

## CHAPTER 2

# Transformative Innovation Policy: Insights from Colombia, Finland, Norway, South Africa and Sweden<sup>1</sup>

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Numerous and critical interlocking economic, social, environmental, technological, political and cultural challenges confront our world. These challenges include resource depletion, environmental degradation, population growth, industrialisation, climate change, urbanisation, inequality and exclusion. These challenges are expressed in various national, regional and continental frameworks. One such continental framework is the United Nations Agenda 2030, which articulates 17 sustainable development goals (SDGs) towards addressing such challenges (United Nations 2015). These challenges concern both low- and high-income countries, and they exceed the ability of any single country, government, body of governance or scientific discipline to manage them.

While innovation is widely invoked as essential to addressing these challenges, the innovation engine often appears to be faltering with the fruits of creative destruction increasingly morphing into destructive creation (Soete 2013; Swilling & Annecke 2012). Innovation may become as much part of the problem as the solution. The ambivalent and open-ended nature of innovation needs be incorporated into the thinking about science, technology and innovation (STI) policy. In this chapter, we argue that innovation needs to be redirected in ways that lead to transformative change, and that for transformative change to take place, a different type of policy and policy-making is essential – transformative innovation policy (TIP). In this sense, innovation policy needs to incorporate concerns that relate to the choice of various innovation options, asking questions about which directions of innovative pathways will indeed address the pressing global challenges confronting our world.

This type of thinking about alternative innovation pathways has begun to be articulated under many different labels, for example, responsible research and innovation (RRI) (Stilgoe, Owen & Macnaghten 2013), inclusive innovation (Agola & Hunter 2016; Chataway, Hanlin & Kaplinsky 2014), social innovation (Joly 2017; Mulgan 2007), grassroots innovation (Gupta 2012; Smith & Seyfang 2013; Smith, Fressoli & Thomas 2014), frugal innovation (Radjou & Prabhu 2014), and innovation for inclusive development (Daniels, Ustyuzhantseva & Yao 2017; Organisation for Economic Co-operation and Development [OECD] 2012, 2013). While differing in many aspects, the basic and recurrent themes of these approaches are attention to alternative futures and the co-production of STI with society; emphasis on the non-neutral nature of technology; and greater consideration for the environment. Other themes include emphasis on the transformative potential of civil society, attentiveness to the needs and wants of users and non-users alike, and the necessity for innovation to respond better to the needs of lower-income segments of our societies.

<sup>1</sup> An earlier version of this chapter was presented as Chataway, Daniels, Kanger, Ramirez, Schot and Steinmueller (2017): 'Developing and Enacting Transformative Innovation Policy: A Comparative Study' at the 8th International Sustainability Transitions Conference, 18–21 June 2017 in Gothenburg, Sweden.

Integral to the new approach to STI policy should be a concern with the transformation of socio-technical systems rather than a focus on technological innovation in specific industries and sectors. This concern is also inspired by the sustainability transitions literature (Grin et al. 2010; Schot & Steinmueller 2018). The main argument for the need for transforming these systems is that optimising existing institutions and practices in individual sectors – such as energy, healthcare, mobility, agriculture, food, communication and water management – will not lead, over the medium and long term, to an adequate response to defined societal challenges such as those encapsulated in the SDGs. In other words, a systemic approach is required. Problems are embedded in the fundamental framing of socio-technical systems and reforms which ameliorate externalities and negative impacts may extend the lifespan of existing socio-technical configurations but might not resolve underlying problems. For example, changes to taxation may lead to resource redistribution but will not provide incentives for different patterns of investment in innovation and economic growth, which could have a more direct and lasting impact. Investment in health systems may lead to short-term improvements in people's ability to access healthcare but long-term pressures on health budgets and demographic changes mean that more radical changes in health, social care and approaches to wellbeing will be needed.

## The Transformative Innovation Policy Consortium

The Transformative Innovation Policy Consortium (TIPC) was formed in 2016 at the 50<sup>th</sup> anniversary conference of the Science Policy Research Unit (SPRU) at the University of Sussex. The TIPC is designed to allow members to co-create a shared understanding about new ways of using STI to directly address economic, social, and environmental challenges (Schot et al. 2017). In its pilot phase, from 2016 to 2017, the TIPC carried out national reviews of STI policies combined with case studies involving five countries – Colombia, Finland, Norway, South Africa and Sweden. The objective of the pilot year was to undertake a mutual learning process between policy makers and researchers with a view to understanding existing efforts to move policy in a more transformative direction.

