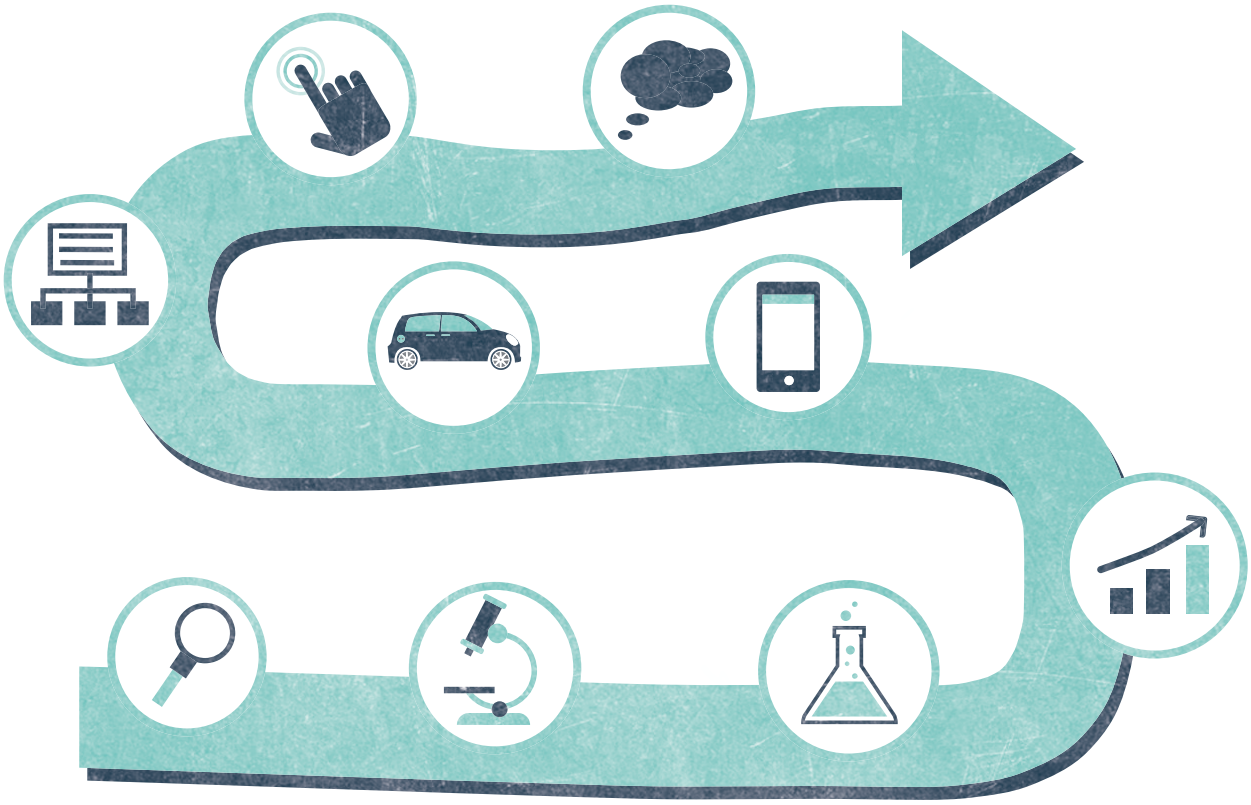

HOW

to design and implement science, technology and innovation (STI) roadmaps to foster eco-innovation for sustainable development?

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to design and implement science, technology and innovation (STI) roadmaps to foster eco-innovation for sustainable development?

Outlook 10

How to design STI policy road-maps to foster innovation for sustainable development?

By Michal Miedzinski, Will McDowall, JesseFahnestock, Olga Rataj[1]

Key messages

Despite being associated with technology management, the roadmapping technique has been applied topublic sector strategies and policy making in both developed and developing countries.

Policy roadmaps fulfil diverse roles in policy process ranging from policy design and planning to providing technical support for programme implementation.

Policy roadmaps assume diverse conceptual and methodological approaches ranging from methods applied in technology management to hybrid approaches blending elements of foresight and strategic planning.

Science, Technology and Innovation (STI) policy roadmapping has a potential to become a systemic policy instrument providing long-term directionality and strategic orientation for design and implementation of STI policy portfolios.

The reviewed policy roadmapping practices suffer many shortcomings, including weak follow-up, insufficient embeddedness in policy mix and limited reflection on roadmap governance.

1 INTRODUCTION

Introduction

There has been a growing interest in roadmaps and roadmapping techniques in the Science, Technology and Innovation (STI) policy community. Although interest in the application of roadmapping to policy processes is rising, there is little research literature in this area, especially in the context of supporting innovation for sustainability transitions. This outlook addresses this gap by critically reviewing selected national and international policy and sectoral roadmaps with a focus on technology areas and societal challenges relevant for sustainability transitions. The paper analytically compares objectives, design features and the embeddedness of roadmapping in strategic and policy processes. It critically discusses the reviewed initiatives and draws tentative lessons for future applications of roadmaps as policy instruments enabling sustainability transitions.

2 THE CHALLENGE OF LONG HORIZONS: EMBEDDING DIRECTIONALITY IN STI POLICIES FOR SUSTAINABLE DEVELOPMENT?

Technology roadmapping is one of the most prominent foresight and strategic planning techniques used in technology management. There is a rich body of literature on foresight techniques, including technology roadmapping, applied by business across in various industrial sectors (see e.g. Schwartz 1991, Lahey and Randall 1998, Christensen et al 2004, Phaal et al 2004, McDowall & Eames 2006, Phaal and Muller 2009).

Despite being associated with technology and industry, the roadmapping technique has been applied to many topics and contexts, including policy making (see e.g. Ahlqvist et al, 2014; Carayannis et al, 2016, Meissner et al 2016), and has increasingly been used in the context of large-scale transformative changes (McDowall, 2012). Most recently, roadmaps have been promoted as relevant policy instruments to support implementation of the 2030 Agenda and SDGs on the national and regional level. In this context, roadmaps are offered to STI policy makers as tools to enable formulation, planning and implementation of public policies, often in relation to long-term ambitious sustainability goals. Although interest in the application of roadmapping to policy process is rising, there is little research literature in this area, especially in the context of sustainability transitions and societal challenges. This outlook addresses this gap, by critically reviewing existing national and international roadmaps addressing technology areas and challenges relevant for sustainability transitions.

3 WHAT IS A STI POLICY ROADMAP?

The roadmap as a planning tool emerged from the fields of innovation and technology management. Roadmaps are most often analysed by authors active in industrial management (Phaal et al, 2004; Phaal and Muller, 2009) and foresight and prospective studies (Saritas and Aylen, 2010). Phaal et al (2004: 9) defines roadmapping as 'a powerful technique for supporting technology management and planning, especially for exploring and communicating the dynamic linkages between technological resources, organizational objectives and the changing environment'.

The distinctive feature of roadmaps is 'the use of a time-based structured (and often graphical) framework to develop, represent and communicate strategic plans, in terms of the coevolution and development of technology, products and markets.' (ibid: 10). Despite being associated with business, the roadmapping technique is pervasive and can be applied to many topics and in many organisational contexts.

