

TRANSFORMATIVE INNOVATION POLICY



GLOBAL CORE PROGRAMME



A TRANSFORMATIVE INNOVATION LEARNING JOURNEY

ABOUT TRANSFORMATIVE INNOVATION POLICY CONSORTIUM (TIPC)

The Transformative Innovation Policy Consortium (TIPC) is giving substance to a new focus for Science, Technology and Innovation (STI) policy based on 'Transformative Change', which aims to contribute to addressing global societal challenges, including climate change, inequality, employment and pathways to economic growth and development. This is known as Transformative Innovation Policy (TIP).

Co-ordinated by the Science Policy Research Unit at the University of Sussex in the UK current members comprise of ministries and funding agencies from Colombia, Finland, Mexico, Norway, South Africa and Sweden. China, Brazil, Ghana, Kenya and Senegal are also taking part in associated pilot projects. Working together in a co-created five year programme TIPC mobilises empirical research and combines it with policy experimentation, evaluation, capacity building and communications. It is building constituencies behind transformative innovation policy (TIP) to allow upscaling and is already generating new frameworks, standards, demonstration and narratives. TIPC also allows exploration of novel ways to harness mutual policy learning between countries in the Global South and North.

ABOUT EIT CLIMATE-KIC

EIT Climate-KIC is a knowledge and innovation community established and funded by the European Institute of Innovation and Technology (EIT) in 2010. Their purpose is to tackle climate change through innovation. They are Europe's largest public-private partnership with this purpose – a growing pan-European community of diverse organisations united by a commitment to direct the power of creativity and human ingenuity at the climate change challenge. They bring together large and small companies, scientific institutions and universities, city authorities and other public bodies, start-ups, and students. With over 350 formal organisational partners from across 25 countries, they work on innovation to mitigate climate change and to adapt to its unavoidable impacts.

The Transitions Hub of EIT Climate-KIC has evolved to be a policy oriented in-house lab unit, with a *knowledge service approach*, located in Brussels and enabling interactions with key EU organisations and external experts. As part of that, they develop actions based in a science-policy-practice interface that includes *evidence-based research* (i.e. EIT Climate-KIC activities, regional development and EU policy). They also produce practice-based knowledge in the form of handbooks (i.e. participatory methods & technical assistance) for practitioners. A main handbook has been the **Visual toolbox**, a collection of ready-to-implement tools to structure and manage the challenges and exploit opportunities of sustainability innovations and transitions. A number of group activities organised for the TIP Learning Journey have used or adapted tools from this handbook.

www.climate-kic.org



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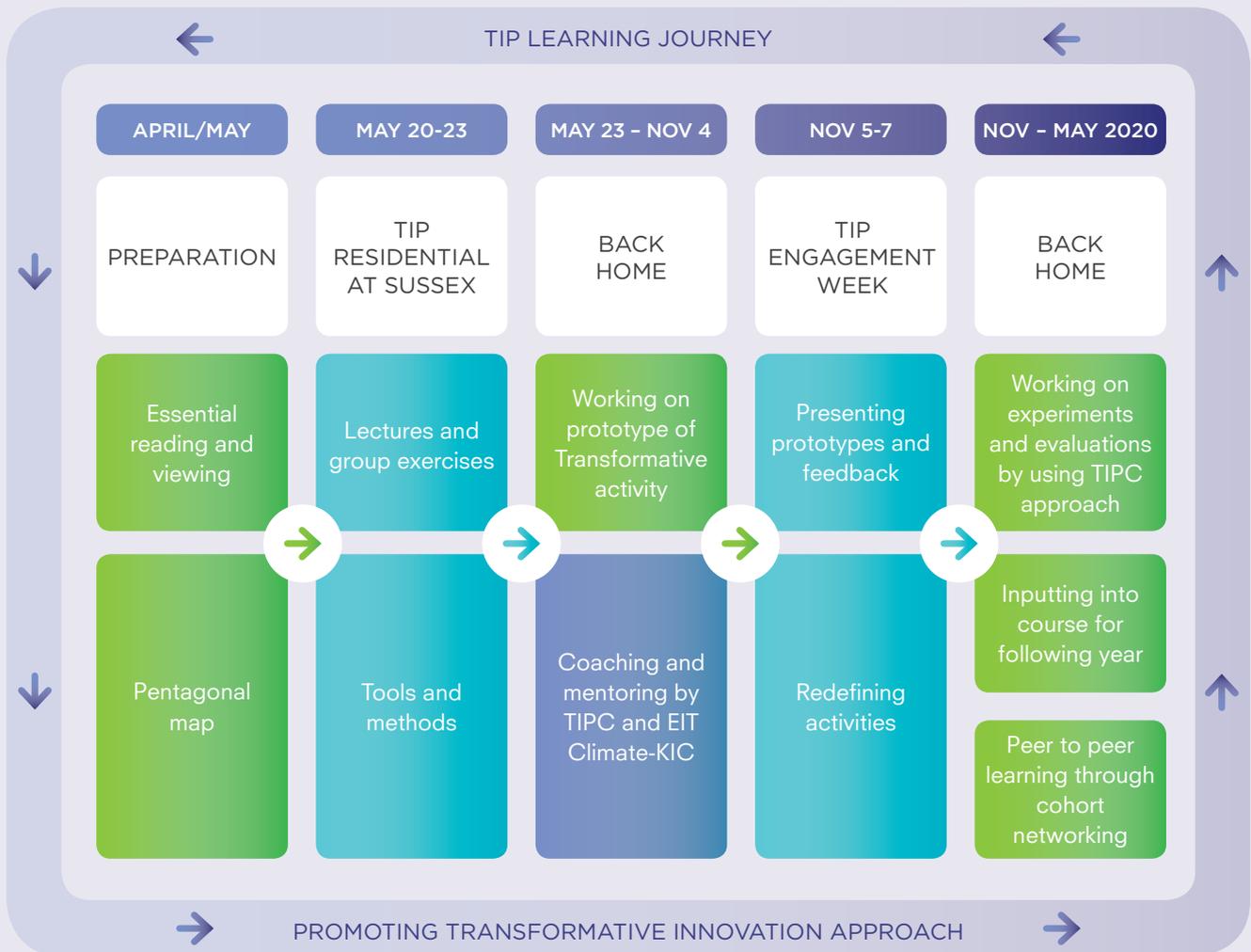
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SPEAKERS AND FACILITATORS

WELCOME TO THE TIP LEARNING JOURNEY

Capacity building, and training on Transformative Innovation Policy (TIP) with policymakers and researchers is an important part of TIPC's Five Year programme, helping to embed the TIP approach in participating organisations and supporting efforts to build a transnational community of practice. Using participatory methods and peer to peer deep learning it will help mobilise new, co-created knowledge into practice.

This is a continuous journey as shown in the diagram below and the aim is to bring new groups along to this journey each year, building on the experience, learning and insights from the cohort of the previous year. It will be an active learning process for all involved where participants and mentors are experientially involved in the journey to promote opportunities for second order or deep learning.



This guide is focused on the first two aspects: Pre-departure and the TIP 'Learning Journey Residential' 3 days held at the University of Sussex.

PRE-DEPARTURE WORK

All participants (either individually or collectively by country) will complete a 'Pentagonal Map'. This will focus on an existing or proposed initiative in your organisation which has the potential to express the principles and goals of transformative innovation policy. For example: a project, programme, or other policy measure in which you have a role. It should be something that you feel confident describing to other participants and that you would like to receive feedback on throughout the journey.

This guide book provides signposts to all the essential reading and watching that you will need to do prior to the course. It is advised that the reading and watching is completed before you start work on the Pentagonal Map as it will help with completion of this exercise.