The TIPC, a global consortium of innovation policy agencies and funders, brings together policy makers and researchers, with a view to documenting the emergence of new ways of framing innovation policy in specific country contexts. In addition, working within this global context of co-creation, TIPC work also explores new approaches to evaluation and governance of innovation policies and capacity building to support transformative innovation policy-making. The theoretical underpinning for the consortium's work, that is, the new framing<sup>2</sup> referred to as TIP (or Transformative Innovation Policy), is inspired by Schot and Steinmueller (2018), (see also Diercks, Larsen & Steward 2019; Steward 2012; Weber & Rohracher 2012). This new framing is informed by theoretical perspectives and literature on innovation and sustainability transitions/transformation and relates to other broader sets of literature, including political economy perspectives and evolutionary economics. TIP ideas question and address the relationship between STI, economic priorities and benefits and social, environmental and sustainability objectives.

The goal of the TIPC is to strengthen innovation, including S&T policy formulation, implementation, evaluation and governance in order to ensure better prospects for achieving transformative change across structures, systems and societies. In this chapter, we provide further background to the TIPC and discuss insights from the work of the consortium in its pilot period year in 2016–17. The following questions underpin the discussions that follow:

1. How can we differentiate between ways of framing research and innovation policy?
2. What are some of the emerging issues involved in promoting transitions to sustainability and formulating and implementing TIP?

2 The three frames of Innovation Policy, discussed further in Section 2.

### 3. What are some of the challenges, barriers and potential pitfalls to transformative innovation policies and policy-making?

Based on Schot and Steinmueller (2018), we briefly characterise two dominant innovation policy frameworks and introduce a third alternative, the new framing. The appendix provides an overview table which fleshes out the three frames. Based on the consortium's pilot year work in 2016 and 2017, we then present a number of issues that the consortium is currently working on in developing TIP initiatives.

## The three frames for innovation policy

Before presenting different ways of framing research and innovation it is important to caveat the analysis. We recognise that the frames below are not water-tight, nor static categories. The three frames (1, 2 and 3) overlap and influence each other but they do not replace each other. They need to be combined. At this stage, Frame 3 is only emerging and it represents a variety of types of policy framings and interventions aimed at directly addressing economic, social and environmental issues related to research and innovation (R&I) and S&T. The characterisations of the frames should therefore be seen as evolving and an attempt to better understand the nature of innovation-related policies and interventions, broadly, rather than as detailed and finalised categories.

### Frame 1: Research and development and regulation

The conceptualisation of the relationship between Research and Development (R&D) and innovation in this frame is quite straightforward. Research (or science) leads to innovation. In this conceptualisation, the key challenge is to invest in research in an enabling way. This frame emerged out of the 2<sup>nd</sup> World War and in the aftermath of the scientific milestones that occurred in those years as a result of significant investment in R&D in addition to regulation. The main justification for investment in research under this frame of thinking revolves around market failure. Market failure argues that it is not possible for private sector funders to recoup investment in basic research, resulting in a 'tragedy of the commons' (Hardin 1968) – no single entity from the private sector will invest in the public good of knowledge. In this way, Frame 1 provides a rationale for why the state needs to step in to fund basic science and research. A further element is the thinking that excellence in science and research (Tijssen & Kraemer-Mbula 2017; Chataway & Daniels 2020) leads to innovation, which in turn can lead to economic growth. In response, governments in Europe and in the US began to expand the research funding architecture. Consequently, institutional support mechanisms, such as peer review and other 'supply-push' mechanisms, began to take hold.

The decades that followed from this expanded investment in research and S&T witnessed a rapid growth in new technologies and economic growth, along with the expansion of sectors and industries such as agriculture, aviation, transport and health. However, alongside this rapid growth came new challenges to the environment and health. In addition, a raft of negative consequences of technological advances began to emerge (not unlike that which was seen after the Industrial Revolution). In keeping with the predominance of science and scientific expertise, these environmental and health consequences from the 1960s onwards were dealt with through science-based regulation. In addition, a parallel infrastructure began to emerge to link experts with policy makers around regulating STI (see for example Jasanoff 1990).

The implications of this approach resulted in the dominance of the so-called 'linear model' of innovation, based on the notion that science or research leads to innovation. While we now appreciate that

the rhetoric of such a linear model failed to capture the complexity of the innovation process, it nevertheless prevailed in policy circles for many years and is still influential in 'pure' or modified forms that see the state investing in the supply of basic and more applied R&D.

## Frame 2: National systems of innovation

During the 1970s and 1980s, increased economic pressures and international competition began to expose the limitations of the first policy framework (namely innovation policy-making based on Frame 1). Differences in countries' ability to withstand economic shocks became more apparent and the lack of substantial progress in bridging the gap between the poorest and richest countries in the world caused concern.

