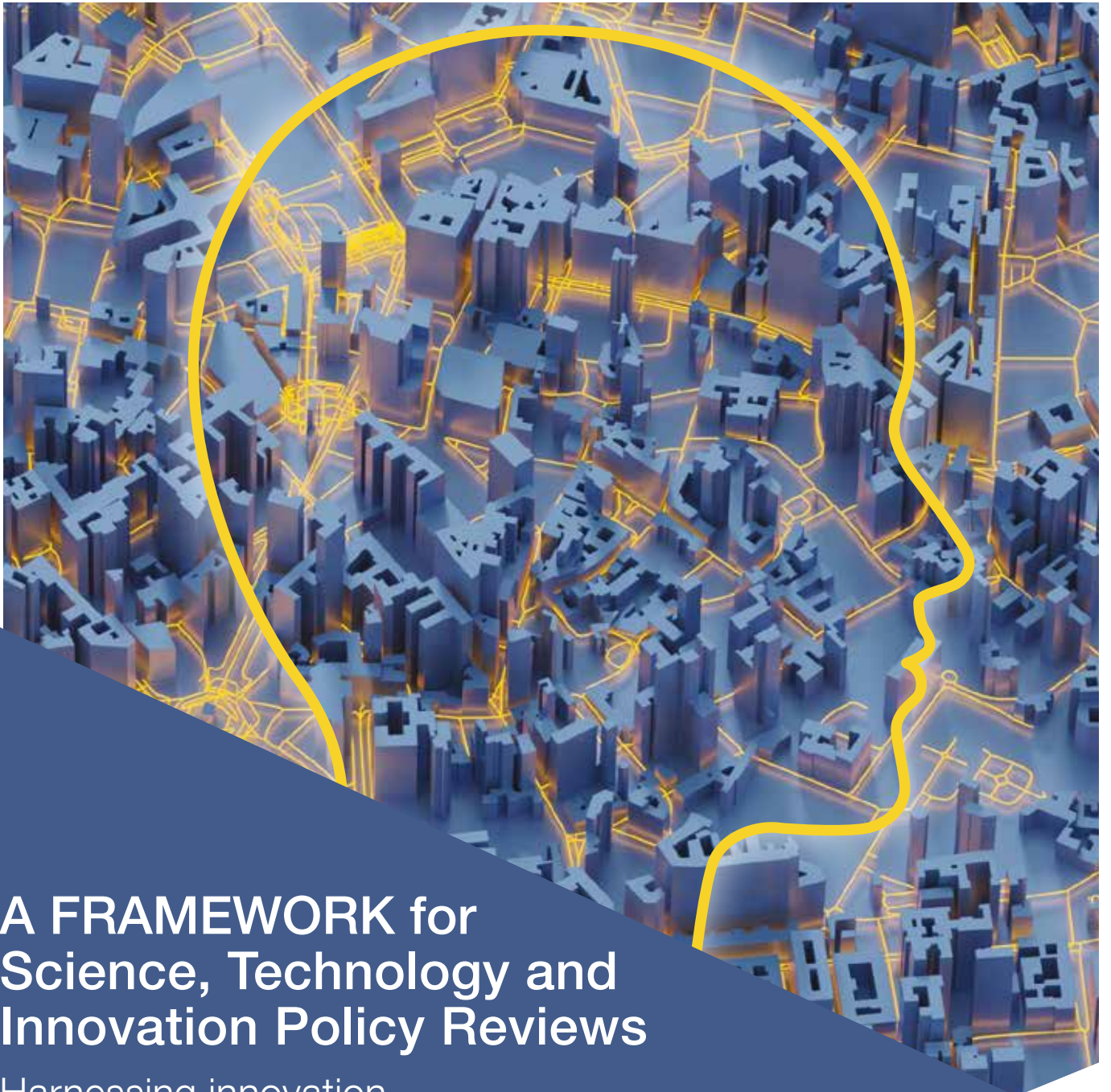


A FRAMEWORK for Science, Technology and Innovation Policy Reviews

Harnessing innovation
for sustainable development





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Foreword

Strengthening the technological capabilities of developing countries will be critical for the achievement of the 2030 Agenda for Sustainable Development. Focused national efforts are needed, backed by international support. As the focal point within the United Nations on science, technology and innovation (STI) for development, UNCTAD's policy analysis, consensus-building and technical cooperation help strengthen technological and innovation capabilities in developing countries, improve innovation performance and embed STI within the national development strategy. A key component of this undertaking is the Science, Technology and Innovation Policy (STIP) Review programme that provides tailored technical support to countries in assessing national STI systems and designing or reframing national STI policies and plans.

STIP reviews have been shaped by the outcomes of successive UNCTAD conferences, and the deliberations and experience-sharing in the United Nations Commission on Science and Technology for Development (CSTD). As of the end of 2018, UNCTAD had completed STIP Reviews in 14 countries, in which the reviews have often ignited a renewal in STI policy, raised the profile of STI policy in national development strategies and facilitated the inclusion of STI activities in international cooperation plans.

UNCTAD XIV (Nairobi, 2016) mandated the organization to continue and enhance the STIP Review programme, and to do so in the light of the 2030 Agenda for Sustainable Development. The methodological framework for STIP Reviews has therefore been redesigned to assist countries in aligning STI policy with their development strategies, while ensuring that STI policies promote sustainable development and help achieve the Sustainable Development Goals. Building on the established approach of addressing the fundamental issue of how STI can support the economic development goals of growth, higher productivity, structural transformation and economic diversification, the revised framework considers the role of STI in reorienting development towards more inclusive and environmentally sustainable outcomes.

A key feature of STIP Reviews is the systematic effort made to involve a broad range of stakeholders. This participatory process can mobilize networks of actors towards transformation through policy experimentation and learning. The STIP Review process thus opens a multi-stakeholder dialogue that can generate consensus among STI policymakers and development stakeholders on future lines of action and cement the ownership of related policy programmes.

This publication is intended to provide policymakers and other stakeholders with a guide to the new thinking that underpins the programme. The new framework presents an ambitious vision for transformative STI policymaking that advances an inclusive and sustainable development agenda. It calls for commitment to an inclusive process involving a broad range of social actors. It also requires flexibility in tailoring the process to each country's specific concerns, priorities, development trajectories and policy needs. Most importantly, it relies on a shared vision among all stakeholders of the power of STI to drive global development that leaves no one behind.

Shamika Sirimanne

Director, Division on Technology and Logistics

1. Introduction

The Science, Technology and Innovation Policy Reviews (STIP Reviews) undertaken by UNCTAD have over the years enabled STI stakeholders to reach a clear understanding of the key strengths and weaknesses of their innovation systems and identify strategic priorities and policy options for their development. From an early focus on economic growth, attention has more recently been paid to the potential of STI to shift pathways towards more inclusive and more environmentally sustainable patterns of development.

The 2030 Agenda, ‘Transforming our World’, requires a view of innovation that appreciates and understands the contributions it can make across all 17 interlinked SDGs (figure 1). For example, a focus on innovation in China’s energy system has led not only to a reported 100 per cent rate of grid connectivity, but also an increase in the proportion of renewables in total electricity generation from 16.2 per cent in 2005 to 23.4 per cent ten years later.¹ Colombia’s Colciencias’ ambition is to use

its innovation policy to overcome inequality and contribute to the peace process (SDG 10 and 16) and has published a national policy on innovation and the SDGs.² A focus on healthcare innovation in Cuba enabled it to develop the world’s first human vaccine (against *Haemophilus influenzae* type B) to contain a synthetic antigen.

These examples and more demonstrate the potential for STI – a focus of SDG 9 – to enhance productive capacities as applied to societal challenges such as clean energy, better health and reducing inequality. However, they still fall short of the ambitions of the SDGs. To meet the goals, innovation needs to contribute to reconfiguring socio-technical systems (see definition in figure 2 below) so that they are able to provide energy, healthcare, mobility, food and education in a truly inclusive and sustainable way (Lundin and Schwaag-Serger, 2018; Schot et al. 2018). The revised STIP Review helps to move in that direction. This document provides an overview of the revised framework, its conception and the flexible process for STIP Review design and implementation according to country needs.

Figure 1. Sustainable Development Goals



¹ Data from International Energy Agency <http://www.iea.org/statistics/statisticsearch/report/?year=2015&country=CHINA&product=ElectricityandHeat> and <http://www.iea.org/statistics/statisticsearch/report/?year=2005&country=CHINA&product=ElectricityandHeat>, accessed 1/5/2018.

² Colciencias (2018) El Libro Verde 2030: política nacional de ciencia e innovación para el desarrollo sostenible, <http://libroverde2030.gov.co/>.