Roadmapping can refer to many related techniques and approaches. There is no a single blueprint or protocol for the methodology or format of the roadmapping process. The roadmaps have multiple uses and formats. Phaal (ibid: 11-14) introduces the following uses of roadmapping: product planning, service/capability planning, strategic planning, long-range planning, knowledge asset planning, program planning, process planning and integration planning. Long-range planning has typically longer time horizons and is often performed on the level of sector or country. Given the complexity involved, the roadmaps are often represented in the graphical format including flowcharts, single- or multi-layer representations, bars, graphs or creative images selected to visualise the process. Some roadmaps are fully or partly text-based (ibid: 15).

Despite these diverse approaches roadmaps are based on a number of common design features (Phaal et al, 2004; Phaal and Muller 2009):

- Roadmaps need to have an explicit purpose usually expressed as a vision and strategic priorities and targets (i.e. 'where do we want to go?').

- The roadmapping process needs a reflection on the current state of development or a baseline (i.e. 'where are we now?').

- Roadmaps include an explicit perspective of time horizon and timelines illustrating the process of getting to the vision. Timelines are often presented with the use of scales, milestones and intervals, typically differentiating between short-, medium- and long-term.

- Many roadmaps opt for presenting the transition towards the vision by depicting various inter-related layers (e.g. product, sector or policy). The latter is to allow for anticipating and possibly managing factors that enable or hamper the transition i.e. how to get there?).

- The development of roadmaps typically requires an active involvement of stakeholders. The process can benefit from diverse inputs in terms of disciplines, economic sectors, business and public actors, functions within organisations, and can include external perspectives where feasible.

- Whether the process is intra- or inter-organisational, the discussions and debates should be seen as a learning process and knowledge sharing exercise.

Given the main features of roadmapping as a planning and management tool, this paper considers it as a pervasive approach which can support policy formulation and implementation, with a specific role to ensure long-term directionality and to improve policy coherence. The latter are among key features of effective policy mixes for sustainability transitions (Rogge and Reichardt, 2016). As noted by previous work (McDowall 2012), roadmaps make active use of the performative nature of technological expectations (Konrad et al. 2017): they are an example of what Konrad has called "governance of and by expectations" (Konrad 2010).

What is a STI policy roadmap?

The approach to policy roadmaps for Science, Technology and Innovation (STI) for the SDGs builds on - but move beyond - classic approaches to technology roadmapping. It retains the technology foresight dimensions of traditional road-maps, but re-focus attention on the policy and governance aspects of long-term change. STI policy roadmapping is viewed as a technique supporting STI policy reflection and planning activities towards greater policy coherence between STI policies and the 2030 Agenda and the SDGs.

4 KEY FEATURES OF STI POLICY ROADMAPS FOR THE SDGS

We developed a conceptual framework to conduct a comprehensive review of STI policy road-mapping with a focus on issues relevant for sustainability transitions. The framework draws on the literatures addressing sustainability transitions, innovation policy mixes and foresight evaluation.

Figure 1 overviews the areas and lead questions which guided the review of selected roadmapping initiatives.

(Next page) Figure 1. Areas and questions for reviewing STI roadmaps

The analysis was based on a critical review of 20 selected policy-relevant road-mapping initiatives focused on areas relevant for sustainability transitions and SDGs, and developed on the national or international level. Since the main objective is to critically review existing practice in using road-mapping to support or influence policy, our purpose was to collate a sample representing variety of practical applications of roadmapping rather than to compose a internally coherent sample.

Already an initial review of established practices of using roadmapping revealed considerable heterogeneity in understanding and applying the concept of roadmap. The use of the word 'road-map' in policy documents does not imply a uniform understanding or application of a roadmapping technique. Some of the reviewed documents are not called 'roadmaps' but they were selected for the review as they bear resemblance with roadmaps, notably by featuring visions and time-based pathways illustrating how to reach the desired future state.

Area	Definition	Review questions
Relevance	The extent to which the vision and objectives of roadmaps are appropriate for sustainability challenges, and the SDGs.	What is the main purpose and scope of roadmaps, and how they relate to SDGs? What is the wider context in which roadmaps emerge?
Roadmap design	The level of sophistication of intervention logic and design of roadmaps in the context of sustainability challenges.	What is architecture of roadmaps, notably how they introduce visions, pathways (targets and milestones, layers etc,) and action plans?
Innovation	The level of ambition and aspiration of innovation activities promoted by roadmaps, including recognition of the role of experimentation and demonstration of system innovation.	What types of innovation activity are roadmaps promoting to enable sustainability transition? What is the level of ambition of innovation?
Strategic specialisation	The extent to which roadmaps encourage innovation specialisation in the most relevant areas for sustainability.	Are roadmaps based on a strategic prioritisation process including existing and emerging areas of specialisation? Are roadmaps aiming at changing specialisation patterns to more effectively respond to sustainability challenges?
Alignment & credibility	The extent to which roadmaps mobilise actors to align their strategies with the shared vision, and to engage in transformative innovation.	How are stakeholders consulted and engaged at different phases of the process?
Actionability	The extent to which roadmaps are based on policy implementation capacity, and absorptive and coordination capacities of actors in the innovation system.	What are the mechanisms by which roadmaps are implemented?
Coherence	The extent to which roadmaps are coordinated and coherent with relevant policy mixes, and with SDGs.	How are roadmaps embedded into wider STI policy mixes?
Learning and adaptability	The extent to which roadmaps support on-going learning and include mechanisms allowing for adaptation of its elements based on new evidence.	How is the implementation of roadmaps monitored and evaluated?

5 LESSONS FROM A COMPARATIVE REVIEW OF POLICY ROADMAPS

5.1. Relevance: scope and purpose of roadmaps

The review focused on the extent to which the vision and objectives of roadmaps align with sustainability challenges and the SDGs. Two questions were addressed in reviewing the documents, notably 'What is the main purpose and scope of roadmaps, and how they relate to SDGs?' and 'What is the wider context in which roadmaps emerge?'
The review suggests roadmaps can be used for a variety of purposes underpinning policy process, including:

- Vision building
- Building a long-term vision of desired future expressed as statements and images of desired and plausible futures.Examples: TIFAC 2035 Technology Vision (India), ICC's Green Economy Roadmap.

- Exploration of innovation and technology pathways
-Exploration and assessments of alternative technology, innovation or policy pathways to achieve a vision, often expressed as scenarios.Examples: CSIRO (Australia).

- Technology advocacy
- Technology and innovation advocacy supporting technology areas or specific technologies within specific areas, often including research and innovation agendas with priority technology areas. Examples: SPIRE (EU), Forest products industry roadmap (USA).

- Stakeholder alignment
- Building or strengthening stakeholder alignment to support the vision and technology, innovation or policy pathways. Examples: ICC's Green Economy Roadmap, Forest products industry technology roadmap (USA).

- Support for policy design and planning
- Providing support for design and planning of policy portfolios or programmes by elaborating selected technological and innovation pathways, often using milestones and quantitative targets. Examples: Japan's New Low Carbon Energy Plan, EU SET-PLAN, RISEnergy.

- Support for policy implementation
- Providing support for implementation and management of ongoing policy programmes or other initiatives. Examples: SET-PLAN and underpinning roadmaps (EU), Jamaica's National Energy Policy 2009-2030, Power Africa (USAID).