PRE-DEPARTURE CHECKLIST

- Watched the video of the seminar 'A journey through Transformative Innovation Policy'**
- Engaged with all the essential readings and videos**
- Prepared Pentagonal Map (either collectively within a country group or individually)**
- Prepared at least 2 questions or observations to share in group work on day one based on what has been read and/or viewed**
- Completed the pre-departure evaluation form**

TIP JOURNEY RESIDENTIAL (3 DAYS)

Over three days participants will work with participants from several countries to engage with the theory and concepts underpinning the TIP approach, considering how to apply this in practice. The Transformative Innovation Learning Journal provided to all participants provides the opportunity to record reflections throughout the week and a practice based project undertaken 'back home' will enable the learning to continue back in your organisation with the support of mentors. Participants will re-convene and present and receive feedback on their projects at the TIPC annual conference and engagement week in Valencia, Spain, November 6th.

The residential is structured to ensure a balance between theoretical discussions and implications for practice. All lectures will leave sufficient time for discussion and questions and there will be many opportunities for participant led and peer to peer learning and reflection.

TIPC has benefitted greatly from a collaboration with EIT Climate-KIC on the development of the approaches and tools used throughout the course.

We hope you enjoy the work you will take part in over the coming weeks and look forward to working together and sharing ideas on how to develop Transformative Innovation Policy.

LOOK OUT FOR



RESIDENTIAL OVERVIEW DAY ONE

MONDAY 20TH MAY

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
1.1	<p>10.00 – 10.45 General Introduction and ice breaker Delivered by: Ed Steinmueller, Sarah Schepers Cristian Matti</p> <p>15 minute break</p> <p>11.00 First presentations of Pentagonal Maps (5 minutes each x 4)</p>	<p>Setting the scene for the course, understanding current levels of understanding of TIP and agreeing expectations.</p> <p>Introduce Transformative Innovation Policy Learning Journal.</p>	<p>Get to know each other.</p> <p>Introduce aims for reflexivity during the course.</p> <p>Hear about some Transformative Challenges from a group of participants (through presentation of Pentagonal Problems).</p>
1.2	<p>11.30 – 12.30 Innovation for Transformation: motive, method and purpose Delivered by: Ed Steinmueller</p> <p>12.30 – 13.30 Lunch</p>	<p>This lecture and discussion builds on from the pre-departure reading and seminar which introduce the notion of the three frames of STI policymaking that underpin the conceptual work on transformative innovation.</p> <p>This session considers the need for transformative innovation policy, how change happens in society and the role of innovative knowledge. We will ask how such knowledge can be generated and the importance given in a TIP approach to participatory planning and implementation.</p>	<p>Appreciation of the two dominant framings of STI policymaking and their limitations for delivering transformative change.</p> <p>Consideration of a third, transformative change, framing and related implications for policymaking.</p> <p>Develop personal questions and consider the challenges and opportunities presented by a transformative change framing.</p>
1.3	<p>13.30 – 15.15 Transformative Change and an actor oriented approach to innovation policymaking Delivered by: Fred Steward</p> <p>with Cristian Matti Bipashyee Ghosh Sarah Schepers</p>	<p>A presentation, followed by a role play exercise using the case of a mobility transformation will facilitate an appreciation of the role of different actors in a transformative change frame. We will aim to understand the different perspectives each bring to the table and promote an actor oriented approach to policymaking. This helps to distinguish TIP from a more technologically driven, mission oriented approach.</p>	<p>Knowledge of the challenges for successful implementation of transformative innovation policy.</p> <p>Awareness of the diversity of actors involved in a sociotechnical system.</p> <p>Appreciation of the variety of interpretations of transformative innovation among different actors. Understanding of the differences between product innovation and system innovation.</p>

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
1.3	<p>13.30 – 15.15 (continued)</p> <p>15 minute break</p>		<p>Insight into the contrasts between technology mission driven and sociotechnical challenge led policies.</p> <p>Familiarity with the distinction between incumbent and emergent actors.</p> <p>Comprehension of managing rather than reducing ('picking winners') variety of innovation(s) in a given context.</p>
1.4	<p>15.30 – 17.00 Socio-technical transitions – key theories and concepts Delivered by: Johan Schot</p> <p>With Bipashyee Ghosh Cristian Matti Blanche Ting Fred Steward</p> <p>16.15 Group work</p> <p>17.00 Journal writing</p> <p>Leave University campus and travel by train back to hotel in Central Brighton</p>	<p>In this session participants will hear from leading experts in socio-technical transitions who will introduce and un-pack some of these key concepts. The multi-level perspective is an analytical approach that can be used to understand socio-technical nature of system innovation.</p> <p>This co-evolutionary thinking of socio and technical change is required to achieve transformative change. Participants will encounter the different levels of a socio-technical system – the landscape (macro), regime (meso) and niches (micro) levels and the interaction between them in driving transformative change.</p>	<p>Familiarise with some of the key concepts underpinning TIP approach that will be encountered throughout the course.</p> <p>Prompt individual questions and clarifications on the key concepts at an early stage of the course.</p>
1.5	<p>19.00 Meet for dinner at The Fecamp Lounge, Old Ship Hotel, Brighton Seafront Walking distance from the hotel</p> <p>19.00 Digesting the theory</p> <p>Table hosts: Chux Daniels Cristian Matti Jose Manuel Martin Corvillo Ana Stival</p>	<p>During a two hour dinner in central Brighton participants will take part in a facilitated small table discussions to focus on the theory in practice.</p> <p>Table participants will identify three key topics or questions from the evening dinner to raise in the plenary next morning.</p>	<p>Establish peer group relationships and cohort dynamic (important for ongoing work and peer to peer learning).</p> <p>Test understanding of key concepts learned during day one with peer group.</p> <p>Consider theory within the local practice context.</p>

RESIDENTIAL OVERVIEW DAY TWO

TUESDAY 21ST MAY

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
2.1	<p>09.00 – 10.00 Innovation policymaking with a transformative change framing</p> <p>Journal writing (10 minutes)</p> <p>Panel: Johan Schot Ed Steinmueller Matias Ramirez Chux Daniels Paula Kivimaa</p>	<p>A facilitated discussion to clarify or respond to questions and challenges raised from the evening dinner.</p>	<p>Consolidate learning from day 1 and give space to questions and challenges.</p> <p>Gain a deeper perspective on some of the questions raised by the new framing and related theory in the context of participant's current practice.</p>
2.2	<p>10.00 – 11.00 Transformation and Policy Experiments Delivered by: Paula Kivimaa</p> <p>15 minute break</p> <p>11.15 – 12.45 Evaluating transformative innovation initiatives – an introduction Delivered by: Sandra Boni Sandro Giachi</p>	<p>Following on from the lecture on day 1 this session will take a deeper look at how experiments in sustainability could improve the performance and spread of potentially transformative innovations.</p>	<p>Develop knowledge of a key approach to support socio-technical system change and understand how it can be applied in practice.</p>

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
2.3	<p>11.15 – 12.45 Evaluating transformative innovation initiatives – an introduction</p> <p>Delivered by: Sandra Boni Jordi Molas-Gallart</p> <p>13.00-14.00 Lunch</p>	<p>TIP poses specific challenges to evaluation such as coherence with the key criteria of the TIP approach, definitions of experiments and the operationalisation and adaptation to different policy contexts. Building on co-created work within the TIPC core programme in this session we will look at formative approaches for evaluating transformative initiatives at three levels: policy, programme and projects and will consider a set of principles.</p>	<p>Consider alternative forms of evaluation that work with a TIP approach.</p> <p>Understand strengths and weaknesses of different approaches to evaluation.</p> <p>How to apply the approaches to a transformative policy experiment.</p>
2.4	<p>14.00 – 17.00 Walkshop: Grassroots Innovation and TIP</p> <p>Follows on from the morning session on niches and experimentation</p> <p>Introduced by: Adrian Smith</p> <p>15 minutes at the end of the session for journal writing</p>	<p>Organised as an early afternoon ‘Walkshop’ we will visit a grassroots innovation project related to the innovation of building and housing.</p> <p>The aims of the Earthship that we are to visit are to deliver a sustainable community centre in response to a genuine local need, change values in the construction industry and inspire positive action in individuals to generate environmental change through modifying people’s behavior to less carbon intensive lifestyles.</p> <p>During the walkshop we will consider a number of questions that emerge from the earlier session on niches and policy experimentation.</p>	<p>Understand how the theory applies in practice. Considering factors such as what sort of knowledge, networks and deep learning is being generated in this project, how can policymakers learn from this, how to include a plurality of knowledge in innovation policymaking and funding decisions.</p>
2.5	<p>18.30/19.00 Dinner at Silo</p> <p>(all travel together by train to Silo Restaurant in central Brighton)</p>		

