CLIMATE INNOVATION INSIGHTS | Series 1.3
Accelerating the Evolution of Climate Innovation Clusters

Climate Innovation Insights offers a platform for reflections and lessons from renowned climate innovation experts to spark discussion about the process of tackling climate change through innovation. The independent opinion pieces discuss best practices, different methodological approaches towards climate innovation and implications for business, society and politics. The series is supported by Climate-KIC, Europe's largest public–private climate innovation partnership.

System Climate Innovation for a Transformative Impact

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Key messages

- Recent decades have seen improvements in the diffusion of low-carbon technologies, but overall progress in 'greening' the global economy has been modest.
- To increase its impact, climate innovation needs to embrace system innovation and tap into opportunities for resource efficiency and circular economies.
- System innovation should involve an 'innovation movement' that brings together diverse stakeholders who build the vision of change and share the risks and benefits of the transition.
- Public policy has a crucial role to play in creating spaces where system innovation is initiated and scaled.

Introduction

Innovation is broadly considered to be one of the most important strategies for addressing climate change. Recent decades have seen considerable improvements in performance and the diffusion of several flagship low-carbon innovations, notably in renewable energy, manufacturing and transport.

But despite these many successes and encouraging trends, overall progress towards 'greening' the global economy has been modest: the overall state of the planet's health continues to deteriorate in many areas, and resource consumption continues to rise. There needs to be a radical shift towards alternative economic and social models of consumption and production in the near future.

Innovations to enable and drive this transition are needed more urgently than ever. This *Insight* argues that the challenges of transition require climate innovation to expand its focus from technology to functional systems. System innovation – a combination of technological and non-technological innovations that, enacted together, deliver transformative impacts – offers an integrated framework to enable synergies between innovation efforts, which are often uncoordinated and pursued in various sectors and locations.

Linking climate innovation with resource efficiency and circularity

The Paris Agreement, adopted by 197 countries in December 2015, recognised the need for an integrated approach to

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tackling environmental crises. This confirmed that the decarbonisation of our economies needs to go hand in hand with the decoupling of economic growth from the use of natural resources and other negative environmental impacts. Evidence on the links between resource efficiency and reductions in greenhouse gas emission points to major potential synergies in a joined-up approach.

A recent report[1] suggests that by 2050, policies and initiatives to improve resource efficiency could reduce global resource extraction by up to 28 per cent and cut global greenhouse gas emissions by around 60 per cent, while also boosting the value of world economic activity by 1 per cent (relative to 2015 levels). Implementing circular economy principles in mobility, food and the built environment could nearly halve Europe's CO2 emissions by 2030, and reduce them by 61 per cent by 2050.[2]

For example, reducing landfill and increasing the recycling of municipal solid waste could significantly reduce annual greenhouse gas emissions:[3] a two-thirds increase in recycling could reduce global emissions by 6 per cent. Given that municipal solid waste comprises only 10 per cent of the total waste stream globally, the overall potential reduction of emissions is much higher.

Towards system climate innovation

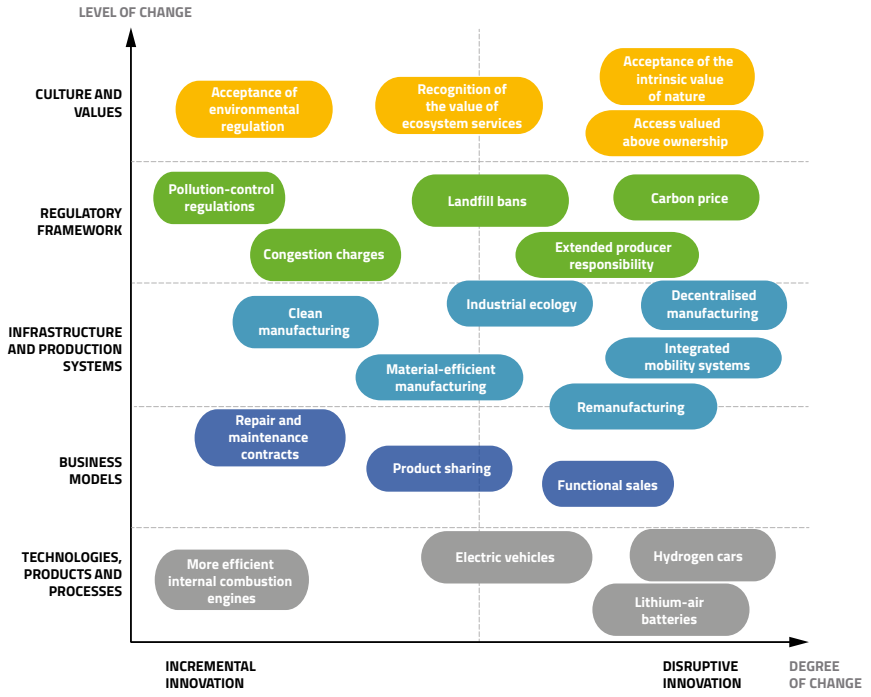
The synergies between economic and environmental benefits open up untapped potential for climate innovation. Considerable policy and business attention over the last decade has focused on developing and disseminating innovative low-carbon technologies and products. However, even the most innovative technologies and products have proven insufficient to drive a transition towards more sustainable production and consumption systems.