One major issue that analysts such as Nelson (1993) began to note is that research does not flow freely. Knowledge is 'sticky' and tacit and difficult to transfer. Countries also do not follow a similar path; varieties of development pathways persist. Development is bound in complex ways with the institutions that produce it. Evolutionary economists such as Dosi (1982) and others began to write about the importance of path dependence in innovation – essentially arguing that countries should follow their own established pathways, and not try to break from established routines and practice in order to follow an idealistic model.

To capture these complexities, numerous scholars from different disciplinary and intellectual backgrounds increasingly began to refer to a variety of innovation systems (Freeman 1982, 1987; Lundvall 1992; Nelson 1993). The capacity, capabilities and nature of the relationships between organisations and institutions in any 'system', be it national, regional or sectoral, deeply impact the rate and nature of R&I that occurs. This framework shifts attention from the creation and diffusion of research to a consideration of how institutions and organisations function and interact (and create demand for research). In this conceptualisation, it is the (interactive) learning and absorptive capacity between different actors in the system which emerges as important, as well as entrepreneurship (the availability and readiness of actors to bring research to the market). This gave rise to the National Systems of Innovation (NSI) approach to science and technology (S&T), and latterly, innovation policy-making. This framing is referred to in this context as Frame 2.

## Frame 3: Transformative innovation policy

In the last decade (since 2010), STIs have been widely invoked not simply as the foundation for future growth strategies but as an important component for resolving a range of social issues such as agricultural, environmental and health challenges. The view of R&I as socially relevant in a multiplicity of interdependent ways, as well as economically beneficial, has led to increasing recognition that the first two policy frames are not well suited to this ambition. This is because neither Frame 1 nor Frame 2 conceives R&I in ways targeted to the scale of transformation that is needed to address complex societal and developmental challenges.

The relationship between R&I in this frame is not focused on ensuring that innovation happens (as fast and as much as possible) but about the direction of innovation. In addition, it is important whether innovation addresses social and environmental challenges, alongside economic goals. A differentiating feature of Frame 3 is therefore the conception of directionality failure (Weber & Rohracher 2012). For the notion of directionality, see Stirling (2007, 2008, 2009). In Frame 1, the challenge is to overcome market failure, whereas in Frame 2, the challenge is to link up organisations and actors which enable

effective relationships for research translation into innovations with (commercial) impact. The aim in the policy approach of Frame 2, therefore, is overcoming institutional failure and shaping markets. Frame 3, however, grapples with directionality failure, or 'needs failure' – a failure to address how to meet social and environmental needs with STI (acknowledging that these needs are not predefined or given but are to be explored in the process too).

Meeting development needs depends on bringing together a diverse understanding and engagement of a wide range of stakeholders across all stages of R&I pathways in non-linear ways. This calls for a stronger shift towards a culture of co-creation or co-production of knowledge (for example science and research) with formal and 'informal' innovation systems actors. Formal in this sense refers to main innovation actors, such as academia, industry and government, while informal relates to innovation systems actors, usually considered to be at the periphery of the innovation ecosystem such as civil society and grassroots innovators. This is consistent with recent research in four African countries which show that policy learning and policy experimentation that incorporate actors and innovations from the informal sector are essential to achieving transformative change through innovation (Daniels, 2017; Daniels & Ting 2019).

Furthermore, there is a need to rethink the governance of STI, research and policy. Rooted in theoretical work on socio-technical transitions and long-term transformative change, initial thinking about Frame 3 indicates that experimental approaches which will challenge existing socio-technical patterns are important. Coordination among actors can emerge through these experiments. Even where new macro level institutions aiming for coordination emerge and signal the need for new direction, such as national councils for innovation, any profound change will revolve around bottom-up socio-technical transitions achieved through opening up a range of options, experimentation, learning, networking, and participation. This thinking underpins the work of the TIPC.