RESIDENTIAL OVERVIEW DAY THREE

WEDNESDAY 22ND MAY

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
3.1	<p>09.00 – 10.00 Country based work on experimentation and evaluation</p> <p>Facilitated by: Sarah Schepers and Ed Steinmueller</p> <p>Journal writing</p>	<p>This is an open, participant led session where each country group will propose one Pentagonal Map to focus on during this day.</p>	<p>Identify linkages between each of the five aspects of the Pentagonal Map.</p> <p>Identify projects that have transformative potential and how they could be stretched further.</p>
3.2	<p>10.00 – 13.00 Group work on TIP experimentation and evaluation</p> <p>10.30 – 11.15 Experimentation</p> <p>11.15 Break</p> <p>11.30 – 13.00 Evaluation</p>	<p>Group work will be practically focused and aims to support the work that will be conducted 'Back Home' and presented in Valencia.</p>	<p>How to apply theory of experimentation in practice.</p> <p>Apply theory of change in practice.</p> <p>To be able to replicate the exercise back in the organisation.</p>

DAY	MODULE TITLE	DESCRIPTION OF MODULE	LEARNING OBJECTIVES
3.4	<p>14.00 – 15.45 In country work</p> <p>14.00 – 14.30 Plenary discussion</p> <p>14.30 – 15.15 Country group work with mentors</p> <p>15 minute break</p> <p>15.30 – 16.30 Country presentations and feedback</p>	<p>We will discuss how to continue this work back in the organisation working with the support of mentors.</p> <p>Each represented TIPC member group will be able to get feedback from the last exercise and ask questions about the in country work.</p>	<p>Consider alternative forms of evaluation that work with a TIP approach.</p> <p>Understand strengths and weaknesses of different approaches to evaluation.</p> <p>How to apply the approaches to a transformative policy experiment.</p>
3.5	<p>16.30 – 17.00 Closing discussions and learning evaluation Delivered by: Sandra Boni Ed Steinmueller Sarah Schepers</p>	<p>A chance for participants and mentors to reflect on the three days and consider any remaining questions.</p>	<p>Reflexivity on the course, learning, continuing the work back home.</p>

ESSENTIAL PRE-DEPARTURE ACTIVITIES

Before coming to the Learning Journey Residential at University of Sussex please read and watch the essential material. This includes the material in this book and shown in the boxes which can be found on the dedicated **Learning Journey** webpage.



ESSENTIAL READING

R&D, Systems of Innovation
and Transformative Change

*Schot J, Steinmueller W E,
Research Policy, 2018*



ESSENTIAL WATCH

Video: A journey through
Transformative Innovation Policy

SUMMARY OF THE THREE FRAMES OF INNOVATION

Re-thinking innovation policy is timely. Many research councils, governments and international organisations want innovation to address a number of societal or grand challenges. Yet how to design, implement and govern challenge-led innovation policies is far from clear.

Many innovation policies are based on the 20th century supply-driven innovation model, which takes competition between nations and support for R&D as the main entry point for policy making without thinking more creatively about the broader suite of innovation policies that are available. Over the last decades two main innovation policy frames have been developed. The third frame is now emerging.



THE FIRST FRAME OF INNOVATION: R&D AND REGULATION

The first framing portrayed innovation policy as providing incentives for the market to produce socially and economically desired levels of science knowledge (R&D). This is mainly implemented by subsidies and measures to enhance the 'appropriability' of innovation (IPR). To identify which areas need support, foresight has been developed. With respect to negative externalities, various forms of technology assessment have been established and, to protect society if the impacts are becoming a problem, regulation is put in place. This framing identifies the most important element of innovation as the discovery process (invention) and gives rise to the linear model in which technology is the application of scientific knowledge. The linear model privileges discovery over application. In part because the rewards of application are assumed to be carried out through an adequate functioning of the market system. Only in the case of market failure, is government action required.



THE SECOND FRAME OF INNOVATION: NATIONAL SYSTEMS OF INNOVATION & ENTREPRENEURSHIP

The second framing aims to make better use of knowledge production, supports commercialisation and bridges the gap between discovery and application. This framing takes as central various forms of learning including: those acquired by using, producing and interacting; linkages between various actors; absorptive capacity and capability formation of firms; and finally, entrepreneurship. The rationale for policy intervention is system failure – the inability to make the most out of what is available due to missing or malfunctioning links in the innovation system. Innovation policy focuses, for example, on technology transfer, building technology platforms and technology clusters to stimulate interaction

and human capital formation. Further, in this model, foresight, technology assessment and regulation are add-ons to the core activity of promoting innovation (on the assumption that any innovation is desirable and good since innovation is the motor for producing economic growth and competitiveness).



THE THIRD FRAME OF INNOVATION: TRANSFORMATIVE INNOVATION POLICY

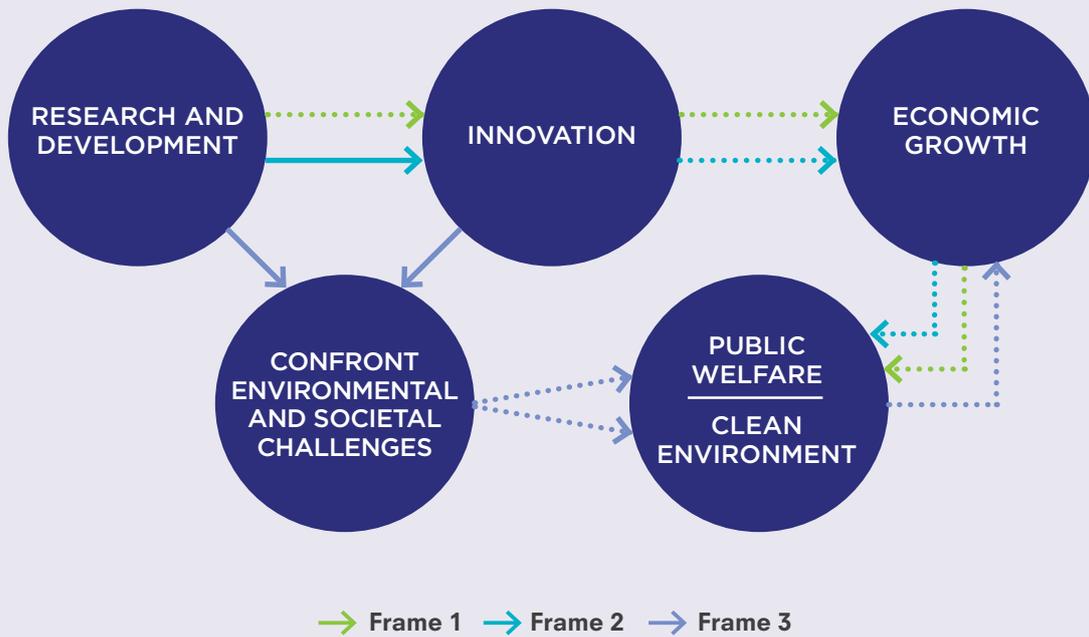
A third frame for innovation policy is that of transformative change which takes as a starting point that negative impacts or externalities of innovation can overtake positive contributions. This frame focuses on mobilising the power of innovation to address a wide range of societal challenges including inequality, unemployment and climate change. It emphasises policies for directing socio-technical systems into socially desirable directions and embeds processes of change in society. Transformative Innovation Policy (TIP) explores issues around socio-technical system change to give a structural transformation in: governance arrangements between the state, the market, civil society and science; experimentation and societal learning; responsible research and innovation; and, finally, a more constructive role for foresight to shape innovation processes from the outset and on a continuing basis.

