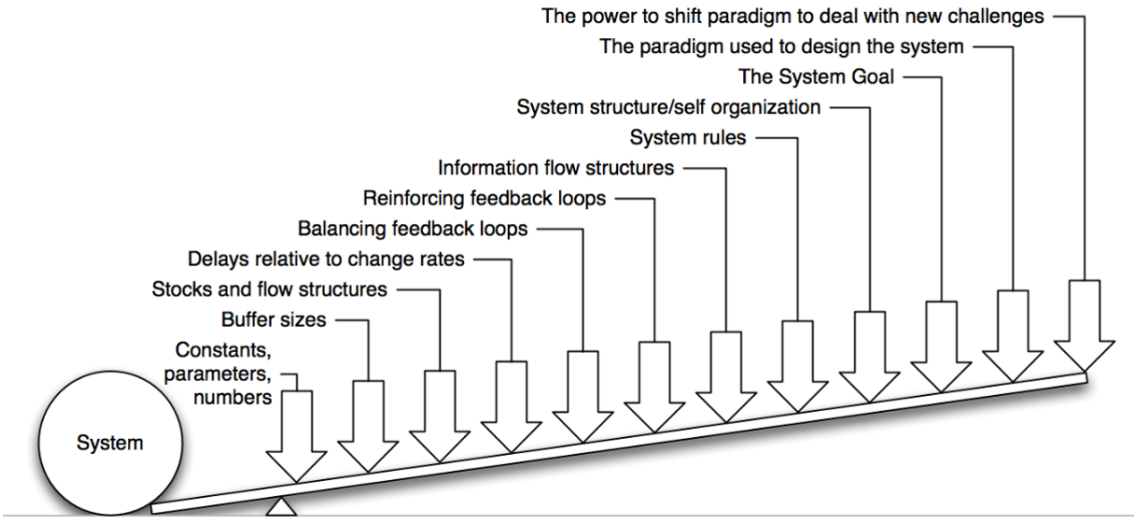
Source: O'Brien and Sygna (2013).

The next layer consisted of political systems and structures, where norms, rules, regulations and incentives facilitated or constrained practical changes. **Much EEA work focused on that layer, seeking to adjust the system structures and thereby create pathways for change**. Established regimes were often resistant to change, however, and saw little need to do so.

The outer layer consisted of the personal sphere, where personal and shared beliefs, values, worldviews and paradigms shaped perceptions of the system. Changing those characteristics could be a significant challenge and could not be addressed as a technical problem. While it was possible to manipulate people, often the right response was simply to acknowledge differences in values.

The three spheres mapped well onto Donella Meadows' '**leverage points for systems change**' (Figure 3.6). In many situations, substantial energy was used on leverage points that have limited influence. Further up were things like information flows but the highest leverage points were in the personal sphere, implying a need to focus more action in that area. For example, conceptual and academic constraints operated in the personal sphere.

Figure 3.6 Leverage points for systems change



Source: Meadows (2008).

The EEA had an important leadership role, particularly in terms of framing sustainability issues and creating spaces for research and policy to connect. It was important that the EEA embrace its role as a leader in this area. In particular, the **EEA could create opportunities for young researchers to come together**, since they were often the scientists least locked in by disciplinary and other conventions.

Transitions were truly important but they could seldom happen without transformations in beliefs and values. Intriguingly, agent-based modelling suggested that a shift in the beliefs of just 10% of a population was a critical tipping point for a change in the social consensus. The key in seeking to create to knowledge for transitions would be to see the issues from new perspectives.

Discussion

In the ensuing discussion, there was widespread agreement that **values, beliefs and worldviews were essential for achieving sustainability transformations**, and that **it was important to consider how the EEA could connect better to the personal sphere**. The following observations were made:

- The presentation had been particularly valuable in emphasising bottom-up activities to achieve transformations.
- It was interesting to reflect on whether investigating transformational change required a **greater focus on initiatives at the micro-scale and how scientists could deal with the mass of data describing such activities**.
- Lock-ins to behaviours, incentives and values in different systems and spheres of transformation were a major obstacle to transformations. Changes in the education system could offer ways to break down these lock-ins and develop new capacities.

Responding to the comments and questions, O'Brien agreed that there was a tendency to prioritise expert knowledge over the responses devised by non-experts. Individuals had agency to influence the systems of which they comprised a part. Their actions were creating new systems and that was something to monitor and assess.

In her view, **the political sphere provided the most opportunities for influencing transformations. Yet there was a need to communicate to different worldviews, using different voices and framings**. Not everyone was conceptual and loved data; some were more interested in narratives and art. **Education had a crucial role to play in shaping beliefs, values and visions but achieving transformations depended on training teachers** and providing them with necessary tools and activities.

Summarising, the co-chair noted that the **socio-ecological perspective played a crucial role in linking the natural sciences (e.g. via planetary boundaries) to narratives on values and worldviews**. The presentation had also illustrated the need for the EEA to avoid simply reinforce prevailing institutions and monitoring processes and achieve more fundamental change in its knowledge development processes.

3.4 Discussion on evidence from theory

Introducing the discussion, the co-chairs noted that Horizon 2020 probably constituted the largest research programme ever and included a core focus on issues such as climate change and sustainability. Calls under the programme increasingly focused on generating integrated, solutions-oriented knowledge. The discussions would therefore address where Horizon 2020 should focus, including issues such as gaps in existing knowledge of transitions, needed research to address those gaps, pitfalls and opportunities in knowledge co-creation. There was also a need to reflect on how to use the knowledge created under Horizon 2020, since studies of previous research programme indicated a poor track record in this area.

Robert Droop from the Netherlands' Ministry of Infrastructure and Environment, provided some reflections as a member of the European Programme Committee for Horizon 2020. He noted that Horizon 2020 fund knowledge development to address policy questions but also in consultation with societal actors. In commissioning research for transitions and transformations, principles such as transdisciplinarity and co-creation were present but

there was a lack of understanding about how to trigger or support such research and about the extent and focus of the knowledge gap. In part, this arose from the short-termism of policymakers, whose focus rarely extended beyond the political horizon of their government. There was also a tendency to approach sustainability challenges from a technological point of view and exclude humanities from research programming, so it was encouraging to hear about increasing interactions among researchers from different disciplinary backgrounds.