## **How does each frame address social, economic and environmental challenges?**

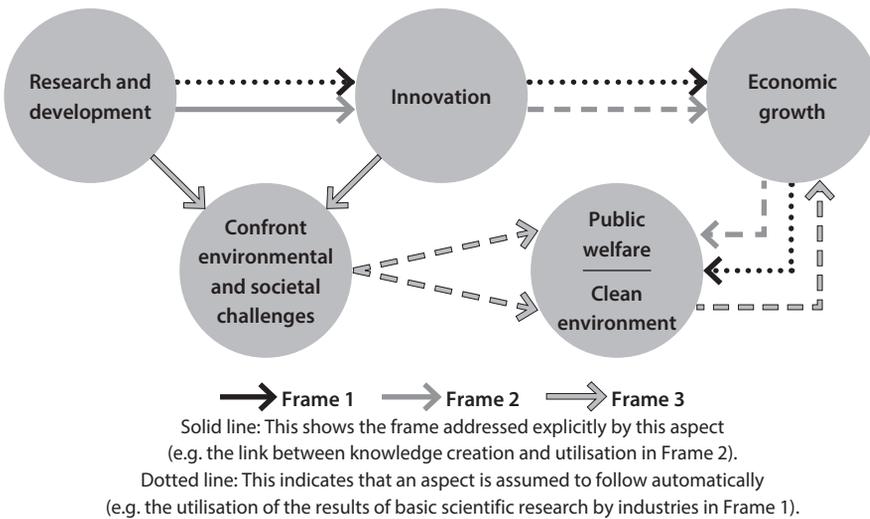
While Frame 3 is explicitly aimed at directly addressing societal challenges, each frame is, in principle, able to address social needs and environmental issues. Frame 1 would suggest mission-oriented R&D focused on challenges associated with social needs and the environment and the regulation and organisation of a social benefit system to compensate those who were left behind. It is a supply-driven model which focuses on research and scientific breakthroughs. Although links with the markets and users are recognised as important success factors for innovation, the main emphasis is on stimulating investment in an effective way. While this frame can integrate needs by allocation of research funding in areas pertinent to addressing social and environmental needs (for example medical research on new vaccines, clean technology programmes), typically it does not enable sustainability transitions, transformative change and inclusion of new non-research actors into the frame. Conversely, these are central elements in Frame 3. The term 'sustainability transitions' refers to the long-term transformation of social and technical (that is, socio-technical) systems in ways that lead to more sustainable modes of, for example, mobility, production, or consumption (Grin et al. 2010; Schot & Steinmueller 2018). In the era of the SDGs, the goal is not only to focus on transitions towards sustainability but to also address challenges such as inequality, inclusion and environmental degradation. Achieving this requires actors to address issues of directionality explicitly, in realisation that technologies are not only technical but also have social and environmental aspects embedded in them.

Frame 2, on the other hand, would suggest intervening in existing NSI to achieve better alignment and coordination (e.g. innovations in the coordination between medical research and healthcare

delivery) or stimulating entrepreneurship in relevant areas. Initiatives using this framing can and often do include a wider array of actors, yet focus on process and product innovation, learning and incremental change. They do not focus on radical (or transformative) change, and tend to leave civil society actors at the periphery. In sum, for both Frame 1 and Frame 2, a deeper transformation which would align social and technological change and redirect mobility, energy, food, agricultural and healthcare systems away from unsustainable pathways is not a core aim. Instead the focus is on stimulating innovation in order to generate economic growth. Questions about the directionality embedded in these innovations are not central.

Frame 3 puts the issue of directionality, social and environmental needs front and centre. It would suggest anticipating and experimenting with new approaches to innovation for social and environmental needs that go beyond a focus on creating knowledge or improving innovation system functioning by focusing directly on creating conditions for deep socio-technical system changes. Here the main rationale for policy is transition to sustainability and transformative change at systems level. Frame 3 policies are open-ended, focused on learning and bottom-up emergence of transformation, while keeping the transformation rationale up as a main driving question (Schot & Steinmueller 2018).

Frames 1 and 2 on the one hand, and Frame 3 on the other hand, are following a distinct conception of how STI policies contribute to achieving, for example, economic growth, public welfare and a clean environment (see Figure 2.1 below). This figure shows that a main difference between Frames 1 and 2, on the one hand and Frame 3, on the other hand, is that the former (Frames 1 and 2) address public welfare and a clean environment through the stimulus of economic growth and regulation, while the latter (Frame 3) encourages addressing public welfare and a clean environment in the innovation process itself, assuming economic growth will follow too (albeit one with a different content). Frame 3 incorporates the notion of directionality, which might also lead to a redefinition of economic growth. Missions can be integrated into Frame 3 as long as the implementation is done in an open-ended way through experimentation.



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**FIGURE 2.1:** STI policy frames and how they aspire to achieve public welfare and a clean environment  
 Source: Authors

## Using the three frames to map STI policy in consortium countries

The TIPC, as stated earlier, carried out its pilot phase between 2016 and 2017. The part of the work associated with the pilot phase was to map national STI policy ecosystems – focusing on research funding and innovation initiatives, using the three frames as the basis for discussion and analysis. The mapping and case-study work was achieved with background research carried out by SPRU and TIPC partners in the context of country-based interviews, focus group meetings, workshops with stakeholders and analysis of policy documents. These workshops brought together a wide range of STI policy stakeholders – government, industry, academia, civil societies, funders and others – to explore the notion of transformative innovation based on selected national case studies.

The case studies cover diverse areas but have been selected according to the following principles, referred to as TIP criteria: 1) directionality: focus on alternative futures associated with technological design choices; 2) goal: focus on grand societal challenges – economic, environmental or social; 3) impact: focus on socio-technical systems and system-level issues; 4) degree of learning and reflexivity: focus on second-order learning, problematisation of operating routines of different actors and the creation of spaces for experimentation; 5) conflict: focus on disruptive change, possibly resulting in major disagreements between actors; and 6) inclusiveness: focus on initiatives with a broad base of participation, including the consideration of non-users as potentially affected parties.