The analysed initiatives often strive for multiple objectives. The choice of objec-tives and design of roadmaps are situated in a specific context in which the roadmapping process is conducted. It depends on factors internal (e.g. capacity, competences and interests of the owner or owners of the exercise) and external to the process (e.g. maturity of the policy agenda on the national and international level, the stage of the relevant policy processes, alignment among local and international stakeholders).

Regarding policy agenda maturity, roadmaps developed at times of on-going or imminent political and policy shifts (e.g. agenda shifts, major organisational changes, early stages of policy design) appear to focus mainly on vision building, stakeholder alignment and technology advocacy (e.g. TIFAC 2035 Technology Vision in India, EC's Roadmap to a Resource Efficient Europe, the ICC's Green Economy Roadmap). The EC's Roadmap to a Resource Efficient Europe, for example, was heavily influenced by changes in DG Environment's portfolio, the predominantly economic narrative of the Europe 2020 Strategy and the arrival of the new Commissioner (Miedzinski 2015). Due to changes in political agenda and organisational setting the process focused on building a shared understanding, vision and stakeholder alignment within the European Commission, notably inside DG Environment and between DG Environment and DG GROW. The roadmap included baseline analysis and a broad narrative vision but had a weak focus on technology and innovation pathways (ibid).

On the other hand, roadmaps supporting more mature strategic processes and policy instruments focus on exploring concrete technology pathways and sup-porting policy design, planning and implementation (e.g. the UK's Renewable Energy Roadmap). Interestingly, roadmaps developed in a close proximity to on-going policy processes also focus on stakeholder alignment. The roadmap developed to support Power Africa programme, for example, aimed to reach out to stakeholders and promote the programme's approach in order to support future programme implementation.

5.2. Roadmap design

We analysed the level of sophistication of design of roadmaps. We examined whether the roadmap included typical elements and responded to typical questions associated with technology roadmaps, including:

- Vision
  - Narrative vision expressed as statements or images.
  - Formal targets often quantitative.

- Innovation pathways
  - Targets and milestones to track progress towards the vision.
  - A structured timeline (short-, medium- and long-term).
  - Theory of change (scenarios of plausible mecha nisms of change).
  - Analytical layers (dimensions of change).

- Action plans
  - A set of short- and medium-term actions that need to be taken in order to achieve the make pro gress on identified pathways towards the vision.

- Baseline analysis
  - Evidence-based analysis of the current state of development which un-derpins vision and innova tion pathways.
  - Combinations of science-driven approaches (e.g. use of models) and participatory approaches (e.g. stakeholder consultations).

The analysed roadmaps assumed contrastingly different research and conceptual frameworks ranging from designs resembling conventional technology roadmaps to hybrid documents blending elements of horizon scanning, broad visions, scenarios and strategic planning.
Figure 2 summarises the roadmaps included in the review.

(Next page) Figure 2. Descriptive features of reviewed roadmaps

Roadmaps	Main purpose	Vision		Innovation pathways				Action plan	Baseline analysis
		Narrative vision	*Targets*	*Structured timeline*	*Targets & milestones*	*Theory of change*	*Co-evolving layers*		
Leading the cycle. Finnish road map to a circular economy 2016-2025 (Finland)	Vision building; Stakeholder alignment; Support for policy design and planning; Support for policy implementation	Yes	No	Yes	Yes (qualitative)	Yes	Yes	Yes	Yes
RISEnergy: Roadmaps for energy innovation 2030 (Sweden)	Vision building; Exploration of technology pathways; Technology advocacy	Yes	No	Yes	Yes	No	Yes	Yes	Yes
ERA Roadmap 2016-2020 (Norway)	Support for policy implementation	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Roadmap to zero emissions for process industries (Norway)	Support for policy design and planning	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Renewable Energy Roadmap (UK)	Support for policy design and planning; Support for policy implementation	Yes	Yes	Yes	Yes (quantitative)	Yes	No	Yes	Yes
Forest products industry technology roadmap (USA)	Technology advocacy	No	No	No	Yes	Yes	Yes	Yes	Yes (per tech)
Low Carbon Technology Plan (Japan)	Support for policy design and planning; Support for policy implementation	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Low Emissions Technology Roadmap (CSIRO, Australia)	Exploration of technology pathways; Support for policy design and planning	Yes	Yes	No	Yes (quantitative)	Yes	No	No	Yes
South Africa's Water RDI Roadmap: 2015-2025 (South Africa)	Stakeholder alignment; Support for policy design and planning	Yes	Yes	Yes	Yes	Yes	No	No	Yes
PowerAfrica: The Roadmap (USAID)	Support for policy implementation; Stakeholder alignment	Yes	Yes	Yes	Yes (quantitative)	Yes	Yes	No	Yes
TIFAC Technology Roadmap for Manufacturing (India)	Vision building; Exploration of technology pathways; Technology advocacy	Yes	No	Yes	No	No	Yes	No	Yes
National Energy Policy 2009-2030 (Jamaica)	Support for policy implementation	Yes	Yes	Yes	Yes (quantitative)	No	No	Yes	Yes
SET Plan (EU)	Support for policy design and planning; Support for policy implementation	Yes	Yes	Yes	Yes (quantitative)	Yes	Yes	Yes	Yes
SPIRE (EU)	Technology advocacy	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Roadmap to a Resource Efficient Europe (EU)	Vision building; Stakeholder alignment; Support for policy design and planning	Yes	No	No	Yes (mostly qualitative)	Yes	No	Yes	Yes
Science, Technology and Innovation Strategy for Africa 2024 (African Union)	Vision building; Stakeholder alignment; Support for policy design and planning	Yes	No	Yes	No (to be agreed on national level)	No	No	Yes	Yes
ASEAN Plan of Action on STI (APASTI) 2016-2025 (ASEAN)	Vision building; Stakeholder alignment; Support for policy design and planning	Yes	No	Yes	Yes	No	No	Yes	No
Carbon Capture and Storage in Industrial Applications (UNIDO/IEA)	Vision building; Stakeholder alignment; Exploration of technology pathways; Support for policy design and planning	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
ICC's Green Economy Roadmap (international NGO)	Vision building; Stakeholder alignment	Yes	No	No	No	Yes	Yes	No	No
WBCSD Vision 2050 (International NGO)	Vision building; Stakeholder alignment	Yes	No	Yes	Yes (qualitative)	No	Yes	No	No

5.3 Innovation for sustainability

The review focused on analysing the approach to innovation in the roadmaps. We compared the level of ambition and aspiration of innovation activities promoted by roadmaps, including the role of experimentation and demonstration of system innovation. Two questions were addressed: 'What types of innovation activity is the roadmap promoting to enable sustainability transition?' and 'What is the level of ambition of innovation?'

Although roadmaps mention various types of innovation, the predominant focus of most documents is on technological innovation, including new technologies, materials, and products. The focus on technology ranges from specific industrial technologies (e.g. US Forest Products Industry Technology Roadmap) to a more systemic discussion on integrated technology systems (e.g. Japan's New Low Carbon Technology Plan). Several technology-oriented roadmaps recognise the importance of non-technological innovations which are seen key for successful technology demonstration or diffusion. These non-technological innovations include inter alia business models seen as 'enablers' of technology diffusion in CSIRO's roadmap and policy and institutional innovations allowing for adjusting energy market design in the UK Renewable Energy Roadmap. Technology oriented roadmaps embody a vision of the future that is determined by techno-economic logic in which non-technological forms of innovation are subservient to achieving techno-economically optimal outcomes.