Chapter 2 provides an overview of the role of STI in addressing the SDGs, with reference both to STI-specific goals and targets and to the pervasive impact of STI throughout the ‘Transforming our World’ agenda. The chapter introduces the concept of the innovation system (see definition in figure 2 below) and key building blocks of actors, interactions and enabling environments, all of which underpinned the previous version of the STIP Review framework. Here, however, updated concepts of ‘sustainability-oriented’ innovation systems and ‘transformative innovation policy’ are introduced, as well as responses to key trends that are changing the context in which developing countries need to learn and build capabilities. This includes addressing new innovation approaches that have been subject to more policy research since the last framework, including social and grassroots innovation, informal sector activity and trends towards digitalization (UNCTAD 2017).

Chapter 3 outlines in detail the process of undertaking a STIP Review, including key questions and criteria that may guide the reviews, the potential methodology and the steps involved in the review process. The chapter discusses different policy instruments and elements of the policy mix which may be required to build capabilities and transform systems. Beyond the analytical process leading to the STIP Review report, the chapter also explains how the participatory co-design aspects of STIP reviews can foster learning, enhance networks and mobilise actors to enable transformation.

Chapter 4 describes the structure of the STIP Review report, including the potential use of STI indicators and the challenges that they raise in certain contexts. It goes on to describe policy

processes and ways in which the STIP Reviews can be taken forward through transformative innovation policy experimentation. It also discusses a monitoring and evaluation process that follows the progress of STI policies, roadmaps and transformations with a view towards the 2030 horizon set out for the SDGs.

Figure 2 presents two key concepts that will be used throughout this document. It is important to note that the choice of this particular definition of the national system of innovation is not intended to negate the validity and relevance in various contexts of many other definitions available in the innovation policy literature.

2. Towards STI policy for sustainable development

2.1. Harnessing the potential of STI for sustainable development

The 2030 Agenda for Sustainable Development recognises Science, Technology and Innovation (STI) as a key driver enabling and accelerating the global transformation towards prosperous, inclusive and environmentally sustainable economies in developing and developed

Figure 2. Definitions

National innovation system – “an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures which determine the rate and direction of innovation and competence building emanating from processes of science-based and experience-based learning” (Lundvall et al. 2009).

Socio-technical system – a system in which human and technological components combine to deliver services such as energy, health, education etc. “Socio-technical systems consist of a cluster of elements, including technology, regulation, user practices and markets, cultural meaning, infrastructure, maintenance networks and supply networks” (Geels 2005).

countries alike. STI – long seen as a vital route to structural change, economic diversification, productivity growth, jobs and competitiveness – features strongly among the SDGs. Goal 9, ‘Industry, Innovation and Infrastructure’, explicitly refers to the role of fostering innovation and technological progress for promoting inclusive and sustainable industrial development. It incorporates increased Research and Development (R&D) expenditure and personnel in target 9.5. Meanwhile, SDG 17, ‘Partnerships for the Goals’, places cooperation on STI at the heart of international cooperation and global partnerships for development, with target 17.6 calling for enhanced “North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation...” But beyond these individual goals and targets, STI is key to delivering on and implementing all of the 17 goals, and, importantly, to the nexus challenges that lie between them, through its central role in processes of transformation.

Many types of innovation can respond to the economic, social and environmental dimensions of sustainable development.

A recognition of the need for transformative change at the socio-technical system level requires STI policy to embrace various forms of technological, social and institutional innovations, ranging from the incremental to the radical, and from low-tech to high-tech. This includes many other forms of innovation, such as social innovation, inclusive innovation, and grass roots innovation. Figure 3 introduces various types of innovation, ranging from process improvement to transformative system innovation, and indicates their possible sustainability benefits. There are overlaps between many of these categories (Smith and Arora 2015). STI policymakers should work to foster various types of innovations in parallel (Leach et al. 2012). In section 2 we discuss how different policy instruments and policy mixes can attempt to do this.

Figure 3. Types and examples of innovation for sustainable development

Product and service innovation

- Innovative technologies serving particular economic or social needs, including enabling technologies (e.g. ICTs) and technologies underpinning specific socio-technical systems (e.g. renewable energy technologies).
- Innovative products:
 - Inexpensive, durable, repairable, re-usable, recyclable, biodegradable materials and products with enhanced accessibility and reduced environmental impact.
- Innovative services:
 - Business to Business (B2B): provision of services aimed at improving processes of clients (e.g. waste management, eco-design).
 - Business to Consumer (B2C): provision of services that are less resource intensive and reduce emissions (e.g. repair services, or energy contracts adapted to marginalized groups).

Process innovation

- More efficient manufacturing processes, enhancing productivity.
- Pollution control and pollution treatment technologies leading to health and environmental benefits.
- Waste prevention and waste management resulting in economic (cost savings, new jobs), health (health risk prevention) and environmental benefits (prevention of illegal dumping of toxic waste).
- Resource efficient processes leading to socio-economic (material energy and water savings, new jobs) and environmental benefits (reduction of environmental pressures).

Organizational (institutional) innovation

- Cooperatives ensuring a higher price goes to primary producers such as small farmers.
- Corporate Social Responsibility (CSR), e.g. including CSR in company reporting.
- Environmental management and auditing systems (such as ISO 14001).

Marketing innovation

- Labels informing customer choices and improving supply chain outcomes (e.g. independently verified eco-labels, fairtrade labels or labels ensuring that the production process of products has respected human rights).
- Science-based campaigns and awareness raising, for example on water and sanitation, sustainable consumption.

Pro-poor and inclusive innovation

- Various types of innovation designed to address the needs of poorer, marginalized groups.

Grassroots innovation

- Innovation that involves grassroots actors (NGOs, communities) in the process of applying knowledge to sustainable development challenges, which are often defined at a local level.

Frugal innovation

- Products designed or redesigned to reduce their cost and complexity (become modular but can still be high-tech) while retaining their core functions.
- Affordable products from the informal sector that have a potential to reduce lifecycle-wide environmental impact due to reduced use of resources and energy, and re-use of materials and components. Region-specific terms include 'jugaad' (India), 'jua kali' (East Africa), or 'gambiarra' (Brazil).

Social innovation

- New collaborative arrangements with social and environmental benefits (e.g. supply chain innovations rewarding primary producers, energy cooperatives, repair cafes, eco-villages).

Source: Drawn and adapted from Miedzinski et al. (2017a, 2017b), UNCTAD (2017), Radjou and Prabhu (2015) and Dutrénit and Sutz (2014).

2.2. Systemic foundations of STI policy

STI policies began taking an explicit form in the 1960s as a means for increasing the competitiveness of economies, while including also mission-oriented programmes in defense, space, or transport, among others fields. Initially inspired by a linear, science-push, model of the innovation process, policies have become more complex over the years, recognizing the diversity of factors and actors that intervene in the process. The notion of

“innovation systems”, formulated in the late 1980s, has provided the conceptual basis of STI policies since then.

Innovation systems develop over time, co-evolving with their economic, political, social and environmental contexts. As such, there is no simple blueprint for building and managing innovation systems that can be replicated between countries. All innovation systems, however, share common features which can be classified into three domains: actors, connections and the framework conditions and environment enabling learning and technology development, and adoption and diffusion.

2.2.1. Actors in the innovation system

Innovation is **a process of discovery of better ways to arrange productive resources in order to address individual or social needs.**

This process is brought about by firms and other actors who interact within learning networks, and through linkages that enable actors to learn by interacting. To better benefit from STI (including with a focus on the SDGs), there is a need to recognize the roles and capabilities of all key actors in the innovation system:

- **Firms and entrepreneurs** have the capabilities to learn, absorb, innovate and commercialize new knowledge and technologies with an innovative effect.
- **Research and education system** have the capabilities to learn, absorb and develop new applied knowledge, and to supply human capital to the innovation system.
- **Intermediary organizations** have networking and coordinating capabilities, and the capabilities to identify relevant knowledge, as well as to support knowledge transfer, management capabilities.
- **Consumers/users** have the capabilities to learn, test and adapt new technologies, altering practices to support or constrain systemic change.
- **Civil society and citizens** have the capabilities to challenge non-inclusive and unsustainable practices, form alliances to lobby for change, mobilize and drive innovation, and pioneer solutions.
- **And last, but not least, government** has the capabilities to mediate innovation priorities, direct public resources into priority areas, support capabilities and connections in the innovation system, remove obstacles to innovation, influence the incentive structure, define and enforce regulations and standards, and attempt to improve framework conditions through public policies.