HOW DOES FRAME THREE DIFFER?

This flowchart below demonstrates the principal difference between Frames 1 and 2, and then that of Frame 3.

Frames 1 and 2 assume public welfare will be addressed through the stimulus of new knowledge and innovation which will be utilised by industry to achieve economic

growth. Frame 3 explicitly and fundamentally addresses societal goals as a primary focus. By tackling societal challenges first and foremost, Frame 3 thinking supposes that, with attention on social and environmental welfare, there will be greater productivity and less inequality, therefore then, increased economic growth. It flows counter to that of Frame 1 and 2 assumptions.



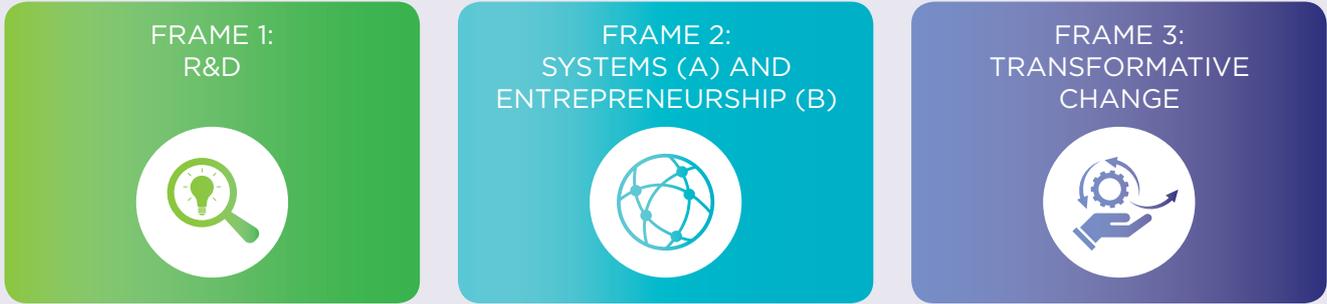
Solid line = This shows the frame addresses explicitly this aspect (e.g. the link between knowledge creation and utilisation in frame 2).

Dotted line = This indicates that an aspect is assumed to follow automatically (e.g. the utilisation of the results of basic scientific research by industries in frame 1).

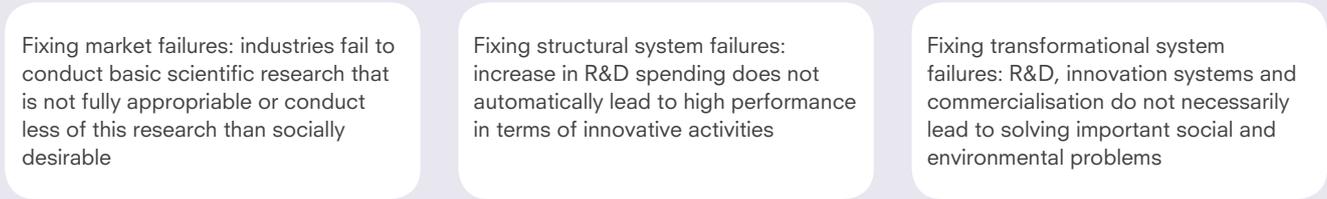
THREE FRAMES: A COMPARISON

The table on the following pages presents an overview of the three frames as they co-exist. For each frame it describes the geographical focus, focal actors, policy interventions, strategies, assumptions about innovation and some likely policy activities.

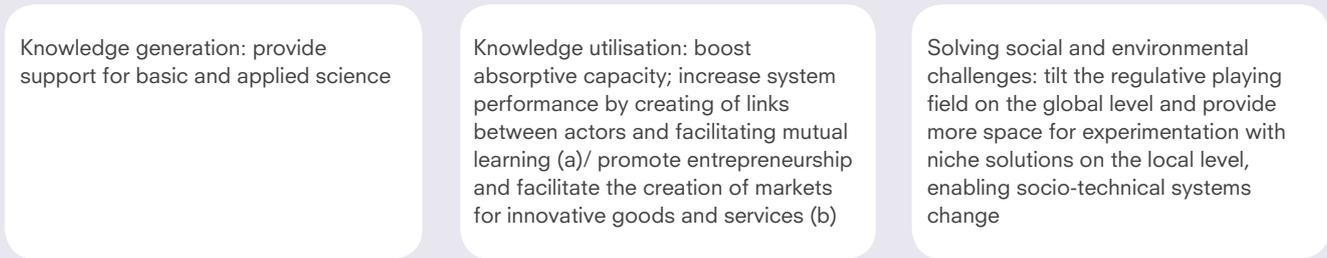
<p>FRAME 1: R&D</p> 	<p>FRAME 2: SYSTEMS (A) AND ENTREPRENEURSHIP (B)</p> 	<p>FRAME 3: TRANSFORMATIVE CHANGE</p> 
<p>TIME OF DOMINANCE</p>		
<p>1960s-1980s</p>	<p>1980s to today</p>	<p>Emerging</p>
<p>MAIN GEOGRAPHICAL FOCUS</p>		
<p>National</p>	<p>National and regional systems of innovation intersecting with sectoral and technological innovation systems (a)/ National with particular attention to “centres of excellence” or “clusters” of innovative activity (b)</p>	<p>Multi-scalar: focus on grand challenges that extend to multiple scales exceeding geographical, sectoral, technological and disciplinary boundaries</p>
<p>FOCAL ACTORS</p>		
<p>Government, scientists and industry actors with a tendency to prioritise large firms</p>	<p>Interlinked configurations of government, science and industry actors with particular attention to the role and missions of universities (a)/ enterprises, markets and the government with a particular focus on New Technology-Based Firms and start-up culture (b)</p>	<p>Government, science, industry, civil society, end-users and non-users (as potentially affected parties and contributors to the innovation processes)</p>



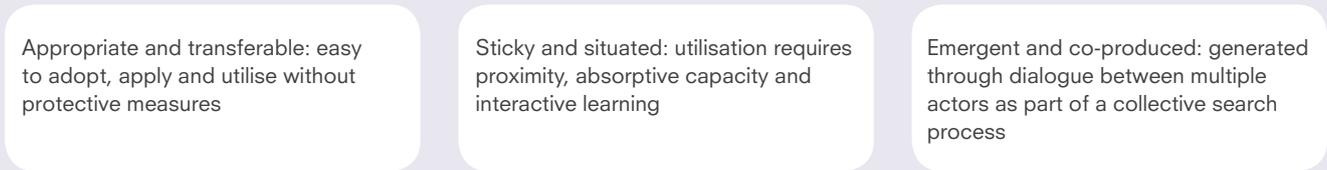
JUSTIFICATION FOR POLICY INTERVENTION



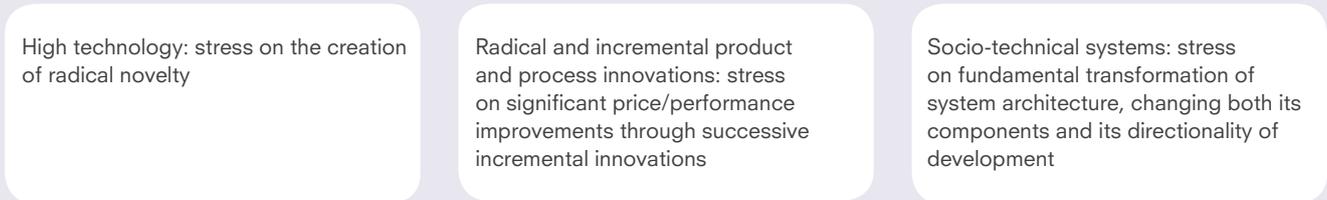
MAIN STRATEGY



NATURE OF CRITICAL KNOWLEDGE



FOCAL AREAS



FRAME 1:
R&D



FRAME 2:
SYSTEMS (A) AND
ENTREPRENEURSHIP (B)