Several reviewed roadmaps had a broader focus comprising technological and non-technological innovations to underpin wider transitions or specific projects. The ICC's Green Economy Roadmap is an example of a document with a system-wide perspective on green economy transition which calls for economic, social and environmental innovations as well as for cross-cutting systemic actions (e.g. changing regulatory framework). Focused on concrete energy projects, the Power Africa programme demonstrates an integrated approach to innovation by promoting technology deployment as well as innovations in finance, organization of utilities and public sector, policy and regulatory framework. Their model considers both 'the hard infrastructure' (power plants and grids) and 'the soft infrastructure' (institutional capacity, policies, and regulatory frameworks) to manage the transition towards energy system based on renewables. These roadmaps appear to follow a different vision of the future determined by socio-economic logic in which a systemic consideration is needed for technological and non-technological forms of innovation.

All reviewed roadmaps have a high level of ambition in terms of supported innovation and wider societal transition. The ambition may be focused on introducing challenging technological innovations or on creating new collaborations and innovative governance models mobilising various actors (e.g. TIFAC's Technology Vision 2035, SPIRE, ICC Green Economy Roadmap, WBCSD's Vision 2050).

TIFAC's Technology Vision, for example, calls for 'National Missions' which should rely on innovative governance modes and implementation paths: "(…) these projects require circumventing bureaucracy and standard operating procedures [and] they also involve specific targets, have a defined timeline, possess a clear inventory of resources and constraints and require only a few (or single) carefully identified players." (TIFAC 2016: 98). TIFAC's manufacturing roadmap elaborating this vision, however, does not make this vision any more realistic as it does not introduce clear targets and milestones, and does not come with clear information on the follow up. This suggests a possible gap between the high level of ambition of desired innovation and the capacity to implement the roadmaps (actionability).

An interesting dimension featured only in a few roadmaps is the approach to perceived risk of innovation (e.g. TIFAC, Power Africa, SPIRE). Risk is an accepted ele-ment of innovation process (e.g. TIFAC's Technology Vision even considers perceived risk as a part of innovation ecosystem). The analysed documents approach risk as manageable and controllable much in the spirit of a technology man-

agement technique. The Power Africa programme has the most explicit approach to risk management and mitigation. The programme focuses on supporting 'first-of-their-kind' energy projects in order to 'de-risk' future similar projects. This is a rational model which assumes that lessons learned from projects implemented in specific social, economic and cultural contexts can be shared and applied in other contexts. Furthermore , it appears that despite being sensitive to the importance of non-technological innovation, the approach does not differentiate between different nature of risks associated with managing technological and non-technological innovations. The SPIRE roadmap, on the other hand, frames risk mainly from the market failure perspective; it considers the main source of risk in the uncertain nature of long-term investments in complex innovative projects. In this respect, the roadmap emphasises the role of public-private collaboration and risk sharing in carrying out high-risk projects.

Given the high ambition of supported innovation and systemic changes (e.g. energy transition), the roadmap documents devote little space to the reflection on risks and uncertainties linked with enabling and managing transformative change. The documents frame risk as something to manage and, when possible, mitigate. They do not reflect on what to do if risks of planned investments cannot be fully assessed or managed due to inherent uncertainties of system innovation, and how to adapt planned pathways should demonstration activities fail. It appears that the level of ambition of planned innovation activities is not reflected by the design of reviewed roadmaps.

5.4. Strategic prioritisation and specialisation

We reviewed the roadmaps to analyse the extent to which they encourage strategic prioritization and innovation specialisation in the most relevant areas for sustainability. The questions we asked were "Are the roadmap's objectives resulting from a strategic prioritisation process based on existing and emerging areas of specialisation?" and "Is the roadmap aiming at changing specialisation patterns to more effectively respond to sustainability challenges?"

The reviewed roadmaps differ substantially in how they approach strategic prioritisation. In general, when considering the question whether roadmaps are based on a strategic prioritisation process based on existing and emerging areas of specialisation, we revealed four modes of roadmapping processes:

- Roadmaps as an implementation tool: roadmaps focus on implementation of specialisation choices already made;
- Roadmaps as explorative scenarios: roadmaps explore and compare various specialisation options without engaging in strategic prioritisation (i.e. no reflection on which options will not be supported);
- Roadmaps as STI agendas: roadmaps put forward a long priority list of topics or technology areas requiring further investment and policy action;
- Roadmaps as a strategic policy planning: roadmaps put forward strategic priorities often based on exploration and comparison of specialisation options.

Roadmaps conceived to inform existing policy strategies and programmes typically reflect priorities and specialisation choices previously introduced by these documents. In this context, roadmapping processes develop pathways for varying numbers of preselected technology and innovation areas (e.g. 37 low carbon technologies in Japan's New Low Carbon Technology Plan).

The reviewed roadmaps focused on vision building and technology advocacy most often refrain from prioritising technology and innovation areas and opt for listing many relevant technology and innovation options relevant for the main challenge or sector. Roadmaps promoting broad future visions may call for a strategic prioritisation but themselves focus on exploring multiple areas with-

out explicitly prioritising any of them (e.g. TIFAC's Technology Vision in India or shift to a green economy in ICC's roadmap).

Roadmaps may be used to articulate and promote research and innovation agendas. These processes prioritise issues based on existing and emerging specialisations in science- and technology-based innovation. Business-led sectoral roadmaps addressed to policy makers come up with long lists of priorities and technology areas reflecting diverse needs and interests of these sectors (e.g. SPIRE, US Forest Products Technology Roadmap).

Some of the reviewed roadmaps incorporated a dedicated process to prioritise key technology and innovation areas (e.g. UK Renewable Energy Roadmap, CSIRO's Low Emissions Technology Roadmap, RISEnergy, Norwegian Process Industry Roadmap). The government-led UK Renewable Energy Roadmap, for example, selects eight priority technologies expected to contribute most achieving the 2020 target. The prioritization was based on commissioned modelling and evidence. Similarly, the CSIRO's Low Emissions Technology Roadmap comprised strategic prioritization of technologies considering deployment opportunities and Australian capabilities. The process was informed by energy system modelling, combined with a set of stakeholder consultation exercises focused mainly on the results of modelling.

In general, the role of roadmapping in respect to strategic specialisation appear to depend on its embeddedness and proximity to the policy process. In some processes roadmaps are implementation tools used to implement choices already made, much as in technology roadmaps which implement company's strategic choices. In others, roadmaps are routinely blended with other strategic planning and foresight tools, and effectively become part of the process of design, selection and strategic prioritization of technology and innovation areas. Several reviewed roadmaps combined elements of several foresight methods under one headline 'roadmap'. TIFAC Technology Vision and its roadmaps, for example, bring together elements of horizon scanning, visioning, scenario development and roadmapping.