Firms and entrepreneurs are at the core of the innovation system. They have a central role in connecting different types of knowledge to bring innovative technologies, goods and services to the market. They need to continuously increase

their capacity to identify, adopt, assimilate and diffuse existing knowledge and technologies. This technological learning is not limited to formal mechanisms of R&D. Learning by doing and by interacting with users, clients and suppliers play a critical role in many contexts. Firms are not the only innovators and they do not innovate in isolation. They need to increasingly immerse themselves in learning and innovation networks and invest in developing linkages with other firms and STI stakeholders.

In developing countries with emerging innovation systems, the private sector may be dominated by small and micro enterprises. The informal sector is often relatively larger than in advanced economies. Start ups in modern production activities outside the informal sector may be few and find little support. The majority of firms and other actors need to develop a basic capacity to learn how to articulate demand for, as well as adopt, assimilate and diffuse, existing knowledge and technologies. In this process they need to act as knowledge producers, not just passive knowledge users, and use foreign inputs to develop their own innovative solutions. Building absorptive capacity and technological upgrading often relies on access to, and assimilation of, foreign knowledge and technology by local actors.

The research systems are also crucial to innovation. Researchers can offer various supporting services, from testing new technologies to fully fledged R&D. Their ability to learn and apply knowledge to innovation processes is critical to technological learning and building the local knowledge base.

Intermediary organizations help mitigate a fundamental systemic failure regarding the connection between the generators of scientific and/or technological knowledge and knowledge users among the other players in the system.

The education system improves the quality of human capital available to firms, governments and research institutions. A modern education system should be relevant to the changing needs of industries, workers and consumers, and to the challenges of the Sustainable Development Goals.

Civil society, non-governmental organizations, social enterprises and engaged citizens are crucial for focusing STI policy on meeting societal challenges. Civil society can mediate between technology developers and marginalized groups

and promote innovations that address their needs. In developing countries, civil society can be instrumental in testing, promoting and diffusing innovations designed to benefit the most disadvantaged communities.

And last but not least, **the government** is key to establishing a consensus on development and STI policy priorities, directing resources towards these goals, fostering capacity building and the creation of linkages in the innovation system, and promoting collaboration across government and with other key actors. They can remove bureaucratic, regulatory or monopolistic obstacles to innovation and adjust the incentive structure as appropriate, all while aiming to improve framework conditions through policy actions. A coherent STI policy mix is crucial to providing a stable and predictable environment for innovation. Establishing a national STI agenda, tackling institutional and regulatory issues that delay innovation, and fostering the creation of entirely new markets in priority areas should be the main objectives.

2.2.2. Connections in the innovation system

The connections and relationships between actors is a vital component of any innovation system. Effective innovation systems have robust and evolving network connections that enable organizations to translate new knowledge into innovations and enhanced productive capacity. Networking and collaboration capabilities are key to enabling adoption of technology, learning, and new technology development. They aid also the flow of key resources, including finance and human capital. It is precisely the link between firms and entrepreneurship and other actors in the system which is missing in many developing countries (Lundvall et al. 2009; Chaminade and Padilla-Perez 2014).

Effective innovation systems encourage local, national and international collaborations that cut across economic sectors, technology areas and scientific disciplines. Collaborations along supply and value chains, including organizations financing innovation and the final users of new technologies, ensure that innovation responds to demand, is socially accepted and has a chance to succeed on the market. Developing links with foreign firms, funders and research centres is a key step for developing countries with an underdeveloped local knowledge base and limited access to market intelligence.

Innovation collaboration can occur spontaneously, but in many innovation areas, notably related to addressing social and environmental challenges, it needs to be actively facilitated by government or other actors, notably non-government organizations (NGOs). Government can support networking in specific locations (e.g. technology parks) or sectors (e.g. competence centres focused on specific topics). There are actors in the system, known as **innovation intermediaries or knowledge and technology brokers**, who specialize in facilitating knowledge exchange and innovation collaborations. All actors in the innovation system, however, should build capabilities to engage in different forms of collaboration, ranging from information exchanges, to forming innovation partnerships or clusters which can become actors on their own. The emergence of successful innovation networks is a long-term process based on shared vision, common goals, and trust.

2.2.3. Framework conditions and an enabling environment

Effective innovation systems provide an enabling environment for actors, notably firms, to engage in innovation activities. The entrepreneurs are at the core of the systems, drawing upon the sources of knowledge and evolving in a more or less conducive context made of institutions, policies and infrastructure. The **building blocks** of innovation systems include the following, all of which exist within, and are influenced by, specific political systems within an international context:

- Policy and regulatory framework
- Institutional setting and governance
- Entrepreneurial eco-systems and access to finance
- Human capital
- Technical and R&D infrastructure

The policy and regulatory framework should provide incentives to established and emerging firms to invest in learning, knowledge and innovation, and take related risks. The policy framework should comprise various STI policy instruments, which should be coherent internally and externally with other key policy areas. STI policy should strive for alignment with industrial policies, but also policies on trade, foreign direct investment (FDI), education and training, and competition (UNCTAD, 2013b,

2015b). STI policies are also more likely to succeed in a context of pro-growth and pro-employment macroeconomic policies, including monetary, fiscal and exchange rate policies.

Institutional setting and governance include the legal rules, standards and norms (including non-written social and cultural norms) in a society, along with the organizational setting and governance mechanisms used to create, regulate and enforce them. Institutions should incentivize actors to invest in productive activities and discourage rent-seeking ones. For STI, the organizations designed to support firms in learning, knowledge creation and the accumulation of technological capabilities are particularly important. Relevant institutions also include education and training organizations, ministries, departments and agencies overseeing STI policy, and organizations for metrology, standards, testing and quality (MSTQ) systems.

Entrepreneurial eco-systems and access to finance are key for encouraging business incubation and growth of innovative companies. Ensuring that promising innovative projects can receive financial support is not only a matter of availability of funds. It is also a matter of organizational capabilities and policy frameworks. Firms and entrepreneurs need to develop managerial competences to develop credible business plans and to assess the risks of their projects. Organizations financing innovation for sustainable development (including government agencies, green/development banks or impact investors) should adapt their instruments to make them easier to access for young social entrepreneurs and start-ups with value propositions relevant for achieving development goals. Government can support this by ensuring a stable regulatory framework and by promoting new financial instruments catered to the needs and capabilities of small and medium-sized enterprises (SMEs) and entrepreneurs.

Human capital enables technology adoption and the innovation process, and can harness the wider benefits of STI, including in the poorest and most remote communities. Human capital relies on all levels of education, and includes the technical and managerial skills involved in a variety of innovation activities, from R&D, design and engineering, to technology brokerage and networking. A strong technical and vocational, basic and higher education system must provide basic science, technology, engineering, mathematics (STEM) and

management skills. With new technologies certain skills have become more essential (problem solving, teamwork, creativity and learning to learn, and ICT skills). Indigenous and traditional knowledge also forms a vital part of the human capital of countries that can contribute to sustainable development.

Technical and R&D infrastructure comprises basic technical infrastructure (e.g. water, energy, ICT, transport and urban structures), specialized infrastructure supporting R&D, demonstration and innovation processes (e.g. laboratories, testing and certification facilities), and existing technologies. Basic technical infrastructure is one of the key factors promoting innovation as it improves physical mobility of people and enables exchanges of information and knowledge locally and internationally.

In many developing countries with inadequate infrastructure, policies target the provision of specialized infrastructure supporting productive capacity by developing different types of clusters in **selected geographic locations**. These clusters might include industrial parks, special economic zones, and science and technology parks, often including accelerators and business incubators (UNCTAD, 2015a). Technical infrastructures (for example, energy, transport, and communications) are functionally connected; synergies between them can provide a strong boost for local development. Therefore, co-ordination is key.

ICT is now considered part of a country's critical infrastructure. As an enabling technology, ICTs create synergies with key technologies such as biotechnology, nanotechnology and advanced manufacturing. ICTs have the potential to contribute to the social, economic and environmental dimensions of development, and holds relevance to virtually all the SDGs. Taking advantage of this potential requires investments in basic ICT infrastructure, which relies upon a dependable energy supply, telecommunications infrastructure and regulation. Ensuring affordable access to ICT and overcoming the geographic, gender, generational and income-based digital divides across and within countries is crucial. Combining virtual infrastructure (communications networks) with material infrastructure (e.g. makerspaces) can help to unleash the power of open, digitally-enabled collaborative innovation (UNCTAD 2017).