Impactful product innovations have almost always been enabled by the complex system behind them. The idea of system innovation emerged to capture this systemic perspective of change.[4] Climate system innovation, therefore, can be defined as a combination of technological and non-technological innovations that, if enacted together, maintain or improve the delivery of desired societal functions, with an absolute reduction in their environmental impacts.[5]

Despite being challenging and risky, there are many examples of emerging system climate innovations. Selected examples include:

- Sustainable cities approaches: viewing cities as integrated socio-technical systems, with a focus on improving people's well-being by optimising various urban functional systems such as energy, water, mobility, waste, food and governance.
- The circular economy: relying on diverse business models, collaborations and coordinated action, such as industrial symbiosis, cascades and product–service systems.
- Sustainable mobility systems: focusing on delivering mobility functions by combining and optimising access to various mobility services, notably in urban areas; see Figure 1b for an illustration of this.

Figure 1a. Mapping climate innovation



Source: authors

Mapping system climate innovation

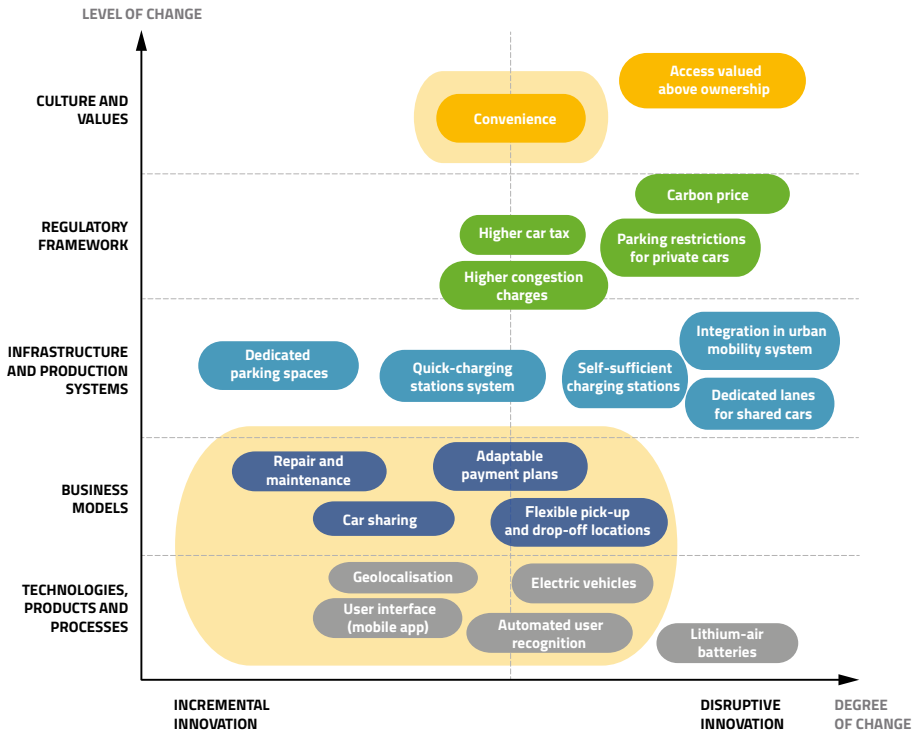
The system map proposed in Figure 1a differentiates between incremental and disruptive innovations and changes occurring at different levels, ranging from products and processes to regulatory frameworks and value systems.

As an example, Figure 1b shows a simplified model of an electric car-sharing system. The system depends on a combination of components that – together – deliver the mobility function.

Single actors initiating a car-sharing scheme control its core business model (highlighted in yellow), but have a limited impact on other dimensions constituting an enabling environment for electric car sharing, notably physical infrastructure and regulatory framework. In collaboration with other actors, however, they can broaden their initial reach. For example, in collaboration with the city authorities, car-sharing operators can improve the relevant infrastructure and co-invest in quick-charging stations, or experiment with business models focused on providing specialised mobility services with high social value (e.g. supporting schools, supporting elderly people).

The economic, social and, ultimately, environmental benefits of this and similar system innovations will depend on such strategic collaborations, which add additional components to the scheme and contribute to transforming an entire functional system.