Regarding the question on changing specialisation patterns as an expected out-come of roadmap implementation, most reviewed roadmaps express high-level ambition to contribute to a systemic shift towards more sustainable economy and society. Many documents demonstrate a good understanding of transitions pointing to the need of supporting technology and innovation as well as creating an enabling environment for the change. There is, however, only a limited reflection on sector and economy wide implications of system transition. Supporting changes in specialisation will have effects on existing socio-economic and socio-technical landscape. The roadmaps did not focus on how to manage phasing out of the established sectors and technology areas which need to be reduced or eliminated if sustainability goals are to be met.
While negative effects inflicted on competitors due to effective implementation of technology roadmaps are not a reason to worry, and even may become a metric of success for companies implementing technology roadmaps, policy roadmaps need to explicitly reflect on and measure wider distributional impacts of technology and innovation choices they promote.

5.5. Alignment and credibility

In considering this criterion, we looked at both the actions taken to engage stakeholders within the process of developing the roadmaps, and the extent to which the roadmap contents (e.g. visions, proposed actions, milestones, proposed actions etc) reflect alignment between stakeholders. This evaluation point focuses on whether the results of the roadmap process reveal alignment and credibility, rather than whether this was an objective of the roadmap design (which is discussed in 3.2 above).

The set of roadmaps reviewed indicate a spectrum of stakeholder engagement, from true authorship and ownership to arm's length consultation, with most road-maps featuring involvement.

from stakeholders at more than one point on that spectrum. Multiple factors appeared to impact how many stakeholders were able to 'own' a given roadmap and its contents. Most significant appears to be the decisions of the authoring institutions - organisations, but also project consortia and initiatives – as to what kind of engagement is appropriate. In many cases (CSIRO, TIFAC, UK RER), the limited, consultative engagement of stakeholders beyond the authors is by design. In other cases (e.g. SET Plan) the authoring group itself consists of some range of stakeholders, and consultation beyond that core group is likely limited as a practical concern. In still other cases (e.g. US Forest Products), the roadmap itself represents an explicit attempt to align stakeholders not otherwise connected by a relevant institutional framework.

The extent to which the roadmaps evince actual alignment between stakeholder strategies and actions also appears to vary depending on "skin in the game," that is, the extent to which the Roadmap has direct consequences for the participating stakeholders. The engagement of donor institutions in the PowerAfrica Roadmap and of research institutes and companies in the SPIRE and US Forest Products Roadmaps likely reflects direct financial implications of the recommendations developed therein. There may also be a trade-off between alignment and novelty. Where roadmaps reflect existing actions and concerns (PowerAfrica, SPIRE, Norway ERA), alignment between content and stakeholder positions is more explicit; where Roadmaps ask stakeholders to embrace novel views or positions the alignment of stakeholders is less clear.

5.6. Actionability

Closely related to the question of stakeholder alignment is that of actionability: What are the mechanisms by which roadmaps are implemented? Do these reflect the absorptive and implementation capacity amongst the impacted stakeholders?

The roadmaps authored by government departments in the UK, Japan, and Norway tend to concern themselves with implementation capacity and actionability, though the analysis of these factors is often limited to a macro level assessment, and lacking the specificity of, for example, an ex-ante impact assessment.

In private-sector and research-driven roadmaps, actions related to policy seem to come in the form of an 'ask' from one stakeholder group to another (e.g. from industry to government or from civil society to industry). In these cases actionability becomes a problematic framing; the proposals in these roadmaps can be seen as part of a societal negotiation rather than as guidelines for action. SPIRE and the US Forest Products roadmap develop research agendas. In this sense they are also 'negotiation' roadmaps, but when successfully attached to a public research programme (as was the case with SPIRE) they can become highly and specifically actionable.

The Power Africa Roadmap represents something of an outlier in this regard, as the process and document seeks to support and strengthen on the ground (trans)actions already underway, and to align them with a long-term pathway, rather than to identify and initiate these (trans)actions. In this case the roadmap is almost entirely concerned with actionability and implementation capacity.

5.7. Coherence

The coherence criterion relates to whether and how well the roadmaps relate to wider science, technology, and innovation policy mixes, including sustainability strategies and policies and the sustainable development goals. On the evidence of the roadmaps reviewed, it appears that these processes and documents tend to inherit their relationships to superordinate policies from their immediate institutional context. Thus a roadmap authored by a government department will refer to the politically established goals for its area of authority; an industry will refer to policy targets or objectives relevant to its activities; etc. This approach was consistent across almost all the reviewed roadmaps.

This approach is simplifying and supports a direct, one-degree-of-separation consistency between important policies and roadmaps. However it can also create blind spots, particularly where systemic innovation is of the essence. The Norwegian ERA roadmap is highly specific and tightly proscribed by the ERA process, but is virtually silent on sustainability goals or policies, either within Norway, in the EU, or globally. The WBCSD's Vision 2050 is deeply rooted in global sustainability objectives, but perhaps inevitably remains disconnected from the national policy contexts that will be crucial for driving private sector action.

An exception in the direction of good practice is Japan's low-carbon technology plan, which highlights the policy-market dynamics and domestic-transnational considerations as essential to implementation.

5.8 Evaluation, learning and adaptability

One of key features of technology roadmaps used as a management tool is that they comprise a system of monitoring and evaluation of progress towards agreed targets and allow for adaptations and revisions of pathways and milestones. We reviewed the selected roadmaps considering the extent to which they support on-going learning and whether they include mechanisms allowing for adaptation of its elements based on new evidence. Whilst some of the reviewed documents included monitoring and evaluation system, we found relatively little focus on the process of learning and adaptation.

Regarding monitoring and evaluation systems, roadmaps supporting existing programmes and strategies tend to rely on the systems set up for these programmes. This appears to be a good practice at first sight. Given, however,that roadmaps addressing sustainability challenges often cover time horizons stretching beyond formal programming periods, the overreliance on programme's monitoring data may be a considerable gap. Roadmapping processes requires a stable monitoring and evalua tion framework covering longer-than-usual time horizons relevant for sustainability challenges and the SDGs. The evaluation systemsare key for an on-going learning and potential adaptations of the roadmap in response to the changing context. Most of the reviewed initiatives have no or only generic provisions for reviewing and adapting the roadmaps. Several roadmapping documents invite feedback from stakeholders and make commitments to conduct regular revisions but either have not fully delivered on them despite explicit commitments (e.g. UK Renewable Energy roadmap had only two annual updates following its formulation in 2011) or there is no evidence of any systemic follow-up (e.g. SPIRE, ICC Green Economy Roadmap).

The reviewed roadmapping initiatives offer elements of good practice in monitoring and evaluation. One approach to monitoring and evaluation involving elements of learning was developed by the Power Africa programme. The roadmap elaborates evidence-based approach to making assumptions about reaching the quantitative targets of the programme based on the notion of 'lead times' (or time lags) to reach financial close and to complete construction of renewable energy projects by 2030. It includes data on 'lead times' for the major renewable energy technologies comparing them with the global average. The progress of Power Africa projects was estimated for 2020, 2025 and 2030 based on the transparent assumptions on lead times. Based on the observed progress in project implementation on the ground, the programme can adjust its assumptions. Importantly, the roadmap document does not introduce new targets but is designed to explain how the targets introduced by its 'mother' programme itself can be met. The programme is based on the learning-by-doing approach where lessons learnt during implementation are used to add regional and country-specific and technology- specific advice. The roadmap does not explain, however, how lessons learnt and evidence collected during the implementation can be used to prevent or learn from possible project failures.