## Methodology

To reiterate, data for the case studies was collected through focus group discussions, semi-structured interviews, analysis of policy documents, and workshops. The workshops with stakeholders were used to construct transformative innovation (policy) learning histories (TILH). Use of the TILH methodology helped to ensure that although the case studies were diverse, there is value in comparing the various transformative innovation attempts to formulate and implement Frame 3 policy and innovation approaches. The transformative innovation and TIP insights we discuss below are based on the five country case studies and results of the mapping exercise.<sup>3</sup>

## Insights based on results of mapping the STI ecosystems and policies of case-study countries

All five countries provide evidence of a move from Frames 1 and 2 towards a Frame 3 rationale. The findings suggest that addressing societal and environmental needs through STI policies is recognised in all five countries and an emerging set of initiatives have already been put in place to implement the new rationale. All consortium member countries are experiencing a different range of economic, social and environmental challenges and these challenges shape both the articulation and implementation of Frame 3 approaches. Cultural and political histories are important and account for some of the differences and particularities. For example, the importance of consensus and bottom-up approaches in Sweden, the legacy of apartheid in South Africa, and of conflict in Colombia have all played a role in shaping the content and institutional features of emergent Frame 3 approaches. While it is true that Frame 3 policies are still marginal, they are presented as critical and, in some cases, as part of urgent and priority policy agendas. There is a weight of expectation which reflects a clear need for new directions in policy but may present problems if policies do not deliver rapidly.

3 The various mapping and case-study reports or TILHs are available from the TIPC website at <http://www.tipconsortium.net/materials/>

Each country has its own specific approach and its own narrative around the emergence of R&I policies targeted at social, economic and environmental challenges. In the case of Colombia, the country's emerging Frame 3 policies are interwoven with its peace process and attempts to overcome regional divisions. Finland's development of Frame 3 policies is integrated into initiatives aimed at overcoming the economic crisis resulting from the loss of Nokia which was the leading technology company and main economic driver in Finland. In Norway, a move towards a more knowledge-based economy is accompanied by using RRI thinking to make R&I more responsive to societal demands. South Africa's Frame 3 type policies are closely aligned to goals towards broader transformation of an economy based on the legacies of apartheid and are integrated into efforts to overcome exclusion and unemployment. Lastly, Sweden is developing green business as it restructures its industrial base and is using state-supported R&I to support that transition.

The findings from the case studies also reveal that some consortium members are currently grappling with how to integrate Frame 3 elements more explicitly into their STI policies, develop relevant policy interventions and build clearer conceptual apparatus to guide their policy formulation, implementation and evaluation. One expression of this desire is that during the mapping process, two consortium agencies began to think about a more extensive mapping exercise that would map all instruments and programmes onto the multilevel perspective representation of transformative change in order to identify gaps in instruments. Here, niche experiments would be thought about in relation to changes needed to facilitate broader meso-level change and in relation to support or obstacles presented by broader policy tools and environments. This kind of exercise would potentially have many benefits, including encouraging reflection on 'policy mixes' which could facilitate successful transition to sustainability (Mohamed 2018; Rogge & Reichardt 2015) and political economy factors which facilitate or impede transition and transformation (Byrne, Mbeva & Ockwell 2018; Chataway et al. 2019).

## Actors and new management and organisational practices

In each country, the constellation of actors involved in initiatives with Frame 3 characteristics and ambitions is different. In all countries, traditional funders of R&I have played a key role. Thus, there is evidence that funders are seeking to move more to a role of change agents for transformative change. This, of course, is far from straightforward. Initial analysis suggests that this may be linked to the point made previously, namely that explicit articulation of Frame 3 rationale and theories of change for how to address societal and environmental challenges through STI policies are missing or at best under-developed.

The active involvement of multiple government ministries, and a host of local actors, including grassroots innovators, informal economy actors, and civil society and city actors, is key to Frame 3 initiatives and policy-making. Involving a multiplicity of actors does not necessarily mean constructive or non-rivalrous relationships between them. In addition, transformation processes typically will induce and provoke conflict, such as oppositions and a diversity of views and positions. This can be productive since it might lead to second-order (or deep) learning, yet obviously it can also lead to non-action or even counter-action. Whether or not conflict exists, Frame 3 approaches add complexity to participation, and this again raises questions about appropriate management and governance arrangements. Thus, one of the aims in the case studies was to explore the way in which conflict and disagreement were handled.