2.2.4. STI policy as a transversal policy

It is clear then that STI policy rooted in innovation system thinking has always been a policy domain integrating elements and instruments from various, mainly economic, policy fields. These include science and technology policy, industrial policy, trade policy, FDI policy, entrepreneurship policy, fiscal policy, regional development and planning, as well as education and training policy. It concerns also specific sector policies such as those focusing on agriculture, energy, transport, health and so on, which include often R&D programmes, as well as sets of regulations more or less favorable to innovation.

The cross-cutting nature of STI policy makes it difficult to position within governments. The most proactive countries in this instance, such as Finland and the Republic of Korea, among the economically advanced countries, have positioned it at the Prime Ministerial level. But there are intrinsic institutional limits to what the policy making bodies in charge of STI can do in policy domains for which they do not have the primary responsibility. The latter domains are precisely those which shape a large part of the so called 'framework' conditions discussed above.

2.3. Different types of innovation systems

Taken together, the dimensions described above – actors, connections and framework conditions, and enabling environment – along with the resources mobilized and invested in STI by the public and private sectors, define the systemic capabilities of innovation systems. We can distinguish between different types of innovation systems based on the level of technological capabilities and the quality of enabling environment for innovation (Lundvall et al. 2009; Chaminade and Padilla-Perez, 2014; World Bank 2010; Cirera and Maloney 2017). This is important to recognise, so that STIP Reviews can cater for local contexts and address relevant societal challenges. Some of these contextual factors are represented in figure 4.

Many innovation systems in Least Developed Countries find themselves at the early stages of formation with very limited technological

and innovation capabilities, as well as underdeveloped networks and collaborations between all actors. They frequently face poorly developed enabling environments, with entrepreneurial eco-systems often dominated by the informal sector, as well as limited access to finance, shortages of skilled labour, low quality technical infrastructure and weak and unstable regulatory and institutional frameworks. These innovation systems should aspire to enable learning by fostering the creation of more technologically advanced economic activities and sectors. They should move away from low-wage and diminishing return activities towards higher-wage and increasing return industries. At the same time, such innovation systems may be less locked-in to unsustainable pathways, and have a wide range of local social, frugal, pro-poor, grassroots, and inclusive innovation activities. They may also possess indigenous knowledge that can contribute to the sustainable development goals.

Innovation in many middle-income developing countries is characterized by the presence of technologically advanced innovative sectors, often highly concentrated in specific regions. These co-exist with sectors and regions with other capabilities, focused on social innovation and informal innovation etc. These innovation systems are sometimes called dual innovation systems (Lundvall et al. 2009). Their main challenge is to establish linkages and learning opportunities between pockets of excellence with the regions which, though lagging in economic terms, have the innovative potential to diversify the economy. The innovative potential of these pockets and the relative absence of lock-in (in comparison to high-tech focused innovation systems) offers particular opportunities for green leapfrogging (see 2.5).

Many high-income countries display high tech focused innovation systems. The main challenge for such innovation systems is renewal – the ability to find new inclusive and sustainable growth paths and technological specializations that address the SDGs. High tech focused innovation systems often display an erosion of traditional knowledge and high levels of energy (often fossil) dependency, resource intensity (waste production) and individualized consumption. The lock-in of these innovation systems to unsustainable development pathways presents difficulties and requires

deep learning in which actors question their own assumptions and the viability of dominant practices to address the SDGs.

Far fewer (if any) innovation systems are characterized by a well-developed enabling environment, featuring stable macro-economic, institutional and regulatory frameworks

prioritising innovation directed towards societal challenges. Such systems would have advanced technological and innovation capabilities, and well-functioning networks and partnerships, with civil society and other (low-tech) approaches incorporated into the system. Investment in innovation is balanced between public and private sectors.

Figure 4. Recognising the specific context of innovation systems in STIP Reviews

Increasing innovation capabilities, with the potential to address societal challenges 	
Actors and capabilities	<p>Low technological and learning capabilities of actors</p> <p>Limited capability to address societal challenges but with relevant local examples of frugal innovation</p> <p>Mixed technological capabilities</p> <p>Mixed capabilities to address societal challenges with globally leading niches and sectors co-existing with underdeveloped and marginalized actors</p> <p>High technological capabilities and dynamic innovation/entrepreneurial culture (including low-tech) combining to explicitly address societal challenges</p>
Linkages and networks	<p>Underdeveloped or missing linkages in the system</p> <p>Co-existence of well-connected technological areas and functional systems (e.g. energy, food) with underdeveloped and fragmented systems</p> <p>Highly developed linkages in the system</p> <p>Functional science-industry linkages</p> <p>High capacity to form public-private and public-public partnerships</p>
Framework conditions and enabling environment	<p>Weak enabling environment for innovation</p> <p>Rudimentary and/or not effectively enforced regulatory framework</p> <p>Limited or absent business advisory and financial support for innovation</p> <p>Good foundations of enabling environment with basic regulatory and policy framework</p> <p>Well-developed enabling environments, stringent but flexible regulation</p> <p>Highly developed entrepreneurial eco-system including in social and environmental fields</p> <p>Business advisory and financial support adapted to the needs of companies at different stages of innovation process</p>

Source: Based on World Bank (2010), Chaminade and Padilla-Perez (2014) and Cicera and Maloney (2017). The notions of societal challenges and sustainable development added by UNCTAD.

2.4. Towards a new model of STI policy for sustainable development

2.4.1. Evolving rationales for government action

To address the SDGs, STI policy needs re-focusing, keeping in mind that the direction and nature of the efforts involved will not be the same for countries at different levels of development and different social, economic and environmental challenges. In the early days of STI policy, notably in Europe during the decades following the Second World War, the rationale behind public intervention in STI was to overcome market failure. This resulted in suboptimal level of investments in R&D. As noted, the logic of public support relied on the predominantly science-push linear model of the innovation process. When STI policies started evolving into the innovation system model, the new approach recognized that knowledge production does not lead automatically to innovation, but needs absorptive capacity and demand for knowledge. Innovation system literature introduced the notion of system failures that hamper innovation. System failures include shortcomings in the capabilities of actors – notably firms and knowledge actors – learning, linkages and networks of actors, as well as the framework conditions of the enabling environment, including regulatory and policy frameworks.

Reorienting STI policy to address the sustainable development goals represents another transition in the history of STI policy.³ The introduction of ambitious and wide-ranging goals further changes its rationale. STI policy is designed to address economic policy objectives by ensuring efficient functioning of the innovation system, keeping both market and system failures in mind. This rationale means the policy remains ‘neutral’ regarding the nature and direction of economic growth and does not give any explicit attention to environmentally and socially sustainable innovations. This lack of explicit indication of an overall strategic direction, and the negative costs to society associated with the resultant forms of innovation, is referred to as directionality failure (Weber and Rohracher, 2012).

The response of innovation policy is to take the question of directionality as a starting point for setting collective priorities in a deliberative fashion.

This has significant implications for STI policy strategy, instruments, processes and governance. It implies, on the one hand, a growing importance of policy coordination and strategic coherence between STI and many related development policy fields, while, on the other hand, a need to allow for policy experimentation with new type of STI policies which may not align with current policies.

2.4.2. Transformative change and pervasive improvement

STI policy aligned with the 2030 Agenda and the SDGs needs to focus on transformation. It must seek to internalize and accommodate economic, social and environmental dimensions of sustainable development, and to take responsibility for social and environmental impacts of innovations and technologies it directly or indirectly enables or inhibits.

The 2030 Agenda and the SDGs can serve as a compass for STI policy to indicate the broad directions of transformative change to be supported by public intervention. Specific national development goals, plans and strategies are established by governments, incorporating sustainable development objectives within them. To navigate the complexity of the SDGs, STI policy can prioritize several SDGs, or link SDGs with existing long-term development goals.

However, prioritizing certain SDGs and acting on specific socio-technical systems should not lead to the neglect of efforts and policy measures that improve the overall climate for innovation. In fact, transformative change will take place more easily in a context where innovative initiatives in general are encouraged and benefit from a supportive environment, independent of any prioritized focus.

It is important that STI policymakers find a balance between support for two types of innovation processes. Support needs to be provided to a wide diffusion of proven technologies and processes requiring basic absorptive capacity in firms (e.g. simple resource and efficiency measures). It is

³ Schot and Steinmueller (2018) introduced the idea of three frames for STI policies. They focus on the need for developing a new third frame (transformation of socio-technical systems), without giving up on the importance of the first frame (R&D and knowledge production) and second frame (national systems of innovation and entrepreneurship). This framework adopts the view that such a third frame is compatible with integration of an innovation systems approach. Likewise, R&D and knowledge production remain important aspects of modern STI policy and systems. However, the framework explicitly supports the move away from linear approaches to innovation.