Another noteworthy approach was developed by Planning Institute of Jamaica to support Jamaica's Vision 2030 National Development Plan. The Institute developed a transparent system indicating progress towards Jamaica's developmental goals. Importantly, the system was made available to all stakeholders and the general public through an online dashboard with indicators based on key NDP objectives[2]. During a dedicated SDG workshop focused on monitoring SDG 7 (Affordable and Clean Energy) and SDG 9 (Industry, Innovation and Infrastructure), the main concern identified by stakeholders was on how to 'translate' monitoring data into insight on the barriers and on adequate policy response[3], which suggests the existing system has to further develop its learning and adaptation capacity.

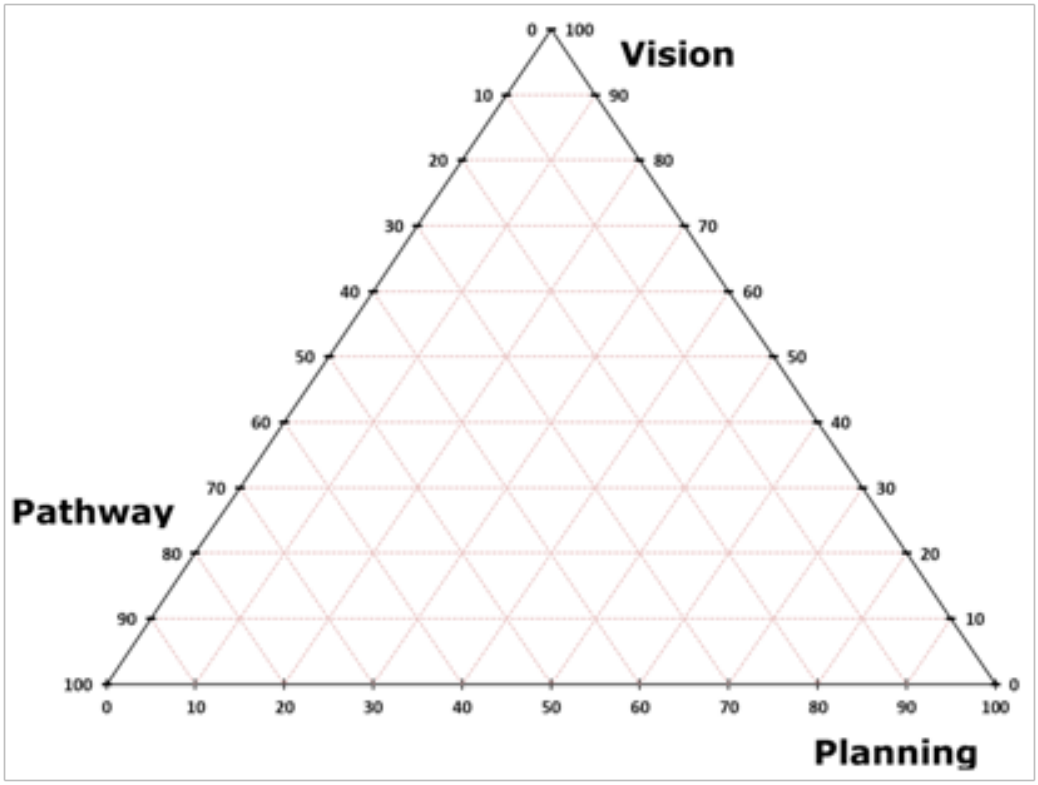
In general, most of the reviewed roadmapping processes have not created learning environments allowing for a reflection and adaptation of pathways following different than assumed outcomes (including failures or unexpected successes) and changing contexts.

6 KEY FINDINGS

The use of roadmaps as a strategic framework and a tool to support policy processes reflects different understandings about what a policy roadmap is. As demonstrated above in some cases roadmaps were considered implementation tools, in the innovation and technology management tradition. However, roadmapping techniques are routinely blended with elements of other strategic planning and foresight tools (such as vision building, horizon scanning or scenarios) under one headline 'roadmap'. Roadmaps serve diverse functions ranging from constructing shared meanings and visions to managing implementation of concrete projects on the ground. It appears 'roadmap' may have been appropriated by policy makers to describe various forms of strategic documents attempting to bridge high-level visions and action plans.

Roadmaps typically combine three future-oriented components: a vision, a pathway (or multiple pathways) and an action plan, all based on the available evidence on historical developments and emerging trends. While most of the reviewed roadmapping initiatives embody some features of these, they differ in their emphases. Figure 3 maps several of the reviewed roadmaps on a triangular diagram showing the distribution across the differing emphases. The nature of these three elements differs across the roadmaps explored. In some, the 'vision' is little more than a quantified target such as the renewable energy target in the UK's renewable energy roadmap. In others, the vision is a less precise and more qualitative depiction of a desirable future state as in the Roadmap to a Resource Efficient Europe (EC 2010).

Figure 3. Mapping policy roadmaps: blending visions, pathways and planning



Similarly, the 'pathway' dimension differs in its emphasis. Some roadmaps emphasise specific technological milestones and developments such as cost or performance targets. These are the closest to classic 'technology roadmaps', setting out milestones and expectations for key developments in defined timeframes. Others are framed in terms of broader technology pathways, depicting (often quantified) transitions in technological system configurations that meet the vision. These are often drawn heavily from techno-economic models.
Still others are framed as broader narratives that encompass technological, political and other dimensions, with prominent public policy elements. Pathways in the roadmaps closely aligned with ongoing policy instruments typically reflect programme theories underpinning instruments they support, or are used to communicate and clarify the logic of the programme (e.g. PowerAfrica).

Pathways reveal assumptions on mechanisms of change expected to be triggered by policy intervention. This is highly relevant from the sustainability transitions point of view wherein theories of change should indicate how policy instruments are to deliver on sustainable development goals. The lack of robust reflection on pathways is probably the most significant gap in most of the reviewed documents. Theories of change explaining plausible mechanisms and dynamics of change are weakly articulated, left implicit or embodied in underlying models.

Finally, roadmaps differ in the way in which they articulate a plan of actions to be taken. For some roadmaps, plans are articulated as 'promises' – steps that leading actors are committing to take. This is most common with roadmaps produced by governments. But the 'planning' elements of roadmaps are often more aspirational: recommended sets of actions, with little sense that any actors feel bound to implement these actions. Moreover, there is divergence in whether plans are static, or whether there is a blending of the 'planning' element with the 'pathway', articulating steps that will/should be taken now and at various stages in the future.

Considering the common characteristics of roadmaps introduced in the introduction, we argue that policy roadmaps addressing sustainability issues should integrate and seek synergies between three future-oriented perspectives. It is the combination of these dimensions that defines the roadmap, as distinct from a purely exploratory scenario exercise (vision and pathways); a strategic plan (planning only, or plan and vision); or a vision (vision only). Importantly, the connections between vision, pathways and planning should not be conceived as only linear; the design of roadmap should allow for iterations between these elements (e.g. quantitative targets could be adapted based on assessing feasibility of innovation pathways). We could argue that processes found at one of the poles or edges of the triangle might not be considered 'real' roadmaps. At least these do not fully exploit the potential of roadmapping. To tap into the potential of the process, STI roadmaps can benefit from the use of various tools and methods selected to meet specific objectives and vision.