The case studies mapping exercise highlighted important questions. For instance, a host of questions need to be asked in relation to the way that more engaged agendas develop. Will 'bottom-up' participative mechanisms actually reflect the need for more radical transformation to achieve environmental or particular social goals or will they reflect lowest common denominators and a series of compromises that

may need to be made? Or, might more radical agendas be captured by powerful interests? In Sweden, an Organisation for Economic Co-operation and Development (OECD) assessment indicates that the Challenge-Driven Innovation programme, used as the case study, builds explicitly on action-oriented approaches involving multiple stakeholders, including end-users, and gives those users more responsibility in implementing and monitoring projects.

Another question often asked is whether the relationship between actors should be managed through administrative coordination such as in various inter-ministerial committees or even a national science, technology or innovation council. Or, might this approach run counter to the experimental ethos which Schot & Steinmueller (2018) suggest plays a crucial role in the development of Frame 3 approaches? In that case the best option is perhaps not to focus on administrative coordination but to engage a range of actors in new initiatives to ensure coordination on the ground.

## Experimentation

The Frame 3 perspective contests the idea that there is a best or optimal approach to achieving the socio-technical innovations necessary for meeting social and environmental needs. It therefore focuses on experimental approaches (Schot, Kivimaa & Torrens 2019). Experimental approaches, in this case, do not imply that randomised clinical trials (RCTs) are the most appropriate means of progressing policy. The levels of contextual difference and variation are too great to make that approach the most relevant vehicle for learning or establishing good practice, and the focus on a broad change process cannot be captured through RCTs. Experiments have to be seen as instruments contributing to niche formation. The relationships between niche experiments, socio-technical transition and transformation are important components of the theoretical framework underpinning TIPC work (Schot & Steinmueller 2018). This includes a focus on shielding, nurturing and empowering of niches. At the same time, a destabilisation of prevailing socio-technical systems is seen as a necessary condition for enduring change too.

The need to view smaller-scale niche experiments as triggers for the introduction of more radical change highlights another aspect of analysis: the need to develop thinking and understanding of the political economy of Frame 3 initiatives. Recent work on political economy perspectives makes a strong argument for ‘discursive institutionalist’ approaches to political economy analysis (Kern 2011; Byrne et al. 2018; Chataway et al. 2019) which are particularly relevant to situations characterised by high degrees of uncertainty in which actors may not fully understand their interests (Hudson & Leftwich 2014). From this perspective, it is important to focus on ideas and narratives, as well as interests and institutions.

In all of the five TIPC case-study countries, there was evidence of experimentation (Schot et al. 2019) with new policy practices and discussions on how new directions for innovation policy can be discerned (while destabilisation policies are not present). In South Africa, the triple challenge of eradicating inequality, poverty and unemployment was the backdrop for new initiatives, such as Cofimvaba Tech4RED,<sup>4</sup> which attempted to devolve responsibilities to local communities, sought to support grassroots-based entrepreneurialism and bring stakeholders together for improvements in rural

4 Cofimvaba Technology for Rural Education and Development (Tech4RED) is an integrated and experimental rural development initiative in the Eastern Cape district of South Africa. Tech4RED was led by the Department of Science and Innovation (DSI) (previously Department of Science and Technology [DST]) in partnership with the Department for Basic Education (DBE), the Province of the Eastern Cape’s Department of Education (DoE), the Department of Rural Development and Land Reform (DRDLR), and other innovation ecosystem actors from industry (for example Vodafone), academia and civil society. As a transformative innovation project, Tech4RED focused on six thematic areas – ICT, Nutrition, Health, Sanitation, Energy, and Science communication. The goal was to foster transformative change at systems level and support the realisation of South Africa’s national development goals as articulated in the country’s National Development Plan (NDP).

education. There is also an indication of broader involvement of actors in Colombia in a limited range of programmes with a particular emphasis on articulating problems from a community level and expressing these online to encourage ideas for solutions from a variety of sources.

One example of experimentation relates to policies and programmes that specifically aim to link research to social goals. The objective is for such policies and programmes to remain oriented to traditional actors but also supported by a new national strategy and by taxation on mineral royalties. A regional development bank has also played an important role in helping to bridge broader development efforts in science and research policy. In both countries, South Africa and Colombia, experiments with new configurations of actors and more decentralised initiatives are secondary to efforts aimed at maintaining or improving traditional STI institutions. A similar conclusion can be drawn for Norway, Sweden and Finland for their responsible R&I initiatives and their challenge-led and strategic programmes.

## The role of funders

The consortium's composition focuses attention on the role of national research funders on the balance between the three frames and the understandings and definitions of social and environmental needs. Because research funders have an ongoing responsibility for the knowledge infrastructure and because they are major players in the national innovation systems, it would be surprising if they chose to cast aside established practices of governance and evaluation mechanisms which support that governance. However, conventional indicators associated with spending on research are powerful and they shape as well as measure behaviour. Governance and evaluation are key to the extent to which Frame 3 is able to take root in policy environments.