Figure 5. Policy instruments to foster innovation for environmental sustainability

	Policy instruments	How can they support innovation for sustainable development?
Regulatory framework	Environmental and health protection regulations	Provide incentives to innovate to comply with regulatory framework (e.g. substitution of harmful chemicals). Provides disincentives for free riders by introducing penalties
	Product and industrial process standardization	Provide incentives to innovate to comply with environmental and social performance standards for products and processes
	Consumer protection, labels and certification	Promotes innovative products and processes by providing information on environmental and social performance of products and services to customers
	Intellectual property rights	Encourages firms to engage in innovation activity by protecting their knowledge; and opens access to knowledge and technologies contributing to sustainable development
	Competition Law	Prevents the emergence of monopolies or cartels that can stifle innovation and hold back its benefits for consumers or the environment
	Bankruptcy Law	Can help to engender a risk-taking, entrepreneurial culture, protecting investors, firms and consumers against some of the negative effects of failure
Economic instruments	R&D funding	Provides direct support for R&D underpinning sustainable innovation
	Innovation funding for companies	Provides direct support for innovation activities aiming in the areas relevant for sustainable development
	Equity support to venture & seed capital	Provides equity dedicated to innovation; de-risks innovation investments
	Feed-in-tariffs and similar subsidy schemes	Provides financial incentives to adopt and diffuse innovative technologies in selected technology areas (e.g. renewable energy)
	Tradable permit systems (e.g. emissions trading)	Allocates or sells emission rights to polluters which can be traded. The price for emission rights and prospect of reduction of emission rights creates incentives for innovation
	Removal of subsidies for unsustainable activities	Removes distortion from markets that inhibits sustainable innovation (e.g. subsidies for fossil fuels)
Fiscal instruments	Tax incentives for R&D for companies	Tax reduction (CIT) for companies undertaking R&D underpinning innovation
	Tax incentives for technology adopters	Tax reduction (CIT) for companies adopting innovations with environmental and social benefits
	Environmental taxation	Tax reduction (CIT) for companies undertaking R&D underpinning innovation
	Removal of tax reliefs for unsustainable activities	Removes distortion from markets that inhibits sustainable innovation (e.g. subsidies for fossil fuels)
Demand support	Sustainable public procurement	Creates markets for goods and services with positive impacts on the local community in the areas relevant for sustainable development (e.g. Green Public Procurement)
	Pre-commercial procurement (R&D and innovation procurement)	Creates markets for innovative goods and services and stimulates experimentation of new application of emerging technologies
	Support to private demand	Provides incentives (e.g. vouchers) for consumers to purchase innovative goods and services with demonstrated positive social and environmental impacts
Education & training	Adaptation of formal education curricula to address the SDGs	Adapting higher education and vocational training curricula to consider sustainable development challenges. The curricula may be developed jointly with industry and other organizations. Provides qualified and skilled workforce
	Placement schemes and staff mobility	Supports learning, knowledge exchange and connections between actors in the innovation system with a focus on actors active in promoting sustainable innovation
Regional innovation strategy & networks	Clusters, industrial zones, and science and technology parks	Encourages smart specialization in innovation and technological areas relevant for societal challenges in regions with high potential and/or need for goods and services with environmental and social benefits
	Technology platforms and networks	Promotes information and knowledge sharing on innovation
	Roadmaps and technology foresight	Creates shared vision, commitments and roadmaps for experimentation, investment and development of eco-innovation, "wires up" the innovation system

	Policy instruments	How can they support innovation for sustainable development?
Trade policy	Trade tariffs	Removes barriers to trade in innovative goods and services which contribute to the SDGs; opens access to knowledge important for adoption and diffusion of technology; also imposes barriers on environmentally and socially harmful goods and services
Capacity building and information provision	Business advisory services	Promotes skills and knowledge relevant for innovation
	Local entrepreneurship and business incubation	Promotes local entrepreneurship and local innovation
	Technology transfer and matching	Promotes identification and acquisition of innovative technologies relevant for tackling specific challenges
	Capacity building for governments	Promotes building up government capacity to design, implement, coordinate and evaluate STI policy with a view of its support for sustainable development
Information and cultural instruments	Market intelligence services	Promotes information, data and knowledge sharing on innovation trends related to sustainable development (reduces information asymmetry)
	Education and awareness raising	Campaigns or programmes can 'popularize' science, technology and innovation and – if appropriately designed – enhance democratic inputs to innovation policy
	Network facilitation and enhancement	Aids lesson learning and sharing e.g. events such as Failure Nights ^a , Start-up weekends ^b etc
	Virtual and material infrastructure/ events for innovation network-building	Hackathons, maker spaces, transformation labs

Source: Miedzinski et al. (2017a) adapted by UNCTAD.

^a An initiative to embrace and learn from failure.

^b An initiative enabling entrepreneurs to learn and network with mentors and each other – see <https://startupweekend.org/>.

important that they also foster radical technological innovation and system-level changes with the potential for a transformative impact. The second type of innovation processes require well developed innovation and collaboration capacities and also present higher risk. More diversity within an innovation system can foster more effective innovation, mitigate against socio-technical lock-in, foster resilience and hedge against risk, uncertainty and ignorance (Stirling 2009).

2.4.3. Policy design: STI policy instruments and mixes of instruments

Addressing complex societal challenges requires the capacity to design and deploy many parallel interventions to address various aspects of the problem. STI policy for sustainable development can draw from a wide range of policy instruments providing direct support to innovators and improving the enabling environment for innovation activities that contribute to sustainable development.

STI policymakers need to learn how to design and implement policy plans and strategies, as well as specific instruments. However, it is critical that

developing countries build a strategic capacity to design and implement comprehensive and coherent instrument portfolios, or policy mixes, rather than focus predominantly on individual instruments. They also need to adopt a clear and effective policy learning cycle to recognize and assess the transformative potential of the dominant mix, and if necessary be able to change the overall portfolio in such a way that it further enables transformation. Figure 5 overviews selected STI policy instruments and their potential role in fostering innovation for sustainable development.

In practical terms, when addressing identified societal challenges and transforming related socio-technical systems, there is a need to focus on quite specific objects (OECD 2015). This means that specific actions to introduce new technologies or social processes or practices need to be planned and resourced. Moreover, in each case, there is a need for fine-tuned packages of complementary and mutually reinforcing instruments from diverse policy fields, such as those listed above (figure 5). These must address both supply and demand factors, as well the whole enabling environment, facilitating the emergence and diffusion of relevant innovations.

2.4.4. New STI actors and emerging governance challenges

Addressing the SDGs calls for engagement and collaboration between many actors with the capabilities to design, develop, test and implement innovations. STI policy should engage a wider variety of innovation actors relevant for developing countries. These might include firms and entrepreneurs, educational and research actors, organizations financing innovation, trade unions and cooperatives, national and international donors, NGOs, as well as social entrepreneurs and grassroots organizations active in the informal economy.

Addressing complex cross-cutting issues, such as the water-energy-food nexus, requires lateral thinking, effective co-ordination and new governance arrangements centring on leadership and organizational reconfigurations that involve many ministries and governance levels. For example, in response to the country's energy crisis, Ethiopia's National Biogas Program (NBPE) was led by a co-ordination office under the Ministry of Water, Irrigation and Energy (MoWE), but worked with other ministries, agencies, Non-Governmental Organizations and the private sector, and led to the dissemination of thousands of biogasifiers (Kamp and Form 2016).

Engaging new actors and facilitation of new strategic collaborations requires political commitment, leadership and collaboration skills from policymakers as well as other actors in the innovation system. Fostering STI collaboration focused on specific sustainable development priorities is likely to require coordinated actions by various ministries, departments and agencies, as well as key actors in the innovation system. These will include the private sector, state-owned enterprises where they are significant, academia and research, financing organizations and civil society.

The role of public policy is to co-design and set up a governance system to engage stakeholders, and to assure that risks and benefits of the transformation are borne in a fair way (Altenburg and Pegels, 2012; Weber and Rohrer, 2012). **In line with the ambition to 'leave no-one behind', policymakers should consider the role and distributional implications of innovations and transformations for different communities, considering any potential impact on different ethnic, gender, generational groups, as well as**

on different regions in the country. The policy should also consider the benefits, costs and risks of innovation for **the informal sector**, increasingly recognized for its contribution to innovation (Kraemer-Mbula and Wunsch-Vincent 2016).