Responding the Chair of the Scientific Committee suggested that DG Research was pursuing potentially contradictory objectives. There was a discourse on sustainability and another on growth but limited reflections on how the two related to each other. Creating more actionable research and reinforcing the science-policy interface did not have to be difficult. For example, establishing observatories (e.g. a European observatory on emerging risks and opportunities) could be useful, as well as increased investments in foresight and horizon scanning.

Several speakers reflected on the **need for better knowledge management approaches** to ensure that research was used to the full in informing decision-making. In addition to findings that **research generated under Horizon 2020 and its predecessors was not being used to the full**, there were concerns that '**grey literature**' produced by institutions such as the EEA was being ignored. Online databases such as SCOPUS focused only on peer-reviewed literature and the IPCC had a policy of only using peer-reviewed literature to support its assessments. Moreover, recent work with the Eionet indicated that there was a massive amount of relevant literature at country level that was not being used. These reflections pointed to the **need to consider how the EEA could contribute to better knowledge management**.

There was some discussion on the **need to engage diverse disciplinary approaches in knowledge creation**. The following observations were made on this topic:

- There were compelling arguments for bringing more socio-economic dimensions into EEA analysis but that might require a shift in the Agency's mandate. The Scientific Committee could contribute to that discussion by preparing a piece reflecting on the implications of new knowledge needs.
- The desire to analyse complex problems in a comprehensive, integrated way could stifle research. Instead, what was needed was a diversity of disciplinary perspectives. The co-chair agreed that there was a need for many different types of research, including but not limited to integrated programmes.
- There was a need to anticipate future risks and opportunities, including risks linked to multiple stressors. Creating more solutions-oriented knowledge implied using science in a different way. The EEA's efforts to develop the relationship between the natural and social sciences were therefore very welcome.

One Scientific Committee member recalled that the biomedical field had combined expert elicitation and statistical analysis into a **framework that integrated the perspectives of many researchers into actionable knowledge**. He questioned whether social scientists had tried to develop such frameworks to overcome the challenge that individual pieces of research could be perceived as unrepresentative. In response, the following observations were made:

- There were risks extrapolating from individual case studies but the socio-technical field had by now produced multiple case studies. They illustrated some shared mechanisms across countries, as well as differences in how they combined and played out. Therefore, **although randomised control was not possible in the same way as in the natural sciences, it was possible to extract policy-relevant messages**.
- It was possible to identify patterns based on expert judgments, although perhaps that process could be better organised than currently. The **planetary boundaries framework was one example where contested judgements had been integrated in an effective way**.
- There was a **need for caution in extrapolating from individual cases and even from apparently substantial pools of data**. Social media and other new sources of big data potentially offered insights into behaviour but it was important to recognise that contributors to social media were not representative of society as a whole.
- The natural and social sciences perhaps did not differ as much as sometimes assumed, since both required broad frameworks to bring together different kinds of assessments (e.g. assessments based on pharmacological paradigms or behavioural paradigms in the biomedical field). The EEA was implicitly making choices in singling out particular academic approaches for analysing transitions. Those selections were well matched to the EEA's policy and knowledge agenda.
- There was a need for more knowledge and better formulation of findings to create a sense of urgency and drive action. But there were also many other political grounds for inaction, including vested interests and lobbying.

Summing up, the co-chair observed that the EEA was in a privileged position for creating knowledge for transitions. That was partly because of its direct links to research communities and to actors with authority to shape policy and set targets. It was partly because of the EEA's public and transparent processes for reviewing its outputs. And it was partly due to the EEA's scope to link science, societal needs and policy approaches in producing its assessments.

4 Session 2: Evidence from practice — on-the-ground initiatives and experiments

4.1 A systems perspective: the German energy transformation

Harry Lehmann, German Environment Agency (UBA), gave a presentation on Germany's energy transformation, the 'Energiewende'. He began by noting that one of UBA's central goals was to develop a view of a sustainable Germany and how to get there. The Energiewende was one element of that broader sustainability strategy.

The Energiewende was a continuing process and had a long history in Germany. A look back on the last 40 years suggested that transformation processes were chaotic. In 1973, the first book entitled Energiewende had been published, calling for an end to reliance on nuclear fuel and oil. Since then there had been social and political changes, the emergence of the Green Party, a shift to local ownership of energy infrastructure, and nuclear disasters in Chernobyl and Fukushima. The Energiewende comprised a diverse mixture of activities since the 1970s at all levels, including cities, regions, companies and universities.

Energiewende's success was grounded on cross-party consensus. **The Energiewende had the support of all parties except the far right, and of 80% of the population**. As a result of the discussions over the last 30 years, there was cross-sectoral, cross-party and cross-generational support for the process. Debate focused on issues such as the pace of change and the degree of centralisation. The German government was proud of the Energiewende and **it was important for the programme's success that the population as a whole was likewise proud of what had been achieved** and what would be done in the future.