The experimentation with practice, noted in the previous section, involves an ongoing set of changes in the structure of governance, encompassing both dispersal of administrative control to other actors and assumption of a more active role in the implementation of initiatives. The principal type of dispersal is in the definition of initiatives where it now seems broadly accepted in all the countries that a local (in terms of geography or sector) definition of objectives and the means of meeting those objectives are desirable. This change, in turn, leads to other questions concerning governance.

Where traditional funding arrangements might focus on well-established actors, new initiatives are likely to involve a multiplicity of organisational types, most of which are less formal and perhaps less stable than the traditional actors. This has implications for the funding agencies' roles in monitoring activities and implementing interventions during the life of particular projects. It also suggests a less arms-length relationship between the funding agency and those who might seek to be included in new initiatives. This raises the following question: To what extent do funding agencies need to develop new capabilities for promoting the availability and assisting in the application for support for social and environmental initiatives that have Frame 3 elements (broader participation, openness to experimentation and attention to issues of anticipation or foresight)?

## Indicators, measurement and evaluation

The TIPIC is at an early stage of developing STI indicators and evaluation tools and perspectives for transformative change. Frames 1 and 2 are associated with a variety of supply, networking and demand policy interventions. The relative success of those interventions can be measured against theoretical and practice-based expectations and learning. Frame 3 initiatives make use of some of the same mechanisms in targeting social, economic and environmental challenges, but as yet, little thought has

been given to whether new instruments are needed or different policies may be combined in novel ways to achieve different aims and objectives, and whether initiatives that do not achieve immediate goals should be judged to have failed.

In summary, the following issues and evaluation criteria will be important to consider as part of developing Frame 3 policy thinking for evaluation:

1. Democratisation of deliberation and choice with regard to goals and possibly implementation (with the accompanying question of how to democratise governance and evaluation). How can TIP criteria be built into evaluation frameworks?
2. Explicit consideration of the means to disrupt existing arrangements that are negatively affecting or blocking paths to meeting social and environmental needs (not only 'bad' prospective innovations but existing innovations that have negative implications) is required. What is the best way to identify and evaluate the impact of negatives?
3. Explicit pursuit of experimental approaches based upon the logic that (a) more of the same (policies and practices) produces more of the same (outcomes, perpetuation of policies and practices); and (b) prior or ex-ante knowledge of best alternatives is unavailable without experience. But, adaptation will be important. How can we promote adaptive approaches?
4. Existing evaluative frameworks and methods reinforce existing practices and bias planning and implementation toward prioritising traditional goals. Nonetheless, new evaluative frameworks and methods are needed for accountability. Can ex-ante methods and theory of change approaches be helpful here or do we need to develop new and alternative evaluation tools and methods? If yes, what resources, capabilities and theories will underpin this exercise?
5. A broader scope of analysis is needed to anticipate alignment in changes with specific socio-technical systems in the direction of more profound change. What should be the indicators and signs of change that we identify and use?

These questions are at the core of the evaluation and accountability analysis that the TIPC hopes to develop and will be important as consortium members carry out experiments in Frame 3 policy. What makes an experiment worth doing? Can an experiment that fails to achieve its initial objectives be seen as an investment with a social return? If there is not a universal path to transformation, how can we evaluate the nature, outcomes and impacts of transition? How can we assess when a particular initiative is to generate higher-order or double-loop learning (learning useful insights about the larger process in which the initiative is lodged that will positively influence the definition and implementation of future initiatives)?

At present, the mapping work suggests that Frame 3 initiatives are being undertaken because of their self-evident value, that is, because their objectives are consistent with addressing social or environmental challenges. In some cases, particularly in the cases of the Scandinavian countries, initiatives have been taken under the premise that better outcomes might be possible by a more 'bottom-up' definition of initiatives. In either case, the eternal evaluative question – how can we know whether progress or transformation has been achieved? – is relevant. For this reason, recent TIPC work has focused on developing an evaluation methodology for addressing this question (see for example Boni, Giachi & Molas-Gallart 2019).

It is important to note that in developing the evaluation tools and techniques, theories of change and development of Frame 3 narratives may be usefully supported by various types of 'futures' and ex-ante evaluation work. Consortium members have begun to think about this. For example, Finland and Norway are to some extent integrating foresight activities into current efforts to link R&I with targeted social and environmental goals. Foresight and other future techniques may well be an important tool for provoking more creative and radical approaches to transformation.