Based on this review, we propose to consider policy roadmaps as strategic framework of action promoting a shared vision and directionality of policy mix by promoting policy learning environment, alignment of key stakeholders and seeking synergies between policy instruments to achieve sustainable development goals. STI roadmaps for sustainable development need to prioritise directionality over a search of horizontal consistency and coherence. If STI roadmaps are to become instruments promoting sustainability transitions they may need come with a mandate to disrupt status-quo and reorient policy mix into towards a shared vision.

7 DISCUSSION POINTS: STI POLICY ROADMAPS AND SUSTAINABILITY TRANSITIONS

In this paper we set out to reflect whether and how policy relevant roadmaps can support design and implementation of STI policies contributing to the transition towards long-term sustainability goals. Viewed from sustainability transitions perspective, roadmaps can become versatile policy instruments supporting directionality and temporal coherence of policy mixes. Their principal contribution is to bridge long-term visions with short-term action plans by deliberating innovation pathways towards long-term targets.

There are, however, several issues regarding policy applications of roadmapping to support sustainability transitions which may become a source of tension. Some of these issues stem from the fundamental differences between the context of policy-making and governance and the practice of business and technology management in firms where roadmaps are routinely applied. Bringing rational business management techniques into policy process requires reflection and redesign taking into account specificity of public policy and governance dynamics. This review points to a number of questions on the current use of policy roadmaps in areas relevant for sustainable development.

How can STI policy roadmaps support strategic prioritisation while encouraging plurality and variety of transition pathways?

Sustainability transitions require a variety of innovations and technologies to be tested and experimented with in various contexts (Steward 2008). Stirling (2014) argues for "emancipating transformation' by ensuring variety: "hopes for genuinely progressive 'green transformations' are not about fear-driven technical compliance, but hope-inspired democratic struggle and choice". Could roadmaps as policy instruments support a variety of innovation pathways?

The roadmaps examined in this review display a tension between 'opening up' (acknowledging & fostering multiple possible pathways; recognising deep uncertainty) and 'closing down' (committing to a narrowly defined single view of the future; playing down uncertainties) (Stirling 2007, 2014). In the context of technology roadmapping, McDowall (2012) described this tension as a 'roadmappers' dilemma': "On the one hand, a confident, prescriptive roadmap developed on the basis of a consensus of a subset of relevant (and powerful) actors will have most influence. Yet on the other hand, this is likely to reflect incumbent interests—who are often precisely those interests tied up with a less-sustainable socio-technical system and, by focusing on a narrow view of what can and will be done, it can downplay uncertainties and alternative pathways".

Roadmaps produced by public policy organisations might be expected to be particularly sensitive to the need to acknowledge diverse interests, but this might depend on whether the roadmap is promoting a broad strategic vision or is associated with a specific programme or project. In the former case, a roadmap should be recognising uncertainty, and the diversity of possible pathways, and assuming responsibility to avoid excessive 'closing down'. On the other hand, a roadmap that is associated with the implementation of a specific programme, or that is focused on the development of a specific sector or technology, might be based on a wide strategic framework that recognises uncertainty and plural pathways (an 'opened-up context'), but might itself be tightly committed to single or several specific pathways (i.e. closed down).

In the context of sustainability transitions, which require a strong directionality, these two perspectives could be part of the same roadmapping framework. STI roadmap could cover, for example, programmes allowing for designing and experimenting with alternative innovations in various regions. Depending on the lessons learned from these situated experiments, policy makers and stakeholders could then adapt the roadmap to focus on the most promising pathways or – in case of failure - try new alternatives. In this approach, prioritisation is a deliberative process based on learning from experimentation. The emerging framework for STI roadmaps for sustainable transitions could

benefit from lessons learned and failings of programmes which themselves encouraged experimentation with a view to mainstream good practices in mainstream policy support (e.g. Regional Programmes of Innovative Actions co-funded by the EU Structural Funds).

How can STI policy roadmaps tackle the uncertainties and risks inherent in system innovation and sustainability transitions?

Sustainability transitions and system innovations are uncertain and risky (Kemp et al 1998, Geels 2005, Altenburg and Pegels, 2012). This review revealed that roadmaps rarely elaborate approaches on how to address and manage risks and uncertainties linked to innovation and technology areas. The mentions of risks are frequent but overly generic (e.g. the need to share risk between private and public sector in SPIRE) whereas uncertainty is rarely brought up. This echoes Stirling's claim that 'despite the impression given by apparently benign-sounding policy language around minimising 'risk', seeking 'consensus', fostering 'trust', enabling 'participation' or promoting 'responsibility' – collective capacities for open, progressive, plural, critical political discourse are increasingly undermined' (Stirling 2014). Could STI roadmaps be seen as policy learning processes encouraging such an open discourse on risk and uncertainty? Further, how can STI roadmaps address risk and uncertainty of system innovation and sustainability transitions in their design? How can they encourage system innovations, and explicitly account for the risk of failure?

Adaptability is among key features of roadmaps allowing companies to take anticipate problems and take appropriate action in case of implementation issues or changes in external environment. Since STI roadmaps tackling sustainable development comprise processes and initiatives far more risky and complex than most technology roadmaps, they could devote a reflection on the nature of risks and include explicit mechanisms to anticipate them and take corrective action in case of failures (or unexpected success) or significant changes in the context. Adaptability of the roadmap depends on the ability to learn throughout the implementation process, which is greatly helped by well-designed monitoring and evaluation systems.

While STI roadmaps alone are clearly no panacea for systemic shortcomings and failings of policy process, we argue that, with its focus on ambitious innovation and emphasis on learning and adaptability, STI roadmaps could be used to help to reframe discourse on risk, uncertainty and failure. For example, elaborating alternative innovation pathways towards the SDGs can help to assess and compare risks and uncertainties of these alternatives. Pathways can also help in assessing distributional impacts, and identify potential 'winners and losers' of alternative technology and innovation choices. This comparison can help to choose more resilient policy options and better inform decisions to invest in risky innovation projects.

What is the role of STI policy roadmaps as a tool in network governance, mobilising stake-holders to learn and innovate, including most vulnerable groups?

System innovations require mobilisation of many stakeholders and resources (Smith et al, 2005). To what extent can policy-driven STI roadmapping engage diverse actors and foster an inclusive mode of transition governance? There is little evidence in the reviewed roadmaps of innovative ways of engaging stakeholders in formation and implementation of roadmaps. We argue that public policy organisations that develop STI roadmaps focused on sustainability transitions could consider mobilising a variety of stakeholders from the outset of the roadmap design, and engage them collectively in co-designing of alternative innovation pathways. This is linked to seeing STI roadmaps as collective learning processes that engages diverse groups of stakeholders. Due to geographical proximity, STI roadmaps conducted on regional and local levels may be better suited to including vulnerable and excluded social groups, including informal sector.

Can policy-makers generate more politically robust learning through the promotion and use of multiple and diverse STI policy roadmaps?