More ambitious innovation projects may call for policy experimentation and support of alternatives, which will complement, and in some cases gradually replace, established practices. STI policy has a role to play in creating protective spaces where experimentation and demonstration of innovation can be initiated and scaled-up, and social participation encouraged. The example of M-Pesa – a mobile payments innovation in Kenya – is instructive. It is an exemplar of inclusive innovation, and at the same time represents a successful transition to a new financial services system. The regulator's willingness to allow experimentation was a key element during the introduction process. Users were invited into the innovation process during the pilot test of the M-Pesa prototype over a period of seven months, between October 2005 and May 2006. The test resulted in numerous product improvements made before a national launch in March 2007. M-Pesa was launched under the key value proposition 'Send Money Home', which exploited the norm of making frequent remittances through familial social networks. Subscriptions reached 1.3 million users by the end of the year. The experiments during the first seven months of testing were key to the success (Onsongo and Schot 2017).

The focus on transformative innovation can create tensions between advocates of change and the incumbents. It requires strategic leadership and competences from policymakers, businesses and other leaders of the transition to anticipate and manage potential conflicts. For example, experience of partnerships in sanitation projects in slums and other contexts in India has shown that they are more successful if the leaders adopt a mobilization and mediation role (Gopakumar 2010). As a general principle, promoting effective collaboration between policymakers and firms must not lead to capture of policymakers and policymaking processes by incumbent firms, even with more traditional innovation approaches. Demands on governance in 'sustainability-oriented innovation systems' which aim to disrupt environmentally unsustainable technological pathways are particularly high (Altenburg and Pegels 2012). Policies pursuing transformative

change need to be able to challenge existing unsustainable practices by withdrawing existing support and providing incentives for incumbent companies to stop unsustainable practices. Transformative change often creates winners and losers, and policymakers may have to arbitrate so that innovative outcomes are not impeded.

2.5. Adapting STI policy to countries' capabilities

STI policy needs to consider locally-defined societal challenges, as well as adapt to the specific nature of the innovation systems in place. Building innovation capabilities enables developing countries to build their own development pathways, responding to economic, environmental and social aspects of sustainable development.

Policymakers in developing countries face similar types of challenges. A common feature among innovation systems in Least Developed Countries is the low absorptive capacity of the majority of firms and other innovation actors, though pockets of stronger innovation capacity do exist (for example, in Bangladesh's pharmaceuticals industry

STI policy instruments need to be adapted to the capabilities of actors and to the economic and societal structure, which in developing countries may be dominated by micro and small enterprises and the informal sector. In Least Developed Countries especially, scaling-up investment in STI will require significant external financial support. Innovation policy should be formed by an integrated package of STI, industrial, trade, FDI, education and training, as well as competition policies. This package should not only result in new local capabilities, but also help make it possible to exploit these capabilities so that producers become internationally competitive.

Different countries' interacting social, technological and ecological systems have co-evolved in historically-contingent and politically-directed pathways which act to constrain future possibilities (Leach et al. 2010). In comparison with countries that have high levels of production and consumption, many developing countries demonstrate more sustainable patterns of resource and energy use. In contexts in which socio-technical systems are less 'locked in' to unsustainable pathways, important opportunities may exist for 'green leapfrogging'

(Watson and Sauter 2011), rather than following established development pathways.

The 2030 Agenda places great emphasis on scientific and technological collaboration (SDG target 17.6) which can involve countries with various types of innovation systems in international collaboration, including different forms of bilateral and multilateral cooperation. These may include "south-south" as well as more traditional "north-south" and "triangular" cooperation initiatives. International collaboration on STI will need to be dramatically scaled up to meet the SDGs. The UN Technology Facilitation Mechanism and the Technology Bank for Least Developed Countries represent additional opportunities to contribute to this goal (SDG target 17.8). Technological collaboration should respect the different development contexts (in terms of locally-defined priorities, innovation capabilities, current socio-technical systems and areas of specialization) of developing countries. Developing countries should be supported to innovate in a way that drives their own development pathways, without assuming that existing technologies can easily be "transferred" to them (that is, adopted and assimilated by actors in the country accessing them) without effort and investment (SDG target 17.7)

3. The STIP Review Framework

3.1. Introducing the STIP Reviews

The STIP Reviews undertaken by UNCTAD are a technical cooperation programme based on an analytical and policy learning process through which a country's STI stakeholders can reach a clearer understanding of the key strengths and weaknesses of their innovation systems and identify their strategic development priorities. This chapter outlines the process involved in country reviews, including the design, key questions and criteria, and the methods that might be used.

The STIP Reviews consider STI a key driver supporting national development strategies, that should now be integrating as a primary objective the structural transformation of economies and societies towards sustainable

Figure 6. Characteristics of the revised STIP Reviews

Sustainable development oriented. The STIP Review is driven by the need to ensure that STI contributes to the long-term sustainable development of the country, in line with national development goals, the 2030 Agenda and the SDGs.

Strategic reflection. The STIP Review process is designed to explore relevant alternatives for STI and STI policy to address key societal challenges facing the country in an effective and responsible way. It focuses on the country's national development goals and promotes sustainable development. The process encourages a strategic reflection on costs and benefits of alternative development pathways to achieve key development goals, and their implications for STI.

Policy oriented. The STIP Review process, findings and recommendations seek, where relevant and appropriate, alignment with the existing strategic STI policy framework and organisational setting and aim for ready application in the ongoing and planned policy processes in the country.

Transformative. The STIP Reviews focus on the potential areas of STI system, innovations and STI policy interventions which demonstrate high potential to contribute to transformative change towards sustainable development and achievement of the SDGs within the local context.

Participatory. The STIP Review process is designed to engage key government and non-government stakeholders from the country to ensure that the analysis and recommendations are relevant and actionable. The process aims at engaging a broad representation of government, including various ministries and agencies relevant for STI. The review reaches out to relevant non-governmental stakeholders. These would include firms and entrepreneurs, research and educational organizations, organizations financing research and innovation, donors and international development banks, as well as users, NGOs and grassroots organizations, especially those active in the informal sector.

Systemic. The STIP Reviews are based on systemic approaches to analysing innovation, notably on the various approaches developed to analyse innovation systems in developed and developing countries (e.g. national, regional, sectoral and technological innovation systems). They are also based on system innovation and theories of socio-technical system transitions.

Context-sensitive. The STIP Reviews are designed to flexibly respond to the specific challenges, needs, competences and contexts of the specific country under review. Broad stakeholder involvement is crucial to ensure that advantages and limitations of the local context are considered sufficiently.

Evidence-based. The STIP Reviews are based on the best available evidence and expertise relevant for the review. The UN team follows a robust and flexible approach to ensure the use of good quantitative and qualitative data relevant for the country context.

Independent. The STIP Review is an independent research and analysis process led by a UN team coordinated by UNCTAD. Reviews do not strive at aligning with formal positions held by governments and other stakeholders. They contribute an independent diagnostic assessment to the policy debate and policy making process.

Policy learning process. The STIP Review process and follow-up is designed to encourage policy learning about, and exchange of experience in, addressing SDGs through STI policy among policymakers, stakeholders and the UN country team.

Capacity building. The STIP Review process and follow-up make concrete recommendations for strengthening existing, and building new, capacities of STI actors with key roles in the innovation system.

development. The reviews emphasise the importance of considering the specific context and capabilities of countries before making choices around how to construct and choose development pathways. They recognise that there is no single and unique model of development applicable to all countries, but argue that valuable lessons can be learnt from evidence and practices that have been implemented with success in other countries. The STIP Reviews therefore assist countries in developing, assessing, trying out and implementing their own development pathways towards meeting their national development goals in alignment with the global SDGs. They help to reconcile local needs with global challenges.

Figure 6 outlines the characteristics which frame the overall conceptual and methodological approach to the process, products and desired outcomes of the STIP Reviews. The structure of the STIP Review report is outlined in the next chapter.

3.2. Steps in the STIP Review process

3.2.1. Before the STIP Review

STIP Reviews are designed to support countries operating within different development contexts. Before engaging in the STIP Review process, it is advisable to consult previous reviews as well as take part in STI events, notably Commission on Science and Technology for Development (CSTD) meetings and STI policy dialogues facilitated by UNCTAD. Such events are open to participation of representatives of all United Nations member states and duly accredited NGOs. They provide an opportunity for mutual learning on the role of STI and sustainable development, with countries sharing insights and experiences associated with STIP Reviews presented at annual CSTD meetings.

3.2.2. Launch

The STIP Reviews are undertaken at the official request of a United Nations member state. The first step to launch the STIP Review process is the formulation by the government of an official written request addressed to the Secretary-General of UNCTAD. High-level political commitment is essential for the success of any policy review exercise. This is normally signaled by a ministerial

level endorsement of the request for a STIP Review. Support will come from the ministries with significant roles in STI policy, such as Science and Technology, Industry, Economy or Education and, if specific socio-technical systems are to be analysed in the review, parallel support from their relevant ministries.