Scenario-based approaches, particularly those that are agent-based and look at how behaviours may change and evolve, could help both in designing and monitoring work and encouraging experimentation. Using futures work in developing theories of change may also be a way to counter the inherent conservatism in ex-ante evaluation of proposals for Frame 3 type work. Inherent conservatism, as used here, refers to the tendency to look for evidence to approaches that have worked in the past, and not to consider the scenarios which may allow them to work in future.

## Conclusion and areas of further work

This chapter has provided an overview of the thinking behind TIP designed to foster new approaches to science, technology and innovation policy for transformative change, and the work of the TIPC. From the analyses, we found that elements of the three frames were present in all the case studies across the five countries – Colombia, Finland, Norway, South Africa and Sweden. In all five countries, there are examples of important experimental initiatives of local municipalities, cities, regional authorities and national governments in promoting Frame 3 (for example, transformative change) approaches.

In terms of fostering experimental approaches, creating space in broader regulatory, organisational and institutional frameworks for these initiatives is a significant issue. An important question relates to how to connect the various experimental initiatives, upscale them and make them transformative. This question may be answered on a national, regional or transnational scale. This connecting-up work might be an important role for national funders and innovation or policy agencies. Ways to join up various experimental initiatives, upscale them and ensure that they are transformative, constitute an area of ongoing or future research and further policy work. Current programmes in the TIPC are exploring policy experimentation, evaluation and related issues (Boni et al. 2019; Schot et al. 2019).

Also, in all five countries, the differences between the frames were found to be implicit rather than articulated. This has consequences for the way in which policy is formulated, implemented, monitored, evaluated and governed. In addition, it seems likely that a lack of a more clearly defined Frame 3 agenda may limit consideration of a more formal reflection of how different framings of policy and policy instruments might support or hinder each other and what gaps might exist. Rather, there is an implicit assumption that policies and policy instruments associated with the policies can be easily combined. There is also limited consideration of new policy instruments and mechanisms that might need to accompany changes in how organisations fund research, build networks or govern STI policies. Frame 3 aims are largely pursued using Frame 1 and 2 instruments, which thus far have proven to be inadequate in delivering intended objectives.

Work in the pilot phase of the TIPC is informing the development of a broader research agenda, experimentation and evaluation approaches, and the development of Frame 3-based theories of change. These evaluation strategies need to be rooted in a theoretical understanding of the relationships between niche experimentation, socio-technical transition and transformation, political economy perspectives, as well as initial learning from the mapping exercise and insights from the case-study findings, discussed in this chapter. Currently, the lack of explicit articulation of Frame 3 rationales and logics is a barrier to being able to develop more precise thinking about what specific partnerships, networks, interventions, and policy instruments or mixes are meant to achieve. This again constitutes an area for future research and further policy work.

Analysis of the TIPC pilot year produced other important insights. For example, the findings revealed that transformative change follows a non-linear policy process and requires proactive policy engagements over a number of years. The proactive policy engagements might be fraught with many uncer-

tainties in the processes involved, necessitating fragmented policy mixes, and often work best through employing a mixture of bottom-up and top-down approaches. In addition, agency matters. Human resources and leadership (policy champions) are important, as people are required to maintain transformative change processes. Successful transformation results in the formation of new routines and new framings of societal challenges. Such challenges have to be open-ended and allow for opening up, tensions and conflicts and then for closing down to allow for acceptable sustainable pathways to emerge. Furthermore, there is a need for evaluation of transformative change policies. Evaluation of transformative change policies, processes, programmes and projects must be context-specific and will require new types of programme theory, indicators and metrics. Early indications from TIPC work suggest that formative evaluation is likely to yield better results in contrast to evaluation for accountability. There is need for more robust empirical evidence in this regard.

To reiterate, elements of all three frames were present in all five case-study countries. Nevertheless, Frame 3 misses a strong narrative, consistency and specific policy instruments required to operationalise the relevant policy objectives articulated in the case-study projects, programmes and policies examined. This has a negative implication for the governance to be exercised in this regard. TIPC members and associates are currently working on developing a more coherent approach to Frame 3 thinking. Learning and adaptation are central to a Frame 3 approach and so is the ability to continually iterate between intended impacts and outcomes. Incorporating TIP ideas into policy formulation is not enough: implementation is vital if we are going to see transformative change. To this end, ongoing TIPC research and policy work aims to accomplish objectives that include: (a) developing new narratives around TIP and Frame 3 thinking; (b) building a set of demonstrators on how to approach, implement, evaluate and govern TIP; and (c) establishing a network of people and organisations working from transformative perspectives in relation to innovation across the globe.

TIPC members and associates believe that innovation should serve the quest for transformation. In order to achieve this goal of transformative change, innovation (including science and technology) policies must focus on societal goals, deep socio-technical changes and a sustainability agenda – as captured in the SDGs. The main aim of public policy should be to induce transformation and ongoing technological change processes.

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