FRAME 3:
TRANSFORMATIVE
CHANGE



TYPICAL POLICY ACTIVITIES

- R&D stimulation (subsidies, tax credits, procurement, mission-oriented programmes)
- Building the Intellectual Property Rights regime
- Education policy with emphasis on Science, Technology, Engineering and Math (STEM) subjects
- Science communication to explain the importance of STEM to wider public
- Foresight to select focus areas, regulation and technology assessment to manage negative impacts

- Constructing links between actors (building platforms, networks, databases) and organising technology transfer
- Stimulation of learning-by-doing, learning-by-using, learning-by-interacting
- Use of demand stimuli (e.g. procurement) to enhance and accelerate market development
- Building regional and national systems of innovation by assessing capabilities gaps and technological opportunities, implementing policies to address them
- Enhancing skill development based on proactive analysis of skill gaps and shortfalls
- Programmes to stimulate entrepreneurship and incubators (including indoctrination in the social value of entrepreneurship)
- Improving business conditions for Small and Medium-Sized Enterprises and start-ups
- Addressing the nature of equity markets (mezzanine level finance, IPO, inclusion in exchanges), especially angel and venture capital markets

- Stimulation of experimentation with niche technologies, scale-up and acceleration of socio-technical transitions (e.g. Strategic Niche Management, innovation intermediaries, Transition Management)
- New institutional solutions for changing the directionality of existing R&D and innovation activities (e.g. technology forcing, Responsible Research and Innovation, policy mixes for stimulating niches and destabilizing existing systems)
- Promoting social, inclusive, frugal and pro-poor innovation
- Bridging science/engineering, social sciences and humanities in the education system

UNDERLYING MODEL OF INNOVATION

Linear model: invention (discovery) leads to innovation (commercialisation) leads to diffusion (adoption)

Interactive and system-bound: chain-linked model stressing feedback loops between invention, innovation and use; evolutionary model, stressing ongoing interactions between actors, networks and institutions (a)/demand-pull model – needs of organisations and individual consumers largely drive innovative activities (b)

Systemic and experimental: quasi-evolutionary model including non-random (purposeful) variation, selection and retention, stress on feedback loops between invention, innovation and use, and ongoing interactions between actors, networks, institutions and technologies

FRAME 1:
R&D



FRAME 2:
SYSTEMS (A) AND
ENTREPRENEURSHIP (B)



FRAME 3:
TRANSFORMATIVE
CHANGE



BASIC ASSUMPTIONS ABOUT INNOVATION

- Division of labour: clear division of labour – government provides, science discovers, industry applies and consumer adapts; increase in R&D will automatically translate into more innovation
- Conflict vs. consensus: most often embedded in a military-industrial context that takes defence needs as forerunners and large industries as the “natural” intermediary to translate scientific advances into commercial application; open conflict with new firms and industries that are not part of the club
- Technological and social progress: the link between the two is largely uncontested

- Division of labour: multiple closely interacting actors with different but partially overlapping roles contributing to the overall performance of the system (a)/ clear division of labour – the task of the government is to facilitate the operation of existing markets and to create markets where they do not yet exist; left to themselves markets provide novel products and services at optimum quantity and price (b)
- Conflict vs. consensus: evolutionary in rhetoric but functionalist in practice, emphasis on cooperation between various actors, leading to the fulfilment of system functions (a)/ tends to be conflict-oriented, mainly stressing international competitiveness of states and competition between enterprises (b)
- Technological and social progress: the link between the two is largely uncontested

- Division of labour: blurred boundaries, multiple actors crossing various domains and enacting overlapping roles, resulting in the co-production of science, technology and society
- Conflict vs. consensus: mix of competition and cooperation is required to achieve disruptive socio-technical systems change
- Technological and social progress: non-neutrality of technology, specific technological designs and the directionality of innovative activities might serve to create, solidify or amplify environmental and social problems

BASIC ASSUMPTIONS ABOUT OUTCOMES

- Dealing with consequences: new technologies are associated with high degree of uncertainty and unpredictability making it virtually impossible to address major environmental and social impacts proactively
- Causality: stress on innovation as a motor of economic growth leads to public welfare as a bonus

- Dealing with consequences: largely reactive, major environmental and social impacts are usually addressed after they have occurred, sometimes with a particular emphasis on the provision of adequate market stimuli (b)
- Causality: stress on innovation as a motor of economic growth and increased competitiveness leads to public welfare as a bonus

- Dealing with consequences: proactive, stress on anticipating alternative futures associated with certain technological choices
- Causality: stress on innovation as means for directly addressing environmental and social challenges leads to economic growth and increased competitiveness as a bonus

FRAME 1:
R&D



FRAME 2:
SYSTEMS (A) AND
ENTREPRENEURSHIP (B)



FRAME 3:
TRANSFORMATIVE
CHANGE



MAIN HAZARDS

- Government failure: insufficient funding for basic R&D
- Market failure: negative externalities that require regulation

- System failure: innovation system fails to perform as a synergistic whole and to enhance innovative activities (a)
- Government failure: too many state restrictions on business activities (b)
- Market failure: regulatory need to deal with negative externalities in a way that would not stifle entrepreneurship (b)

- Transformative failure: failure to induce fundamental transformation to socio-technical systems forming the backbone of modern societies
- Societal and environmental needs failure: failure to solve extra-economic and collective problems on multiple scales

PARALLEL COUNTER-NARRATIVES

- Appropriate Technology movement, focus on small-scale solutions

- Politics and democratisation of Science and Technology
- Inclusive and interactive

- Technological fix: strong state intervention with massive investment in Big Technologies which promise to solve large social and economic issues

TOOLS TO SUPPORT A TRANSFORMATIVE INNOVATION POLICY APPROACH

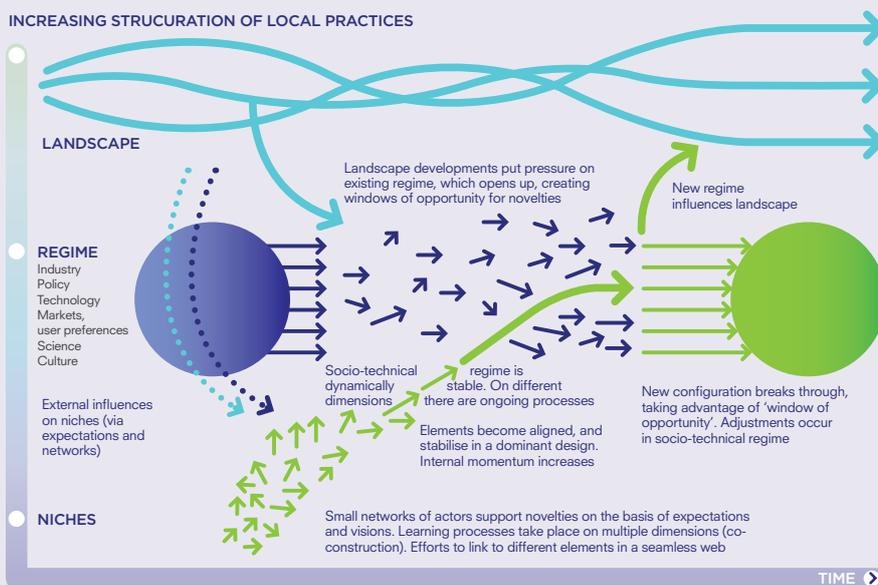
Transformative innovation policy is an exploratory concept. Although it is still rather unclear how to design, implement and evaluate transformative innovation policies, our initial work suggests that experimentation and formative approaches to evaluation take a central role. This is also supported by the role described for experiments in the sustainability transitions literature.