Given the transversal and systemic nature of SDGs, it is recommendable that the request reflects the perspectives of relevant ministries and organizations, rather than one line-ministry, and that the design, implementation and follow-up of the STIP Review are discussed at cabinet level prior to launch.

The official request should identify the main counterpart of the UNCTAD secretariat for the implementation of the STIP Review. **The identification of a strong, credible national counterpart is a critical step for the success of the process and for ensuring a long-term impact. It is therefore recommended that careful consideration be given by the national authorities to their choice.** Ideally, this role should be assigned to an institution with sufficient human resources to provide sustained support and collaboration during the review process and beyond. Its leadership should enjoy access to policymakers at the ministerial level or above, and have widespread contacts among STI stakeholders, including the private sector and civil society. Another measure that helps to ensure a high-quality STIP Review process is the inclusion in the official request of a brief issues note outlining key challenges and policy questions in the context of national development plans, strategies and goals, as well as the SDGs which the STIP Review process is expected to address.

UNCTAD's STIP Reviews are extra-budgetary activities. Therefore, before substantive activities can be launched, funding for the exercise must be identified and mobilized. When funding is not immediately available, the secretariat will assist the authorities of the requesting country in securing the necessary funds.

3.2.3. Inception phase

Once approved and funding has been mobilized, the review process begins with the drafting of a terms of reference of the STIP Review by the UNCTAD secretariat. A first preparatory mission may be undertaken to agree on the terms of reference, to discuss the thematic scope and specific content of the review and to establish a

common understanding about its key objectives and expected outcomes.

The scope and content of the review is tailored to fit the country's circumstances and priorities, including its productive structure and key development goals and challenges. At this stage, agreement is reached about the respective roles and responsibilities of UNCTAD and the national counterpart. The optimal timing for the implementation of the review is determined, including the consideration of any political calendar issues, reforms in institutional structures or legislative changes that may affect the STIP Review.

The definition of the terms of reference should involve a deliberative process in order to ensure 'buy-in' by those in the stakeholder group, but should also reflect high-level political commitment in the country. As far as practicable, it should be drawn up with a 2030 timeframe in mind in order to provide a basis for short, medium and long-term alignment with the national and international SDG processes. An implementation schedule including field missions, national workshops and the publication and dissemination of the outcome of the STIP Review is also agreed upon. Based on the terms of reference, a STIP Review team is put together.

The STIP Review team is led by UNCTAD staff and includes STI experts from UNCTAD and other UN agencies, as well as a small group of independent experts. A targeted effort is made to include national STI expertise. A diverse team membership (in terms of gender, ethnicities, and regional knowledge) is likely to provide a more robust review. In parallel, the national counterpart is strongly encouraged to put together a national STIP Review group. This group will include representatives of the major ministries, firms and industries, development and sustainability interest groups with a role in STI academia, and civil society, as well as other stakeholders, especially those related to any particular areas to be adopted as a focus for the review. It is important that this stakeholder group goes beyond the traditional actors in the innovation system (primarily government, research organizations and firms) and includes any new actors described above. The 'major groups' established under the UN Conference on Environment and Development (Rio 1992) can act as a guide to the groups who will engage in the revised STIP Review process.⁴ Their

engagement in the process facilitates recognition of innovative contributions of a wide range of actors. It projects visibility, contributes to the continuity of the process, helps address concerns that may emerge about threats to institutional mandates or resources that may emerge from the review process, and facilitates a broader dissemination of the outcome of the STIP Review.

3.2.4. In-depth focus on selected societal challenges, the SDGs and socio-technical systems

Though not compulsory, earlier STIP Reviews would often look beyond horizontal STI policies to additionally adopt a focus on particular sectors or strategic areas. These included oil and gas in the Islamic Republic of Iran, ICT in El Salvador, energy in the Dominican Republic, and traditional and herbal medicine in Ghana, as well as selected topics such as diversification, human capital and labour in Oman, or research system organization in Ghana. The revised STIP Review framework also invites introduction of specific socio-technical systems for energy, mobility, healthcare, food, water, finance, and education provision – all of them relevant for sustainable development – in order to encourage more focused learning, reflection and mobilization in order to foster transformation for a particular societal challenge.

As discussed in section 2.2, the application of STI within the 2030 Agenda requires cross-cutting engagement beyond traditional STI actors. The revised STIP Reviews provide the opportunity for member states to identify priority areas where STI can play a particular role in transforming socio-technical systems in order to address specific SDGs and deliver on a number of SDG targets. Such areas might be jobs, energy, healthcare, mobility, food, education, finance etc. Although some SDGs are specifically focused on these areas, in reality many of these lie at the nexus of different SDGs, which have been shown to interact both at the goal and at the target level (ICSU 2017). At the same time, the ways in which particular SDGs interact at a national level is context-specific (Nilsson et al. 2016), and any analytical approach to setting priorities should be firmly based within the national context.

⁴ These include: Business and Industry, Children and Youth, Farmers, Indigenous Peoples, Local Authorities, NGOs, Scientific & Technological Community, Women, Workers and Trade Unions, Persons with Disabilities, Volunteers (Volunteer Groups Alliance), (Stakeholder Group on Ageing, Education and Academia (Stakeholder Group)).

It should be noted that socio-technical systems in developing countries that may be candidates for transformative change can be traditional economic sectors, such as textiles. They are often an important source of jobs, which need not only to keep up with the global competition in upgrading their productions, but also to reduce negative environmental impacts, as well as to provide better working conditions.

3.2.5. Preparatory research

It is recommended that the national STIP Review group prepare a brief self-assessment of the major STI capacities and gaps, national development goals and SDG challenges confronting the country, together with the group's expectations of, and perspectives on, the STIP Review. Informed by the preparatory mission, scoping interviews and early deliberations with stakeholders, this document can provide the basis for ongoing engagement between the STIP Review team and national stakeholders and may contribute to the final STIP Review report. The self-assessment should be seen as a starting point for discussion, not as a definitive statement or assessment. It could include questions and issues to be addressed in the review. A training exercise that is focused on the SDGs, to prepare the group for the self-assessment following the request for a review, might be a consideration.

This phase includes desk research mapping the kinds of innovations (figure 3), the basic components of the STI system (actors, connections and framework conditions – section 2.2) and an STI policy mix, in particular the mix of frame 1, frame 2 and frame 3 policies (see figure 5). If off-the-shelf STI metrics and indicators are available, these should be included, as should key SDG indicators. An introductory workshop with stakeholders may be implemented at this stage in order to present the preparatory research, explain the process of the STIP Review and generate 'buy-in', shared ownership and commitment to the review.

3.2.6. Field missions, the review report, and stakeholder consultation

Field missions (typically two missions, two-to-three weeks in length, over a period of three to five months) are organized to allow the STIP Review team to collect information and data about the key STI issues and players. They

will also conduct interviews with an extensive representation of the country's STI actors and carry out site visits. The missions, together with desk research, provides the content of a draft STIP Review report that is submitted to the national counterpart for comment. Some of the key questions asked as part of the STIP Review process are discussed further in section 3.3.1. The criteria against which policies and the policy mix are analyzed, assessed and evaluated are discussed further in section 3.3.2.

The methods adopted in the empirical research are to be context-specific, depending on the type of innovation systems, the prioritization of particular challenges, sectors, SDGs or strategic areas for action. They may include participatory and deliberative methods (workshops, study visits), empirical research (interviews, surveys) and/or other approaches to the solicitation of expert and stakeholder views. Methods are further discussed in section 3.4.

A revised draft STIP Review report is thereafter presented and discussed in a national workshop with national STI stakeholders. The workshop provides an opportunity to openly discuss and validate the information and to receive feedback about the analysis and the recommendations reflected in it. Equally important is the way in which the workshop often becomes an opportunity for the embedding of a longer-term national dialogue and process about STI policy. Experience indicates that launching such processes can facilitate the inclusion of STI policy considerations in broader strategic national development discussions and planning.

At the end of this phase, the final STIP Review report, which considers the field missions' research, as well as the outcome of deliberations with policymakers and STI stakeholders, including those of the national workshop, is prepared by the UNCTAD secretariat for publication.

It is advisable that the STIP Review field missions be used to organize tailor-made capacity building sessions on STI and STI policy addressed to key STI stakeholders in the country. These events can be designed as training sessions or mutual-learning sessions involving local and, if relevant, foreign STI policy experts and policymakers. This can contribute to the objective of leveraging the STIP Review as a policy learning process.