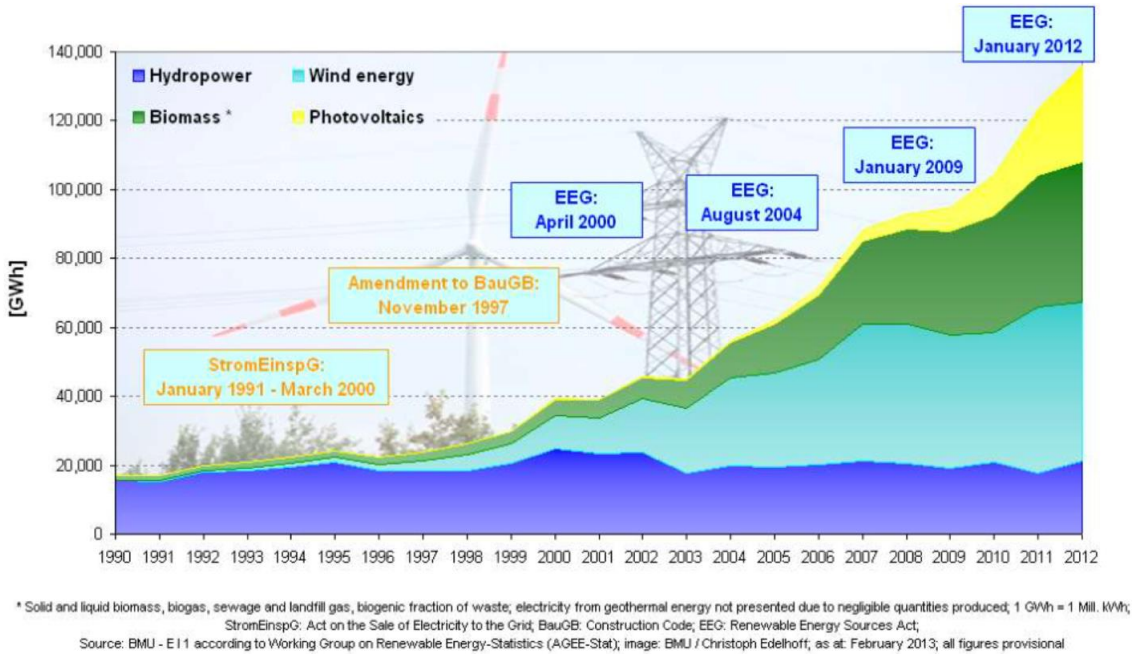
Today, Energiewende was based on three pillars: affordable energy, security of supply, and environmentally sound energy. It was also multidimensional, extending beyond the power sector to embrace many other sectors and policy areas, including households and consumers; agriculture; technology, research and IT; finance and investment; and the EU and international relations.

The Energiewende had been a success story since the 1990s. A stable policy framework had provided the basis for rapid growth in electricity generation from renewable energy sources. The German government had tried to sustain momentum following the adoption of the first global climate change agreement in Paris in December 2015, which necessitated the decarbonisation of all major industries. Since then, Germany had started to collect information from people from across society on their views on the climate to 2050. Those ideas would contribute to Germany's 2050 climate plan.

In negotiating the climate plan 2050, the key question related to the level of ambition. To achieve an 80% reduction in greenhouse gas emissions would require fundamental transformation of the electricity system. A 95% reduction could only be achieved by also addressing other sectors, notably transport, steel and agriculture.

Since the 1980s, Germany had developed lots of scenarios for achieving its energy and climate targets. The **scenarios had supported policy discussions and had been indispensable in supporting the adoption of science-based policy in the last 20–30 years**. Even ministries had created 'light' scenarios, which were used to identify ideas for future policy.

Figure 4.1 Electricity generation from renewable energy sources in Germany, 1990–2012



* Solid and liquid biomass, biogas, sewage and landfill gas, biogenic fraction of waste; electricity from geothermal energy not presented due to negligible quantities produced; 1 GWh = 1 Mill. kWh;
StromEinspG: Act on the Sale of Electricity to the Grid; BauGB: Construction Code; EEG: Renewable Energy Sources Act;
Source: BMU - EI1 according to Working Group on Renewable Energy-Statistics (AGEE-Stat); image: BMU / Christoph Edelhoff; as at: February 2013; all figures provisional

Source: BMU (2013).

UBA was exploring the possibility of creating a greenhouse gas neutral energy system in Germany as a whole. Experience over the last 20 years indicated that problems could only be solved in a solutions framework. **Scenarios could help define policy but there was also a need to investigate lock-ins or technologies where no solutions were yet apparent**.

Creating a greenhouse gas neutral system implied limiting emissions of CO2-equivalents to one tonne per capita. That implied particular challenges in meeting energy needs for air travel, as well as in monitoring progress in the building and transport sectors more broadly.

In conclusion, a combination of core factors contributed to successful transformation processes. These included:

- **engaging all layers of society early in the process**, otherwise societal movement will not happen;
- **creating a knowledge-driven process**, rather than a feeling-driven one;
- improving the **knowledge of teachers and universities**;
- **finding the right message** (for example the concept of energy efficiency did not engage and motivate people but renewable energy did).

History was chaotic and success depended on being prepared to take advantage of **windows of opportunity**. The adoption of the 40% target in Germany and the feed-in tariff for renewables had been spontaneous events. **UBA was now preparing new papers, ideas and integrated scenarios to be ready for the next opportunity**.

Discussion

In the subsequent discussion, Lehmann responded to questions about the volatility of electricity prices in Germany, the pace of progress outside the electricity sector, and the role of finance in the Energiewende.

Regarding electricity pricing, he explained that the very low price of electricity was partly due to the fact that expensive fossil fuel energy producers had been pushed out of the market and competition among the remaining suppliers was reducing prices. In addition, it was cheaper for producers to keep burning lignite continuously, rather than stop and restart the process. That was true even in situations where there was enough renewable energy to cover 80% of electricity demands. The effect was to distort prices on the exchange, so that they had even registered negative prices.

Regarding the transition outside the electricity sector, Germany had achieved notable advances in the building sector. State of the art buildings in 1978 used ten times more energy than their equivalent today. However, those advances in construction techniques were very slow in affecting the building stock as a whole. Owners had limited incentives to upgrade their homes and, historically, only 1% of the housing stock had been retrofitted every year.

Mobility was also a problem in Germany, where big cars were still subsidised. The air transport industry had committed not to increase greenhouse gas emissions after 2022 but increasing demand meant that emissions would increase even if the most efficient planes were used across the sector. Biofuels were not a good option but converting energy to liquid might offer a viable solution, in part because it was compatible with existing infrastructure. Marine transport was another major problem because ships burned extremely toxic fuels.

Regarding finance, the Energiewende had gone through three phases. The first was with the introduction of the feed-in tariff, which was organised to ensure bankability, i.e. so that banks were confident about future cash flows and were therefore willing to extend credit to an anyone seeking to invest in renewable energy technologies. The second phase saw an increase in private investors, who recognised that there were profits to be made. The third saw companies and utilities starting to invest, for example in offshore installations.