A SOCIO-TECHNICAL SYSTEM PERSPECTIVE

TIPC uses a notion of transformation derived from the sustainability transitions field. Being transformative means that socio-technical systems developed to deliver societal services (e.g. heat, power, mobility, food and water, healthcare) need to become more sustainable. This implies not only economic sustainability but also environmental and social sustainability, involving changes in technology and infrastructure, practices and routines, professions, organisations, and policies and institutions. The assumption is that many current systems are not sustainable, and thus need to go through a radical change.

This focus uses the 'multi-level perspective', taking into account interrelated changes at the level of markets (user behaviour and preferences), institutions and regulations, business, science, technology and culture.

The short videos produced by EIT Climate-KIC and suggested here as essential viewing have been chosen because they give an idea of how this theoretical perspective can be used in practice. The tools themselves will be used during our journey as they offer ways of working that support analysis and planning experiments and projects using a transformative approach. The focus on visualisation and group participation is in line with the key values inherent in our approach



Multi level perspective of the socio-technical transition framework. Source: Geels, 2002; Geels and Schot, 2007

ESSENTIAL WATCH

Trajectories of Change

Flourishing Multi-level

Context Map

Climate-KIC is supported by the EIT, a body of the European Union

EXPERIMENTATION

Experimentation can be a way for creating alignment between multiple socio-technical dimensions that are required for system innovation. Discourses, consumer practices, business models and policies all co-evolve alongside with technology. Experiments can be seen as tools for building niches which are an important source for socio-technical change. In other words experiments are a means for opening up new socio-

technical developments, challenging existing ones and setting collective priorities towards acceptable transformation pathways, including the emergence of a 'compass' for guiding sustainable transformation. TIPC has been developing new thinking to develop a set of 'transformative outcomes' for experimentation which may, in combination, influence full transformations.



ESSENTIAL READING

Transforming Experimentation:
Experimental Policy Engagements and their
Transformative Outcomes
*Johan Schot, Paula Kivimaa
and Jonas Torrens*



ESSENTIAL WATCH

Six Systemic Strengths



EVALUATION

TIPC is co-creating with members a formative approach to the evaluation of TIP experiments performed in protected technology niches, or policy experiments aimed at destabilising dominant, unsustainable socio-technical systems.

A formative approach to evaluation should be able to deliver a real-time assessment of policy and local

experiments, addressing directionality and societal goals, and enhancing systemic impact, reflexivity and inclusiveness. This will involve a transformation of the role and the practice of funding agencies, as well as their relationships with partners and other stakeholders for evaluation and so, consideration is given to the policy implications of such an approach.



ESSENTIAL READING

Key Principles for a Formative Evaluation of
Transformative Innovation Policy

A TRANSFORMATIVE INNOVATION POLICY APPROACH

During the pilot year, TIPC members co-created a criteria of six elements which constitute steps towards achieving Transformative Innovation Policy. In the Transformative Innovation Learning History (TILH), conducted for each country's exploratory phase, the extent to which these criteria were present was analysed. The criteria informs Transformative Innovation Policy practices.

However they should not be seen as a blueprint. They should be considered a set of guiding principles for broadening thinking about transformative innovation. Within TIPC we are co-creating new understandings of the applications of these criteria to policy practice. For example through the work on policy experimentation, evaluation and even in the design of the group work for this course.

1

DIRECTIONALITY:

Did the policy suppose non-neutrality or were a wide range of technological options considered and did it address which social and environmental issues they would provoke?
Did the project and policy consider the non-neutrality of technology?

2

SOCIETAL GOAL:

Did the initiative focus on grand societal challenges such as those encompassed in the United Nations' Sustainable Development Goals?

3

SYSTEM-LEVEL IMPACT:

Does the initiative address change on the level of socio-technical systems?
Does it have wide impact?

4

LEARNING AND REFLEXIVITY:

Does the project allow for 'second order' or 'deep' learning?
Is the opportunity for this embedded within the policy and project?

5

CONFLICT VS CONSENSUS:

Were differences in opinion between stakeholders acknowledged and encouraged?

6

INCLUSIVENESS:

Have civil society actors and/or end-users been included?

1

From the outline, it follows that a **Transformative Innovation Policy (TIP) needs to engage with 'Directionality' – the first of the criterion.** The question here is whether in policy formulation and stakeholder engagement there is recognition that there are alternative pathways or trajectories by which technology can develop. The risk of not engaging with directionality is that existing trajectories may simply be replicated or extended.

2

The case study selection criterion of **'Societal Goal' represents the extent to which a policy initiative can be said to be directed at one or more specific social challenge.** Identifying the challenge or challenges is important to locate the case study for comparative purposes. It also provides a basis for exploring how different actors understand the nature of the challenge and the means for meeting it. These understandings are a basis for diverse viewpoints – and capturing this diversity is an important part of the case study research. It is a principal reason why we have adopted the methodology of Transformative Innovation Learning Histories (TILH).

3

The criterion of **'System Level Impact' is an indication of whether the innovation is aimed at a transformation of underlying routines.** Impact can be considered as the extent or scale of expected change. As noted in the above working definition, one indication of transformative is the extent of the disruption or break with past routines and practices. As always, there is a risk that novelty in language is a substitute for more fundamental change. By considering how routines and practices will be altered, the scale of system level impact can be judged in comparison with other efforts to enact change or reform.

4

The **degree of 'Learning and Reflexivity' is a further indication of the transformative nature of the policy initiative.** These are further indications of the ways in which routines and practices are altered by the innovation policy. Here, the focus is one of the accumulation of knowledge about the new routines and practices that emerge as new directions are explored. What is learned? Who learns? Do processes of learning involve questioning of existing routines, and understanding each other's assumptions and worldviews? Are these current and future learnings shared or exchanged with others? How are they preserved and applied over time?

5

6

The last two criteria – **'Conflict vs Consensus' and 'Inclusiveness' – relate to the social aspects and politics of the initiative** – addressing issues of democratisation, interests and inclusiveness. The issue of 'conflict' is about the recognition of interests. Some of these interests may support while others may oppose the transformative nature of policy (transformative in either sense). Conflict is expected although it is expressed in different societies in different ways. In some cases, it is made explicit, in others there is a search for common ground that allows widespread consent. There is no 'best way' for managing conflict, but considering how it is manifested and resolved is an important question for the case study research. The issue of inclusiveness recurs at several different levels in the policy cycle (the planning, implementation, and evaluation of policy). Inclusiveness refers both to the breadth of participation and empowerment and also its depth – the extent to which included actors are able to influence the processes of the policy cycle.

TIPC GLOSSARY OF TERMS



In TIPC, the overall aim is the co-creation of knowledge about TIP. However, participants have different prior understandings and experience which has required the construction of a shared vocabulary.

The meanings and contextualisation of this vocabulary will differ across participants. It is not productive either to dictate¹ this vocabulary or to pursue a 'grounded approach' that begins without pre-conceptualisations. Instead, we need to begin with a set of starting points for discussion about key terms and concepts and then discuss how these are understood, translated, and applied in thinking about and gathering evidence concerning member case studies. This glossary² offers a set of starting points shaped by a position on: academic

pre-conceptions, the initial accounts of practice offered by partners and reflections on the case studies that have been offered by the partners. To simplify, the notes below make declarative statements rather than qualified and tentative statements such as 'some scholars or practitioners understand <vocabulary term> to mean <definition>'. Since this glossary is a tool in the research process, we do not reference the terms here. In TIPC publications, we will provide more detailed references.



These terms relate to the rationale for TIPC and the glossary demonstrates terms that have received attention in TIPC discussions and analysis.

ACTORS

The proponents of and opponents to transformative change that respectively seek to accomplish or seek to block, divert, or slow transformative change for a variety of reasons including a perception or the reality that such change will disadvantage their current interests. Actors can be individuals, groups of individuals working within organisations and across organisational boundaries (so networks or coalitions) and organisations.