Figure 1b. A car-sharing model as a system innovation



Source: authors

Barriers to system climate innovation

Despite this potential, system innovation is challenging. As a strategy it rests on the premise that it can be co-designed and managed; the extent to which this is possible is open to debate.[6]

System innovation suffers from market and system failures. These include technological risk, uncertain market demand, low innovation capacity, weak innovation collaboration, and unfit institutional and regulatory frameworks. Further barriers include:

- Delivering social and environmental benefits is not fully rewarded in the current economic and policy system.
- Business cases for climate innovation are often limited to profitability and compliance with existing or future regulations.
- Disruptive innovation will compete against well-established incumbents and may suffer from political and social resistance.

Conclusions

System climate innovation is not about creating a fully controllable mechanistic intervention, but rather about generating an 'innovation movement' that brings together many actors who share the benefits and risks of change. The challenge is to mobilise actors with shared incentives, who can then co-design and jointly implement innovations and, at the same time, actively create an enabling environment for them to take off.

Given the complexity of challenges, the process will require collaboration between government, business, research and civil society. This is a governance challenge prompting new mechanisms of social deliberation and collaboration. Indeed, public policy at all levels has a crucial role to play in creating innovation spaces, where experimentation and demonstration can be initiated and scaled, and social participation encouraged.[7]

How, then, should system climate innovation be approached in practice? Table 1 proposes seven steps for designing and implementing the process, drawing on various foresight and strategic planning approaches. The steps are addressed to the 'system entrepreneurs' who initiate the process. The leadership of the process will vary depending on the context.

Table 1. Seven steps for system climate innovation

1. System diagnosis	• Diagnose and map the system in focus • Use scientific evidence and be explicit about uncertainties in the analysis • Map and compare problem frames and perceptions of market and system failures
2. Stakeholder alliance	• Build a shared understanding of the challenge and problem boundaries • Engage relevant actors with key roles in the system; this is the time to start looking for future leaders of the initiative
3. Vision and innovation pathways	• Build a shared vision of the desired future system • Explore alternative scenarios and innovation pathways to achieve the vision • Be concrete about timescales of action and impact and allow pathways that are based on various combinations of technological and non-technological innovations • Describe and critically analyse pathways: the key actors, shared value propositions, incentives to pursue the pathway, alignment with existing regulatory and policy frameworks, socio-cultural barriers, timescales, budgets, etc. • Compare pathways and select one or preferably more alternatives for demonstration and implementation
4. Roadmap and strategy	• Develop strategy and collaborative roadmaps of innovation pathway(s) • Introduce different timescales of action • Introduce a risk-management plan
5. Deliberative governance and leadership	• Co-design a dedicated governance model, including key players, and agree on leadership arrangements for the alliance • Agree on roles, commitments and risk sharing • Be aware of the 'politics of transition' and seize political opportunities to create protected niches • Be open to new stakeholders joining the process, aligning with roadmaps or proposing active participation in the implementation of new technologies
6. Collaborative implementation	• Experiment and demonstrate system innovation in selected cities and regions • If feasible, allow for competition between different demonstrators • Grow and connect innovation spaces and adapt wider framework conditions (political support is needed for this)
7. Evaluation and social learning	• Develop an evidence base and evaluation systems to measure the short- and long-term economic, social and environmental effects of system innovation • Create space for collective reflection on pathways and progress towards objectives • Based on the evidence, expand, merge or abandon pathways

Endnotes

1. UNEP (2016) *Resource Efficiency: Potential and Economic Implications*, Nairobi: International Resource Panel
2. Ellen MacArthur Foundation and McKinsey Center for Business and Environment (2013) *Growth Within: A Circular Economy Vision for a Competitive Europe*, Cowes: Ellen MacArthur Foundation/ New York: McKinsey Center for Business and Environment
3. Bijleveld, M., Bergsma, G. and Nusselder, I.Y.R. (2016) *The Circular Economy as a Key Instrument for Reducing Climate Change*, Delft: CE Delft
4. For a recent overview, see: OECD (2015) *System Innovation: Synthesis Report*, Paris: OECD Publishing
5. See also: Eco-Innovation Observatory (2013) *Europe in Transition: Paving the Way to a Green Economy through Eco-innovation*, Eco-Innovation Observatory; and Draper, S. (2013) *Creating the Big Shift: System Innovation for Sustainability*, London: Forum for the Future
6. Mulgan, G. and Leadbeater, C. (2013) S*ystems Innovation*, Nesta discussion paper, London: Nesta
7. Transition management is one relevant approach in this context; see, for example, Kemp, R., Loorbach, D. and Rotmans, J. (2007) 'Transition management as a model for managing processes of co-evolution for sustainable development', *The International Journal of Sustainable Development and World Ecology*, 14 (1), 78–91

Climate-KIC UK and Ireland

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Our partnership consists of dynamic companies, the best academic institutions and public authorities. We drive innovation in tackling climate change through creative partnerships large and small, local and global, and between the private, public and academic sectors. The UK and Ireland is a core geographic region within Climate-KIC and is home to some of the most energetic climate innovation clusters and businesses in Europe.

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