The politics of sustainability is inherently a societal negotiation between multiple objectives and stakeholders often requiring trade-offs. This suggests that there is a need to rethink the role of the roadmap as a policy instrument influencing policy. Rather than simply improving methods and processes for developing individual roadmaps, there may instead be a need for synthetic analyses, with an explicit recognition of the political economy thinking at play in different cases, in order to make roadmaps more useful tools in policy formation. From a governance perspective, actions and recommendations proposed in various roadmaps could be handled through a portfolio approach which encourages plurality and variety of innovation pathways. This approach would consider the strengths and potential synergies as well as weaknesses and trade-offs of different roadmap processes. This approach could be underpinned by a learning environment in which lessons learned from successes and failures of roadmap implementation are exchanged between various stakeholders.

Can STI policy roadmaps be used to disrupt dominant regimes and phase out unsustainable practices?

Kivimaa and Kern (2016) argue that STI policy for sustainable transitions should include elements of creative destruction by both supporting new sustainable innovations and destabilising unstainable regimes. Could STI policy roadmaps align with this "creating new and destabilising old" approach? Could policy-led roadmaps be used to explicitly support disruption? How to make such policy instruments legitimate and credible? In this respect, one could argue that by prioritising directionality over a search for policy consistency and coherence STI roadmaps for sustainable development may be considered as instruments of creative destruction by supporting niches emerging in response to societal challenges which may challenge innovation pathways pursued by incumbents.

8 CONCLUSIONS AND LESSONS FOR POLICY MAKERS

Policy proclamations on the usefulness of, and need for, STI roadmaps appear to neglect the huge diversity of roadmapping practice observed in the STI arena. Calls for roadmapping may be answered in a wide variety of ways, not all of them useful, and some embodying rather narrow views of the future that fail to represent diverse interests or the scale of systemic uncertainties involved in achieving sustainability.

While there are good grounds for thinking that roadmapping can be a useful tool across a number of governance processes, current roadmapping practice falls short in a number of ways, which we summarise briefly below:

- Weak follow-up: failure to bridge vision with action (inherent problem of foresight)
- Limited link to experimentation (e.g. testing pathways)
- Weak embeddedness in policy mix
- Weak reflection on theories of change in pathways
- Weak reflection risks and uncertainties
- Weak reflection on governance of roadmaps
- Limited adaptability and learning.

In light of the current resurgence of interest among policy audiences for STI road-mapping in support of the SDGs, there is a clear need to ensure that roadmapping becomes a strategic framework promoting transformative change rather than simply a vehicle for reproducing incumbent socio-technical systems and structures. The fact that there is not a single blueprint or protocol for the methodology or format of the roadmapping process should not prevent policymakers from embarking on it.

Lessons for design and implementation of STI policy roadmaps for the SDGs

Where are we?

- Policy roadmaps require a comprehensive and robust baseline analysis based on available evidence and expertise.
- Roadmaps should be based on analysis of similarities and differences in the way different stakeholders perceive and understand the scope and nature of addressed challenges.

Who are we?

- Policy roadmaps can pertain to any chosen group of stakeholders at different geopolitical levels, including a continent, region, country, city, etc. They may also have different levels of ambition, priorities, and bargaining power. It is crucial that within the group a common direction can be agreed upon (where do we want go), while the distance to target and the capacity of single stakeholders to achieve it may vary (e.g. STI Strategy for Africa 2024).
- Policy roadmaps are not only about policy makers. Neither their formulation has to be initiated by them (e.g. Leading the cycle. The Finnish roadmap to a circular economy 2016-2025) nor their implementation has to be their single responsibility. In this regard it is important to design the roadmaps as inclusive and participative processes, so that all stakeholders have a feeling of ownership. This is also a prerequisite for successful execution of tasks allocated to them in the roadmap.

Where do we want to go?

- STI policy roadmaps for the SDGs can have a variety of goals but their level of ambition needs to be high given the ambition of Global Goals.
- Policy roadmaps may concern a variety of areas with different levels of detail, reaching from a specific technology (e.g. UNIDO/IEA Technology Roadmap - Carbon Capture and Storage in Industrial

Applications), through entire sectors (e.g. South Africa's Water Research, Development, and Innovation (RDI) Road-map: 2015-2025) to broadly understood socio-economic development challenges (e.g. ASEAN Plan of Action on Science, Technology and Innovation (APASTI) 2016-2025). Regardless the focus area, it is important to precisely define its scope. This process usually occurs as part of the roadmapping exercise and may follow different approaches, i.e. it may be designed bottom-up or top-down. In each case it will require consensus between stakeholders, as well as prioritisation of topics of interest.

- After the delimitation of the roadmap area, it is crucial to capture the status-quo on the one hand, as well as to define the state desired in the future, which will allow for identification of gaps.

- Quantification of baseline and future goals is recommended – this is key for a reliable monitoring of the roadmap implementation impact.

How do we go there?

How do we go there?

- As soon as the stakeholders know 'where they are' and 'where they want to go', they may decide how to achieve the vision. This should involve identification of existing mechanisms which prevent the change as well as of those which support it and should be strengthened.

- There may also be a need for creating new mechanisms such as innovation and research agendas, new patterns of cooperation between different stakeholders.

- It must not be overseen that roadmaps, in the framework of which the chosen mechanisms are mitigated, strengthened or created, do not exist in a vacuum, but are woven into a wider structure of policies/ research agendas/ business models/ cooperation patterns/ etc. vertically (at different geopolitical levels - nationally, regionally, internationally, globally) and horizontally (in various sectors).

- Due to the high level of its complexity, the roadmap should also foresee approaches to the management of risks and uncertainties.

- Policy roadmaps addressing sustainability issues should integrate and seek synergies between vision, plan and pathway. It is the combination of these dimensions that defines the roadmap, as distinct from a purely exploratory scenario exercise (vision and pathways); a strategic plan (planning only, or plan and vision); or a vision (vision only).

- The connections between vision, pathways and planning should not be conceived as only linear; the design of roadmap should allow for iterations between these elements (e.g. quantitative targets could be adapted based on assessing feasibility of innovation pathways).

What should we do?

- The mechanisms, by which the roadmap goals are going to be achieved, have to be operationalized as concrete actions, i.e. it has to be made clear who (which stakeholder) should do what (which task with which outcome), how well (which target) and when (which deadline).

- An important issue is what the cost of actions is and who should bear it.

- A successful roadmap should also foresee a sound governance structure, including a system of monitoring and task execution, which would ensure an uninterrupted implementation of the document as a whole.

- Due to the fact that various actions and mechanisms are interrelated, any failure may result in undermining the roadmap objectives. In this context, as well as due to long implementation horizon and evolving external circumstances, the action plan should allow for adaptive learning. Roadmaps do not have to be static documents, but may be amended ed along the process of their implementation.

- In addition to the monitoring of implementation progress, it is also advisable to establish a system tracking the implementation impacts. As the main idea behind roadmapping process is to achieve a certain objective, the distance to it should be assessed along the way. This would allow for any corrections and amendments of actions and mechanisms.

End notes

[1] Feedback and input on the Jamaican case from RuurdSchoolderman, TNO, are gratefully acknowledged.

[2] http://devinfolive.info/dashboard/Jamaica_vision2030/index.php

[3] Communication with the workshop facilitator.

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ABOUT

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