ACTOR-MAP

Overview of proponents and opponents as well as included and excluded actors and how they relate to each other and interact with each other. The actor-map would include attention to power-dynamics between actors (their dependencies, struggles, conflicts, divergent rationales and values)

¹ The word 'dictate' suggests that there is an authoritative definition of vocabulary or that, for the purposes of the consortium, we defer to some authority (e.g. for purposes of expediency). Since we regard transformative innovation policy itself to be innovative, there is no prior authoritative definition. Our collective desire to engage in co-production means that it is inappropriate to defer to either an external or internal authority.

² Version 1: Ed Steinmueller, Johan Schot, April 10 2017

CO-CREATION

A process in which participants attempt to reach a common understanding based upon reasoned discussion with attention to the opportunities and barriers for conveying this understanding to others. The aim is not consensus, but a better understanding of points of differences and overlap. Other words used sometimes are co-production, and co-construction. In our research process these words have a similar meaning

DEMOCRATISATION

In our project refers to participation. It is expected that achieving transformative change may require participation by many actors and drawing on their innovative potential. Participation also means that many actors have a voice and the least powerful are in the position to challenge the most powerful actors.

DIRECTIONALITY

Based upon one of the stylised facts of innovation research we can say that innovation is cumulative (building upon the past), innovation can be said to have a direction. Only certain solutions are looked for while others are typically ignored. This direction (sometimes called a trajectory or pathway) can be altered by transformative innovation that establishes a new direction and thus process of accumulation (also a new trajectory or pathway). A corollary is that a change in directionality involves the abandonment or destruction of an older direction (trajectory or pathway) (although it may involve the old pathway becoming much less prominent and influential).

The process of change can follow a range of patterns. Two major ones: 1) substitution so competition between directions and in the end full or almost full replacement; 2) hybridisation (or reconfiguration) where several directions are combined, so elements of the old regime persist.

INCLUSIVENESS

Closely coupled with democratisation, this refers to the inclusion of all actors in decision making processes, but goes beyond that since it also refers to actors having the access and capabilities to participate. So it includes a consideration of the context in which actors interact.

Consideration of interests, democratisation, and inclusiveness is linked to the politics of innovation policy and therefore to issues of legitimacy (the extent to which innovation policies are seen as legitimate roles for state actors) and accountability (how the outcomes of policies are assessed).

INNOVATION

An idea, or process whose novelty distinguishes it from prior ideas and processes and is taken up and utilised (including processes of articulation, adaptation, or customisation) by people other than the originator(s). The idea of process can be a re-invention or re-use of older ideas and processes. Innovation is basically a process of renewal. Please note that for us innovation does not refer to a product or process technology, but of course includes the development of new artefacts (products). In the context of transformative innovation policy we are interested in innovation which builds up new socio-technical systems.

REFLEXIVITY

This notion refers on the one hand to the ability of actors to reflect on their own routines, and worldviews, the routines, position and worldviews of other actors, and the rationality. For example in some countries supply is intermittent rather than continuous and, of course, there are significant differences in the prices for use of electricity in different countries. The poor in a number of countries may have to pay in advance for access.

SECOND ORDER LEARNING

Or deep learning refers to a process in which routines are questioned. This includes a fundamental rethink of how problems are defined, and what solutions are considered appropriate. First order learning refers to a process in which routines are sharpened and become better defined. For example in a project on carbon calculations the actors can seek to optimize the calculations but also more fundamentally question the design and use of these calculations.

SOCIAL NEEDS

While *transition* is specifically related to social and environmental sustainability which is taken to be a social need, there are other social needs that may stand alongside or complement transition to sustainability. Examples include health, quality of life, and social justice (which are all included in a broad definition of sustainable development, and captured by the UN sustainable development goals).

SOCIO-TECHNICAL REGIME

In our project we look at sets of routines which are often aligned. This is what we call a socio-technical regime. We can make a distinction between heuristics (design rules, search rules); policy routines, user routines (preferences), cultural routines (expectations, perceptions, frames). These routines can be formal and informal. An example of formal ones are published standards; examples of informal ones are rules of thumb or norms people follow.

SOCIO-TECHNICAL SYSTEMS

Norms, routines, and standards (regimes) become expressed in socio-technical systems. Such a system is a configuration of actors (their knowledge, skills), technologies (products, infrastructures), and institutions (regulations, cultural symbols, markets) for fulfilling a certain societal function (mobility; or inland mobility; urban mobility).

Example: The socio-technical system of grid distributed electricity includes the power plants, the electrical power cabling, the safe wiring of newly constructed buildings, and the existence of public or private arrangements for generating and distributing electrical power. Markets are: use of electricity in homes or businesses for purposes of illumination, heating, motors or powering electronic devices. This is a large system with many different societal and technical features. It is over a century old and although it is not universal, about 85% of the human population participates in this system. In terms of relations between people, large numbers of people participate in this system as consumers using a myriad of electricity using technologies while a much smaller number of people are responsible for the generation and distribution of electrical power.

One might imagine an alternative socio-technical system involving household generation of electrical power without connection to the grid. In this system there are very different relations between people (e.g. there are not separate groups of people engaged in the supply of electrical power). This alternative system would also create different relations between people and technology (e.g. it is likely that one would have to more carefully plan for how much electrical energy one uses and when it is used) and this alternative system is likely to be associated with different social, cultural or political models.

TRANSFORMATIVE

In our context, there are two important meanings for this adjective as applied to innovation: 1) a break or distinction from past practices or routines which opens new possibilities for further innovation across a broad front or over a wide variety of contexts (i.e. this definition is a qualitative statement of the potential or an achievement being large as compared to other innovations) and 2) further to 1), a process that establishes a new directionality.

TRANSITION

In its simplest form, the change from one socio-technical system to another (which thus also implies a change of regime, e.g. rules). The term is usually built on the premise that current socio-technical systems are not socially or environmentally sustainable and there is a social and/or economic need for a specific type of transition, one whose directionality is more compatible with social or environmental sustainability.

10 FREQUENTLY ASKED QUESTIONS ABOUT TRANSFORMATIVE INNOVATION POLICY

1. ISN'T ALL INNOVATION POLICY MEANT TO BE TRANSFORMATIVE?

Yes, in the sense that innovations, when successful bring about change. However, the perspective implied by the phrase 'transformative innovation policy' is that it is possible to seek and implement innovations that address social and environmental needs as their primary objective. There is a critical underpinning to this perspective. Not all innovations serve to improve social or environmental wellbeing. Some worsen wellbeing, others have little effect on social or environmental issues.

2. THE 'THREE FRAMES' PERSPECTIVE IS SAID TO BE A FOUNDATION FOR TRANSFORMATIVE INNOVATION POLICY. IN WHAT WAY?

In previous rationales for innovation policy (Frames 1 and 2), social-wellbeing was indirectly addressed by the presumption that innovation would increase society's wealth either by increasing the flow of scientific knowledge available for commercialisation (Frame 1) or improving on the system for generating and distributing knowledge (Frame 2). Frame 2 was also expected, and has had some success, in improving economic competitiveness. Nonetheless, these earlier rationales are implicated in some of the social and environmental problems summarised in the sustainable development goals (SDGs). This is because of underlying assumptions such as more GNP is synonymous with greater social wellbeing, labour markets adjust to technological change, the earth's environment and resources are secondary considerations, and innovations should be planned and implemented by those most expert in the domains in which innovation occurs. Frame 3 challenges each of these assumptions and proposes that the directionality of innovation influence can and should be subject to participatory decision making and experimentation. At the same time, however, Frame 3 does not suggest eliminating curiosity-based research or neglecting the coherence of knowledge distribution systems (key elements of Frame 1 and 2).