4.2 Experiences from grassroots initiatives in European cities

Niki Frantzeskaki, Dutch Research Institute for Transitions (DRIFT), gave a presentation on grassroots initiatives in European cities, drawing in particular on the findings from the FP7 project 'Accelerating and Rescaling Transitions to Sustainability' (ARTS). She said that there were **two reasons for focusing on acceleration**. First, there were **lots of initiatives under way in cities, which meant that a lot of new knowledge was emerging**. Second, the urgency of the challenge was growing ever more apparent, implying that Europe needed to speed up its transformation processes.

Those realities pointed to three basic research questions: 'what are the main mechanisms contributing to acceleration of sustainability transitions in city regions?', 'which strategies can local transition initiatives adopt to facilitate these mechanisms and accelerate transitions?' and 'how do local transition initiatives seek to increase the inclusivity of transitions in city regions?' The presentation focused on the first question and what that might imply for the EEA's work in developing knowledge for transitions.

The ARTS project was based on a cross-case analysis in five green city regions: Brighton, Budapest, Dresden, Genk and Stockholm. In each location, the governance context was mapped, an inventory of transition initiative compiled, a selection of case studies was analysed in more depth, and that was followed by a comparative analysis and modelling. Knowledge co-production and transdisciplinarity were high priorities for ARTS. The project engaged closely with local communities and governments to explore ideas and narratives, bridging science with art and linking to creative groups.

'Local transition initiatives' were defined as 'locally based activities that aimed to drive transformative change of existing societal systems towards environmental sustainability. Such **initiatives were inspiring changes in doing (practices), organising (structures) and thinking (culture)**. ARTS had identified more than 1 000 such initiatives, largely based in civil society.

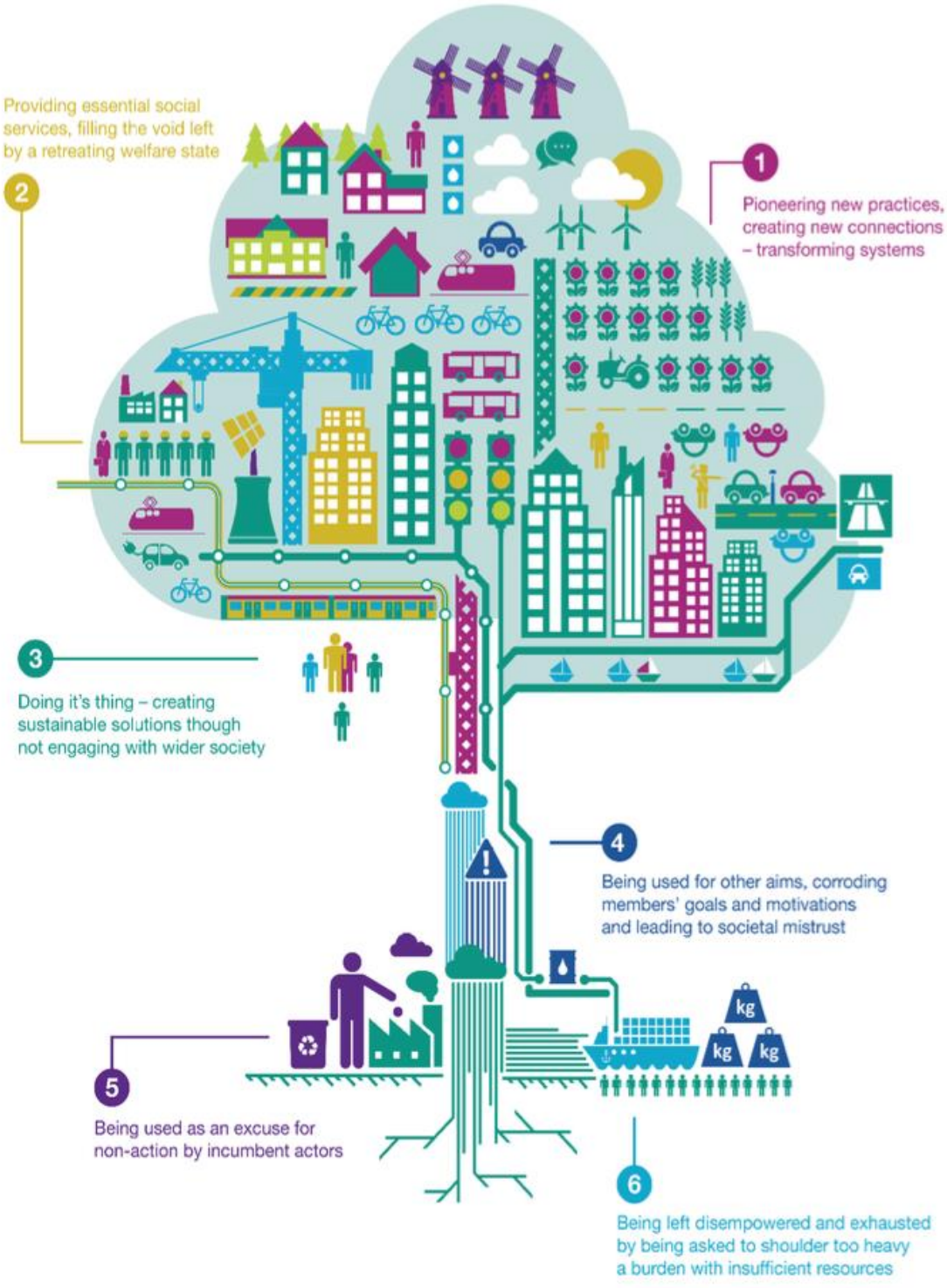
The project had distinguished **five mechanisms for accelerating transitions**:

- '**Upscaling**', i.e. growth of members, users and supporters. Upscaling was particularly apparent in the food domain, where members and users of food initiatives was really expanding. Growth was not a universally shared goal, however, and could create tensions. Much depended on the skills and capacities of those involved.
- '**Replicating**', i.e. repeating, emulating (hybridisation) or branching of an activity. Replicating was often a useful alternative to upscaling and occurred both within and between regions, even across continents. Ideas had been found to travel very fast and ICT was particularly important in that area. In addition to increasing the diversity of social innovation in cities, replication had contributed to the reskilling of the local service economy, particularly in post-industrial cities such as Genk.
- '**Coupling**', i.e. partnering with other initiatives to seek or exploit synergies. Coupling enabled the pooling of resources, competencies and capacities. There were platforms of initiatives at the city, EU and transnational levels. Such platforms enabled initiatives to go far beyond individualised models of social innovation and instead intermediating among themselves and with policymakers. ECOLISE was a meta-network that also engaged academics and actively represented initiatives.
- '**Instrumentalising**', i.e. seizing opportunities to strengthen local activities. Initiatives were successful in the long term when they were well integrated into local society. Funding was important and EU funding was particularly valued because it was perceived as more neutral than other sources. Other resources such as access to networks, knowledge and skills were also regarded as crucial. Partly for that reason, contact points in local government have played a critical role in strengthening local initiatives by facilitating access to funds, networks, advice and guidance.
- '**Embedding**', i.e. aligning old and new ways of doing, organising and thinking in order to anchor them in city regional governance patterns. Transition initiatives actively change city regional patterns, helping create space for social innovation. Local and national governments need to be well informed about initiatives to foster dialogue and knowledge co-production.

Concluding, she said that studying acceleration dynamics suggested that urban **transformations necessitated that all actors shift their roles**. Civil society, for example, could perform a variety of roles in transitions processes, both positive and negative (Figure

4.2). But preferably, citizens would shift from the role of users to being prosumers and stewards of the urban commons; scientists would move from 'ivory towers' to acting as knowledge co-producers and intermediaries; and local governments would move from being regulators to innovators and facilitators.

Figure 4.2 Potential roles for civil society in sustainability transitions



Source: presentation by Niki Frantzeskaki.

Discussion

At the invitation of the co-chair, Kees Schotten, EEA National Focal Point (NFP) for the Netherlands, provided a brief summary of the **E3I transitions initiative**, which had some similarities to the analysis of grassroots initiatives in the ARTS project. He explained that the E3I project had been initiated by the NFPs from a number of EEA member countries, who were keen to explore what transitions processes were under way across Europe and how the Eionet could contribute to developing knowledge on transitions.

In collaboration with the EEA, the NFPs had developed a background paper and questionnaire during summer 2015, which aimed to elicit information about niche innovations and emerging transitions from Eionet partners, including European Topic Centres. Seventy-five responses had been received and analysed, revealing a wide range of innovations and supporting programmes and activities across Europe. The findings were being further analysed and would be compiled, alongside additional inputs from external sources, into an Eionet publication during summer 2016.

Responding to a query about whether it was possible to extrapolate from the findings in the five ARTS cities, Frantzeskaki emphasised that the mapping of grassroots initiatives under ARTS was complemented by work under the Towards European Societal Sustainability (TESS) project and other EU-funded activities. DG Research had been very helpful in supporting coordination of the projects and the ECOLISE meta-network also had an important role.

4.3 Enabling private sector innovation: Norway's electric vehicles success story

Petter Haugneland, Norwegian Electric Vehicle Association, gave a presentation on the growth of the electric vehicle market in Norway and why it differed from markets elsewhere. He said that **the key word explaining such differences was 'policy'**.

The annual electric vehicle owners survey revealed that battery electric vehicles sales had been growing for some years and now accounted for about 17% of new vehicles nationally. In one region, Hordaland, the figure was as high as 34%. Norway had seen unique growth in electric vehicle sales partly because the absence of a domestic car industry had contributed to very high import and registrations taxes for cars, based on the 'polluter pays principle'. Zero-emission cars avoided that registration tax, as well as the 25% value added tax normally charged on purchases and leasing. They also benefited from a low annual road tax.

In addition to those fiscal incentives, local governments provided a range of additional incentives to compensate for the lower range of electric vehicles and uncertainties about battery lifetimes. These included no charges on toll roads or ferries, free municipal parking, access to bus lanes and a 50% reduction on company car tax.

As electric vehicles had become more widespread, the demographics of purchasers had shifted. Initially, buyers had consisted of technology enthusiasts, who drove small electric vehicles on short commutes to and from work. In contrast, Norway was now shifting to an early majority market, with families and all sorts of other users buying electric cars.

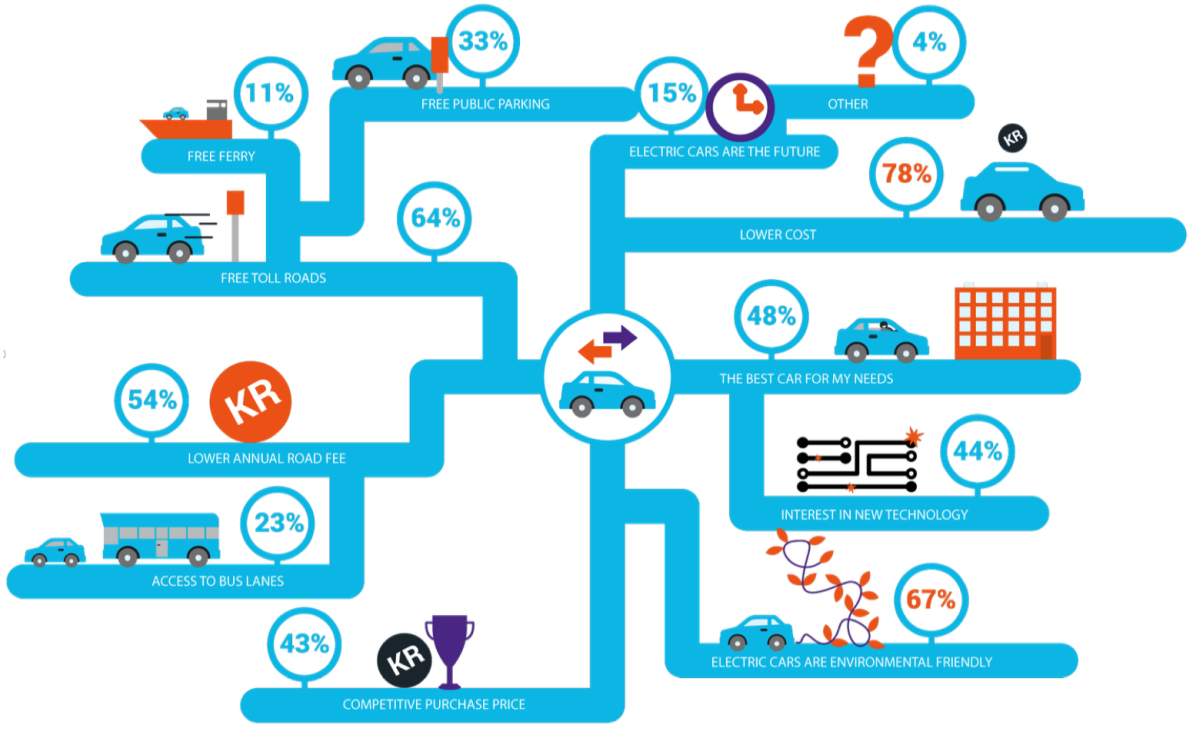
Electric vehicles were often bought as second vehicles for a household but often ended up as the preferred car because they were better and cheaper to run. According to the Norwegian electric vehicle owner survey 2015, owners reported using their electric vehicles for most