3. WHAT IS MEANT BY DIRECTIONALITY?

Based upon a summary of several decades of innovation research we can say that most innovation is cumulative (building upon the past), and thus innovation can be said to have a direction which has often been seen as 'natural' or inevitable. Only certain solutions are looked for while others are typically ignored. Transformative innovation proposes that this trajectory or pathway can be altered by defining a new direction to fulfil societal or environmental goals, and thus also a process of accumulation (a new trajectory or pathway). A corollary is that a change in directionality involves the abandonment or destruction of an older direction (trajectory or pathway) (although it may involve the old pathway becoming much less prominent and influential). The process of change can follow a range of patterns. Two major ones: 1) substitution so competition between directions and in the end full or almost full replacement; 2) hybridisation (or reconfiguration) where several directions are combined, so elements of the old regime persist.

4. IN TRANSFORMATIVE INNOVATION APPROACH WHAT IS MEANT BY INNOVATION?

An idea, or process whose novelty distinguishes it from prior ideas and processes and is taken up and utilised (including processes of articulation, adaptation, or customisation) by people other than the originator(s). – in short 'the translation of novelty into practice'. The idea of process can be a re-invention or re-use of older ideas and processes. Innovation is basically a process of renewal. Please note that for us innovation does not refer to a product or process technology, but of course includes the development of new artefacts (products). In the context of transformative innovation policy, we are interested in innovation which builds up new socio-technical systems.

5. SO, WHAT ARE SOCIO-TECHNICAL SYSTEMS?

A sociotechnical system is a configuration of actors (their knowledge, skills), technologies (products, infrastructures), and institutions (regulations, cultural symbols, markets) for fulfilling a certain societal function (mobility; shelter, energy, food, communication etc). Socio- technical systems express norms, routines, and standards (regimes) which are often aligned. This is what we call a socio-technical regime. We can make a distinction between heuristics (design rules, search rules); policy routines, user routines (preferences), cultural routines (expectations, perceptions, frames). These routines can be formal and informal. An example of a formal routine is published standards; examples of informal ones are rules of thumb, norms or routines people follow. Routines has a special meaning reflecting answers to the question 'how are things done around here?' which generally represents some previous discussion of 'how should things be done' that leads to discussion and potential controversy. A routine can then be thought of as an 'organisational truce' that ends or closes down this discussion.

EXAMPLE

The socio-technical system of grid distributed electricity includes the power plants, the electrical power cabling, the safe wiring of newly constructed buildings, and the existence of public or private arrangements for generating and distributing electrical power. This involves use of electricity in homes or businesses for purposes of illumination, heating, motors or powering electronic devices. This is a large system with many different societal and technical features. It is over a century old and although it is not universal, about 85% of the human population participates in this system.¹ In terms of relations between people, large numbers of people participate in this system as consumers using a myriad of electricity using technologies while a much smaller number of people are responsible for the generation and distribution of electrical power.

One might imagine an alternative socio-technical system involving household generation of electrical power without connection to the grid. In this system there are very different relations between people (e.g. there is not a separate group engaged in the supply of electrical power). This alternative system would also create different relations between people and technology (e.g. it is likely that one would have to more carefully plan for how much electrical energy one uses and when it is used) and this alternative system is likely to be associated with different social, cultural or political models.

6. WHAT DOES TRANSITION MEAN IN THE CONTEXT OF TRANSFORMATIVE INNOVATION POLICY?

In its simplest form, the change from one socio-technical system to another (which thus also implies a change of regime, e.g. rules). The term assumes that current socio-technical systems are not socially or environmentally sustainable and there is a social and/ or economic need for a specific type of transition, one whose directionality is more compatible with social or environmental sustainability. Transition is linked to transformation because we assume that transition requires: 1) a break or distinction from past practices or routines which opens new possibilities for further innovation across a broad front or over a wide variety of contexts (i.e. this definition is a qualitative statement of the potential or an achievement being large as compared to other innovations) and 2) further to 1), a process that establishes a new directionality.

7. IS TRANSFORMATIVE INNOVATION POLICY ONLY ABOUT ENVIRONMENTAL SUSTAINABILITY?

No. It is also about meeting other social needs. While transition is specifically related to social and environmental sustainability which is taken to be a social need, there are other social needs that may stand alongside or complement transition to sustainability. Examples include health, quality of life, and social justice (which are all included in a broad definition of sustainable development); these are captured by the UN Sustainable Development Goals.

8. IN WHAT WAYS IS A FRAME 3 APPROACH TO INNOVATION POLICY DEMOCRATIC?

Frame 3 approaches are based on co-creation, a process in which participants attempt to reach a common understanding based upon reasoned discussion with attention to the opportunities and barriers for conveying this understanding to others. The aim is not consensus, but a better understanding of points of differences and overlap. Other words used sometimes are co-production and co-construction. In our work these words have a similar meaning. It is expected that achieving transformative change will require participation by many actors and drawing on their innovative potential. Participation also means that many actors have a voice and the least powerful are in the position to challenge the most powerful actors. Inclusiveness is closely coupled

with democratisation; this refers to the inclusion of all actors in decision making processes. But it goes beyond participation since it also refers to actors having the access and capabilities to participate; it includes a consideration of the context in which actors interact. Considerations of interests, democratisation, and inclusiveness are linked to the politics of innovation policy and therefore to issues of legitimacy (the extent to which innovation policies are seen as legitimate roles for state actors) and accountability (how the outcomes of policies are assessed)

9. ARE THERE OTHER DISTINGUISHING FEATURES OF A FRAME 3, TRANSFORMATIVE INNOVATION APPROACH?

The democratic processes which underlay Frame 3 seek to promote second-order or deep learning, a process in which routines are questioned. This includes a fundamental rethink of how problems are defined, and what solutions are considered appropriate. First order learning refers to a process in which routines are sharpened and become better defined. For example in a project on carbon reduction the actors can seek to optimize the calculations but also more fundamentally question the design and use of these calculations. The questioning process involves reflexivity. Reflexivity refers on the one hand to the ability of actors to reflect on their own routines, worldviews, routines and position as well as the worldviews of other actors, and the rationality behind it. On the other hand it refers to a process which stimulates actors to engage with each other and allow for second-order learning.

10. IS MISSION-ORIENTED INNOVATION POLICY COMPATIBLE WITH THE FRAME 3 APPROACH?

It can be. Mission oriented innovation policy reflects a renewal of public purpose in innovation policy which is compatible with the Frame 3 approach. However, the history of mission-oriented policy is technocratic (expert led) and technology focused which conflicts with the direct democracy underpinning of Frame 3 thinking and its emphasis on a broader variety of types of innovation. New mission led policies do not have to follow this history. The urgency of social needs may, however, suggest to some that democratic processes are too slow to bring about transformation. We do not have a blueprint for meeting social needs and recent history suggests the hazards of making changes, even ones that experts agree upon, in which broader social engagement is not employed.

¹ In some countries supply is intermittent rather than continuous and, of course, there are significant differences in the prices for use of electricity in different countries. The poor in a number of countries may have to pay in advance for access.

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Adrian Smith is Professor of Technology and Society at the Science Policy Research Unit, University of Sussex. His research analyses relationships between politics, technology and sustainability at local, national and international scales in the global north and global south. Over the last ten years he has led a series of international research projects looking at **prototypes** and innovations for sustainability developed by citizens and grassroots organisations operating in civil society settings. The work has engaged groups involved in food, housing, manufacture, energy, citizens science, cities, and other areas, and sought to help them advance their transformational aims. His publications on this topic include the book, **Grassroots Innovation Movements** (Routledge, 2017), scientific articles, and blogs, including for the **Guardian** newspaper.

ED STEINMUELLER

Professor Ed Steinmueller has been with SPRU since 1997. He studied computer science, mathematics and economics at the University of Oregon and Stanford University. At Stanford (1974-1994), he engaged in teaching, research and consulting while being Deputy Director of the Stanford Institute for Economic Policy Research. In 1994, he was appointed Professor at UNU-MERIT, the University of Maastricht, The Netherlands where he was the founding Director of their PhD programme. Steinmueller's published work spans information and communication technology industry economics and policy, science policy and the economics of basic research. Recently he is researching socio-technical transitions and sustainability.

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BLANCHE TING

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