daily tasks. Moreover, electric cars were overwhelmingly used as a substitute for petrol or diesel cars (86% of users), rather than to replace public transport (8%), bicycle or walking (3%) or other modes of transport (3%).

Norway's electric vehicle owners had very positive attitudes towards their cars and this appeared to have contributed to some **contagion in the uptake of electric vehicles**. On average, owners reported that they had inspired three members of their social circle to buy an electric vehicle. Electric car ownership also seemed to contribute to a deeper shift in environmental awareness, with 62% agreeing that they were 'more conscious about their energy use after buying an electric vehicle'.

The owner survey appeared to confirm that a combination of price incentives and environmental values were the primary factors motivating purchases of electric vehicles. In total, 78% of owners identified lower cost as an important reason for switching to an electric car and 67% identified environmental friendliness (Figure 4.3). However, when asked to choose between those reasons, financial considerations were clearly prioritised. 59% identified 'saving money' as the most important reason against 24% pointing to 'saving the environment'. A further 9% identified 'saving time' as the most important factor.

Figure 4.3 Reasons given by Norwegian EV owners for buying an electric car, 2015



Source: NEVA (2015)

In conclusion, the **electric vehicle market in Norway was firmly established due to a combination of top-down state interventions to shift incentives and more diffuse social networking activities that were altering norms, behaviours and values**. With that in mind, the Norwegian Electric Vehicle Association foresaw a complete shift to electric vehicles in Norway. Uncertainty only persisted regarding when that shift would occur, not whether it would.

Discussion

The ensuing discussion, focused primarily on the **challenges of creating needed charging infrastructure and the impact of the fiscal incentives on government finances and public support for electric vehicles**. The following observations were made:

- With electric vehicles accounting for 30% of car purchases in some areas, it was interesting to know how charging infrastructure had been arranged and how the electric grid was able to cope with surges in demand related to car charging (e.g. at the end of the working day).
- The success of electric vehicles in Norway was largely based on the generous financial support provided. This was presumably affordable for Norway because it was earning so much money from oil production but it raised questions about whether the model could be duplicated in other European countries.
- The Norwegian experience illustrated some really important points about transition processes such as the **ability of policymakers to stimulate a transition**; **the importance of a policy mix rather than a single measure**; the potential for **radical innovations to have unintended consequences**, such as the impacts on values; and the way that **continuous interactions create new markets and economies of scale**. The presentation also pointed to two challenges: first, the fact that the subsidies primarily went to wealthy people, which raised equity concerns; second, the fact that so many electric cars seemed to be second vehicles for households, which raised wider sustainability issues.

Responding, Haugneland said that in Norway most people charged their cars at home and the country had limited public charging stations. However, such infrastructure would be needed to meet the demands of the next waves of users, who would expect fast chargers to be widely available for long trips. Surges on the grid had not proven a problem as charging could be done at low rates and apartment buildings had systems to manage demand.

Regarding the financing of Norway's generous tax rules, he said that the high taxes on polluting cars more than financed the concessions afforded to electric vehicles. The tax rules would, however, be reviewed in 2018 and other benefits to electric vehicles had already been revised. Providing free parking for electric vehicles had provoked complaints and from 2017 municipalities would be allowed to choose whether to maintain that right or treat electric cars like other vehicles.

In Norway, there were 2.5 million passenger cars and more than 600 000 were second cars. The data suggested that Norwegians were replacing their second cars with electric cars, rather than buying additional vehicles. At the same time, however, social innovations such as car sharing would also be desirable.

On the question of the distributional impacts of the fiscal measures**, it was difficult to combine environmental policy with equity policy**. New technologies were often luxury goods, implying that subsidies to support their diffusion would inevitably go to wealthier households. The same challenge arose in relation to subsidies for solar panels, which would inevitably go to those wealthy enough to own their own home. While the newspapers did discuss 'Tesla envy', there was cross-party support for Norway's electric vehicle policy. Other instruments were needed to address equity policy.

4.4 Discussion on evidence from practice

Reflections on the presentations on evidence from practice

Fred Steward introduced the discussion on evidence from practice with a set of reflections on the three presentations during session 2.

Commencing with Harry Lehmann's presentation on the Energiewende, he noted that the emergence of national transitions policies demonstrated the relevance of the transitions framework to policy. As the Energiewende example illustrated, Germany was a clear leader in institutionalising such strategies. Like the UK's Low Carbon Plan and the EU's Roadmap to a Low-Carbon Economy, the approach was welcome.

The emphasis on using scenario-based knowledge to support the strategy had advantages and disadvantages. The modelling scenario approach worked very well where substitute technologies were available and economic costs could be clearly defined. When applied to the energy system, using **modelling approaches to identify solutions therefore tended to privilege electricity production technologie**s.

Germany's strategy had ambitious greenhouse gas reduction targets and acknowledged the need for multisectoral approaches, including efforts to address transport and buildings, to achieve them. In reality, however, most discussion was about electricity generation technologies. In Lehmann's presentation, for example, changes in energy consumption had been reduced to annual incremental improvements, whereas installation of new capacity had been presented in much more transformative ways. **These imbalances seemed to reflect a problem with the scenario-based approach for developing national transition strategies**. It was unclear whether modelling could be adjusted to address these limitations.

Turning to Niki Frantzeskaki's presentation on grassroots initiatives in city regions, he noted that research like the ARTS project was grounded in a **recognition of the city or region as a knowledgeable innovator**. This was interesting because policy-oriented efforts to map innovation systems or knowledge systems never mentioned cities or regions, focusing instead on institutions (such as universities) or businesses. **Most discussions on cities saw them as governance levels or service providers, rather than as sources of knowledge and innovation themselves**. Addressing cities as members of a knowledge and innovation system was extremely significant in policy terms, since it acknowledged that knowledge did not only reside in experts. The ARTS project showed that adopting that framing made it possible to capture actionable, practice-based knowledge from actors in the system.

Making sense of the diverse activity apparent in European cities and articulating it in broader knowledge terms opened the way to generating practice-based knowledge that could contribute to transitions. Questions had been raised about how far it was legitimate to generalise from individual case studies and how much initiatives were actually contributing to systemic change. Those were good questions but **if they were pushed too far then they risked crushing what practice-based knowledge could offer**.

Much more could be made of that type of knowledge. **If the EEA wished to reconfigure the knowledge system in a more practice-oriented direction then it should prioritise engaging with such initiatives**. **There were a number of project like ARTS and an overview of existing studies could be interesting.**

Practice-based knowledge suffered from some legitimacy concerns. It was often reported in grey literature with low status when judged using normal academic metrics of research performance, and this could reduce its influence on policy. Even peer-reviewed research publications were likely to be very different to natural science publications. For example, in preparing the 'human settlements' chapter in its WG3 Fifth Assessment Report, the IPCC appeared to adopt an approach to peer-reviewed sources that was over-cautious in its interpretation. The result was a disappointingly weak endorsement of urban policy action for climate change mitigation.

Peter Haugneland's presentation had also offered practice-based knowledge, with a focus in particular on the diffusion of electric vehicles. Despite its focus on private sector innovation, the example differed from the practice-based knowledge normally presented in business schools in not restricting its focus just to one business organisation but applying it more broadly. In general, business schools were quite effective in gathering best practice and generalising it for users, typically describing situations where one company 'X' did 'Y' and had a success. What made the Norwegian electric vehicle case particularly interesting was that it **coupled a top-down approach, bringing together a mixture of policy measures, with bottom-up behavioural change and networking**. That pointed to the possibility of a broader set of practice-based innovation studies that showed greater diversity in terms of the practices involved.

Discussion

In the ensuing discussion, several speakers reflected on the challenges and opportunities in transforming the food system. The co-chair noted that the Energiewende example illustrated the way that science and knowledge could support systemic change. It was therefore interesting to reflect on the extent of knowledge available regarding the food system, which was associated with huge environmental pressures, as well as being closely tied to other core systems, including energy.

Responding, Harry Lehmann said that UBA had created a 'food unit' in recognition of the fact that the agricultural system represented a substantial problem. There was ample information about the system but, in contrast to the situation in the energy system, there was no social consensus about the need for change. Another speaker noted that food was seldom recognised as a climate issue but in fact accounted for more than one third of the UK's carbon footprint due to imports. That made it hard to address via conventional sectoral policies.

Cathy Maguire, EEA, reported that she and colleagues were undertaking an analysis of the European food system. The food system's numerous links to environmental, economic, technological and cultural systems made it very hard to analyse. The project was therefore focusing on a few issues and exploring opportunities for intervention. Niki Frantzeskaki's presentation on the ARTS project had provided some interesting insights that were relevant to the food system work.

Many participants offered ideas on how the EEA could seek to bring practice-based knowledge into its work. The following observations were made:

- **SOER 2020 could include a systemic assessment of solutions**, including reflections on the knock-on effects that initiatives could produce, rebound effects and distributional impacts. Such an assessment could not be comprehensive but it could provide a start.

- In seeking to create the solutions-oriented knowledge base, there was a **need to move from evidence-based to evidence-informed knowledge**. The alternative was 'paralysis by analysis'.
- Similarly, experience in Germany illustrate the **risk of paralysis in the search for consensus**. Cities that had sought complete consensus among stakeholders had made less progress than those that had accepted some disagreement and pushed ahead with activities anyway.
- Knowledge could play a variety of roles but to achieve a systemic approach it needed to target actors that could change systems, particularly those not getting as much attention as they deserved. With that in mind, **the city level looks like a really good target for knowledge development**. Bottom-up initiatives deserved closer attention. Cities were not just random experiments but could reconfigure quickly.
- In creating actionable knowledge from grassroots initiatives, **there was a clear need for translators and aggregators. The EEA could perform exactly that role**, intermediating not only between science and policy but also among the initiatives themselves.
- In seeking to draw lesson from local initiatives in cities, the **EEA could benefit from a planned database listing initiatives and lessons learned from FP7 projects** such as PATHWAYS, TESS and ARTS.
- Distinguishing between macro-scale transitions such as the Energiewende and bottom-up transitions activities at the micro scale was mistaken. Large scale systemic change required local actions and behavioural change from consumers.
- Some radical actions were paving paths for more widespread shifts. For example, vegetarianism was once radical but was today commonplace. It was not possible to plan in a controlled way but **knowledge could help create a receptive environment, supporting self-organising change processes**.
- In shifting to assessments that focus on solutions, **the EEA could have a role in questioning underlying mental models** relating to change, innovation and entrepreneurialism. For example, the notion of 'entredonneurs' — innovators that really contributed something to society — provided some interesting lines of thinking.
- It was essential to understand **what types of information influenced individual choices**. Fair Trade products, for example, created incentives that steered consumption patterns in different countries. Correspondingly, it was important to find ways to advertise externalities on products.
- It was sometimes argued that local activities could not address systemic challenges at the macro scale. In fact, they were important seeds for change, potentially stimulating discourses and leading to an advocacy coalition and policy support, or encouraging intervention by small firms and then larger firms, as the case of car sharing illustrated. Adrian Smith had argued that **bottom-up initiatives faced a dilemma between staying radical and small or making compromises and expanding**. That dilemma had not been addressed in the scientific community and would be interesting to explore.

5 Concluding remarks

In concluding, Per Mickwitz said that it was important to return to the question of what the EEA should be doing, in particular in relation to preparing for SOER 2020. There was a need to reflect on the ideas that had been put forward throughout the seminar but the discussions already suggested some potential frameworks for organising future analysis. One was the multi-level perspective presented by Frank Geels, which emphasised the need to effect change at the landscape, regime and niche levels. The **EEA could seek to generate information at each of the three levels**. For example:

- at the niche level the EEA could explore what was happening, what could be learned and how societies could accelerate change;
- analysis at the regime level could explore lock-ins, feedbacks and opportunities to destabilise the dominant system;
- past EEA reports such as SOER 2015 and its report on global megatrends, had arguably served to create pressure at the landscape level.

There had also been a significant debate about **knowledge**, in particular the importance of knowledge in driving processes such as the Energiewende. Yet it was apparent also that communicating knowledge and motivating action also required a good story, so **there was a need for knowledge that created feelings**.

There had also been a significant focus on methods. In many fields, discussions were under way about the merits of different methods. Case studies, in particular, were acquiring a much stronger position. Social scientists often sought to be very impersonal and neutral in their analysis but Robert Putnam, for example, had greatly increased the impact of his work by making it intensely personal. This suggested that **the power of case studies had been hugely underestimated**.

Hans Bruyninckx expressed his gratitude to the presenters and all the participants. He said that the seminar had illustrated that systemic and transitional knowledge was an essential part of the knowledge base needed in Europe and globally to face major challenges in the decades ahead. Many speakers had emphasised that **there was not a need for 100% clear evidence but rather reasonable evidence to identify pathways and support assessments**.

Developing the needed knowledge at the EEA required strategic planning and a form of transition in internal processes and understanding. It required the adoption of new language and its integration across EEA reporting, networks and interactions in the EU system. It implied that the EEA needed to be engaged and engaging, providing an interesting hub for collaboration.

Scientific Committee membership would be changing, as some of the current membership were coming to the end of their terms in 2016. The need for new knowledge on systemic challenges and transitions had informed the framing of the call for new members.

The EEA worked using the 'DPSIR' model, which organised environmental analysis in terms of environmental drivers, pressures, states, impacts and responses. The seminar's deliberations had focused a lot on 'drivers' but it was clear that **the EEA also needed to retain its focus on other elements in order to fulfil its legal mandate**. In the context of

budget constraints and related loss of staff the EEA needed to keep a balance between work on policy implementation and more long-term systemic assessment work. It was essential to convey the message that focusing on one without the other did not make sense. In that regard, the EU's macro-policy frameworks addressing the circular economy and the low-carbon society were key.

Sociological research suggested that values were shifting. For example, young people seemed to have different attitudes on car ownership than previous generations. At present, the EEA did not connect with those kinds of concerns but **establishing connections with young scientists might be a way to respond**. More generally, it was clear that exploring the EEA's role in contribution to knowledge for transitions would be an iterative, incremental process. The seminar had provided a step on that journey.

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Annex Seminar agenda

Wednesday 18 May 2016, 08.30 to 17.00

European Environment Agency, Kongens Nytorv 6, Copenhagen, Denmark

08.30 – 09.00	Registration and coffee
09.00 – 09.10	Welcome by the Chair of the Scientific Committee Sybille van den Hove, EEA Scientific Committee
09.10 – 10.00	Setting the scene by the co-chairs of the seminar Per Mickwitz, EEA Scientific Committee Hans Bruyninckx, Executive Director, EEA
SESSION I: EVIDENCE FROM THEORY: MODELLING, TRANSITIONS AND TRANSFORMATIONS	
10.00 – 10.30	Sustainability transitions: the role of quantitative systems modelling Andries Hof, Netherlands Environmental Assessment Agency (20 min) Discussion and input from other participants (10 min)
10.30 – 11.00	Transitions in socio-technical systems: innovation and technology Frank Geels, University of Manchester (20 min) Discussion and input from other participants (10 min)
11.00 – 11.30	Coffee break
11.30 – 12.00	Transformations in socio-ecological systems: adaptation and social change Karen O'Brien, University of Oslo (20 min) Discussion and input from other participants (10 min)
12.00 – 13.00	Discussion: scientific knowledge on sustainability transitions – implications for policy and support needs from H2020 (moderated by the co-chairs)
13.00 – 14.00	Lunch: informal (sandwiches and fruit)
SESSION 2: EVIDENCE FROM PRACTICE: ON-THE-GROUND INITIATIVES AND EXPERIMENTS	
14.00 – 14.30	A systems perspective: the German energy transformation Harry Lehmann, UBA (20 min) Discussion and input from other participants (10 min)
14.30 - 15.00	Experiences from grassroots initiatives in European cities Niki Frantzeskaki, DRIFT / University of Rotterdam (20 min) Discussion and input from other participants (10 min)
15.00 – 15.30	Enabling private sector innovation: Norway's electric vehicles success story Petter Haugneland, Norwegian EV Association (20 min) Discussion and input from other participants (10 min)
15.30 – 16.00	Coffee break
16.00 – 17.50	Discussion: transitions knowledge from on-the-ground initiatives – implications for policy and support needs from H2020 (introduced by Fred Steward, University of Westminster, and moderated by the co-chairs)
16.50 – 17.00	Concluding remarks by the EEA
17.00	End of seminar