3.2.7. Policy appraisal and recommendations

STI policy can be appraised and evaluated at the level of overall STI strategy and objectives, individual STI policies (including specific instruments) and the overall policy mix. Beyond these, the policy mix and interactions between horizontal STI policies and sectoral policies should also be considered, where appropriate. Candidate quantitative and qualitative criteria for evaluating innovation policies are outlined in 3.3.2 and in figure 6.

Ideally, however, appraisal should adopt a ‘broad’ and ‘open’ approach. This approach is particularly appropriate when focusing on the adaptation or development of specific socio-technical systems. There are often conflicting views on the ways and means to reach identified goals. ‘Broadening out’ policy appraisal (Stirling 2007, Ely et al. 2014) refers to the inclusion of multiple stakeholders and interests in order to enhance the knowledge-base that is informing decisions. ‘Opening up’ refers to the presentation of plural policy and innovation options: making explicit any assumptions and uncertainties, and directionalities (to what extent they contribute to poverty reduction, action on climate change etc), that are embedded in specific options (Stirling 2010).

Next to opening up and broadening out, the appraisal will lead to the identification of a number of acceptable pathways for moving forward – so-called ‘roadmaps’ (for STI and the SDGs). This identification process should again involve multiple stakeholders and engage with them in an informal yet structured way. The process should bring in a wide range of perspectives (business, government, research, civil society, and users). It should work on structuring a specific sustainable development challenge and formulating a transformation agenda that includes immediate short-term actions which may lead to experimentation with specific options. An important tool for working with the stakeholders could be back-casting. This is a foresight method which first builds desirable futures and then works back towards the present to identify and prioritize possible actions that will bring the desirable future to life (Vergragt and Quist 2011).⁵

These actions should include identification of areas for further experimentation and investment that aims for transformative change and can lead to the achievement of the SDGs. These experiments could

focus on new policy developments, adjustment of current policies or policy mixes. They could also go beyond policy and focus on supporting, connecting and upscaling a wide range of innovations that are already happening on the ground, such as social innovation, and grass-roots innovations (see figure 3), and the upscaling of these projects (Torrens and Schot 2017).

The appraisal delivers policy recommendations for short-, medium- and long-term action, all included within the STIP Review report and discussed at the national STIP Review workshop. In providing independent recommendations, STIP Reviews present options for consideration by the national government and stakeholders, rather than unitary prescriptions. This approach to building roadmaps for SDGs through ‘opening up’ appraisal and identification of acceptable pathways draws on technical analysis, but also recognizes that policy decisions are subject to discussion, participation and, in the end, political accountability at the national level.

3.2.8. Publication and dissemination

The STIP Review report is published under the exclusive responsibility of the Secretary-General of UNCTAD, and its findings and recommendations are not binding. However, the whole process is designed to encourage strong national ownership of its outcome. The presentation of the report at the annual session of the CSTD, normally with the participation of ministerial level representatives from the client country, is an important step to achieving this. The CSTD is the top global forum for science and technology for development, and it provides the General Assembly and the Economic and Social Council of the United Nations with high-level policy advice. The presentation of the report at the CSTD enables governments to benefit from a discussion of their main concerns and to share experiences in the area of STI with world-class experts. It also provides a forum in which the government can give visibility among development partners to its plans in the area of technology and innovation and to launch proposals for technical cooperation to implement the STIP Review recommendations. The STIP Review is also launched in the client country through dissemination events in collaboration with counterparts in the country. Within the context of the Technology Facilitation Mechanism, and in parallel with processes under the UN Framework Convention on Climate Change (UNFCCC) Technology

⁵ For further details of backcasting, see http://www.tellus.org/pub/TFSC_Backcasting_for_Sustainability.pdf.

Mechanism, the STIP Review can provide a context-specific national level roadmap to the implementation of SDG targets 17.6 and 17.7.

With the agreement of the government, the STIP Review may also be presented in other intergovernmental bodies of UNCTAD, as appropriate. Efforts are also made to disseminate the report in other forums to ensure that the policy analysis and research is shared with the broadest audience of STI peers and policymakers.

3.2.9. Evaluation and long-term assessment

The STIP Reviews offer recommendations and establish roadmaps for improving the country's STI capabilities. By addressing societal challenges presented in the SDGs in the short-, medium- and long-term, the STIP Reviews also assist national governments to identify approaches to tracking transformative change in the subsequent years. The integration of the 2030 Agenda into the STIP Review process lends itself to long-term assessment and monitoring of the progress emanating from the review. The scope for UNCTAD's long-term involvement in this process will be subject to negotiation with the national government and the funding body. It is preferable, however, that a commitment is considered to enable monitoring. Similar criteria to those stipulated in section 3.3.2 should be used to track progress and change against the baseline established in the STIP Review.

3.3. Key questions and criteria guiding the STIP Review

3.3.1. Key questions guiding the reviews

The overarching question of the STIP Reviews is to what extent and how STI contributes to tackling the SDGs. How can STI policy be developed and strengthened to reorient the innovation system and productive capacity of developing countries, taking into consideration the synergies between economic development, social inclusiveness and environmental sustainability?

In conducting the review, the STIP Review team can adopt a number of methods to produce an assessment of the country's innovation system and its effectiveness in addressing societal challenges,

sustainable development and the SDGs. These are discussed in more detail in section 3.4 below. Together, they can be used to answer the most pressing questions regarding the country's innovation system and its effectiveness in addressing these challenges. The precise questions to be included in a STIP Review depends on the nature of the country's innovation systems. It depends on its political priorities and development goals, the priorities of its government (and the STIP Review), its knowledge, natural resources and other endowments, as well as the governance context of the country in question. These details should be subject to discussion alongside the other aspects of the terms of reference and throughout the inception phase.

The candidate questions listed in annex 1 can help the team to map the actors, connections and enabling conditions in the country's innovation system and to highlight limitations and areas of weakness (which can inform policy recommendations). The extensive list of questions is purposefully rather generic in order to be adapted to very different contexts.

As well as 'input' characteristics of the innovation system (including a number of standard STI policy indicators), the framework also attempts to pose questions with regard to the outputs/performance of the national innovation system. Here it is important to look at outputs/performance of various types of innovation and actors involved.

Beyond characterising the innovation system, the questions in annex 1 provide a selection of questions for understanding the current situation with regards to STI policy at the level of overall strategic objectives, individual instruments (which can be analysed on the basis of their design and implementation) and various characteristics of the policy mix. Depending on the nature of the innovation systems in question and the sophistication of the policy framework, issues associated with policy mix may be more or less complex.

In STIP Reviews where national governments have identified development priorities and/or socio-technical systems that require particular, additional focus, similar questions (regarding inputs, performance and policies) can be asked, with reference to cross-sectoral policies and their interactions. This is with a view to highlighting potential synergy areas in which co-ordinated policy approaches can support multiple innovation actors to foster transformations. This will require additional expertise within the team, as well as political support by the relevant ministries (beyond that (or those) which focus on science, technology and innovation).

3.3.2. Key criteria for policy review

Traditional criteria for science, technology and innovation policy reviews require reconsideration in the context of STI for sustainable development. Candidate criteria for reviewing and evaluating transformative innovation policy is listed and described briefly in figure 7 below.

As with the research questions above, these criteria should be subject to discussion within the

STIP Review team and negotiated alongside the other details of the terms of reference. They will depend upon the maturity of the innovation system in question, the priorities for government (and for the STIP Review) and – due to the complexity of evaluation of some of these criteria – the resources (including expertise, financial support and time) available for the review.

More generally, **the comprehensive review framework that is proposed in this document**

Figure 7. Policy review criteria for STIP Reviews

Transformative potential. The extent to which the focus of STI policy is on supporting systemic transformation towards sustainable development and the SDGs.

Agenda centrality. The position and relative importance of STI for sustainable development and the SDGs in the policy debate and policy agenda.

Relevance for national development priorities and SDGs. The extent to which STI policy vision and objectives are consistent with the priorities in the national development plans and adequate for the sustainable development challenges faced by the country.

Directionality. The extent to which STI policy mix is oriented towards sustainable development and the SDGs, and able to transform systems as required.

Robustness of knowledge-base. The extent to which knowledge from all actors in the innovation process is used policy process, including reflexivity on power biases related to selecting and interpreting evidence.

Policy stringency. The extent to which policy protects marginalized groups and the natural environment.

Alignment. The extent to which STI policy mobilizes key stakeholders to engage in innovation activity relevant for sustainable development, and fosters innovation partnerships.

Legitimacy. The extent to which choices on direction of development pathways have democratic and social mandate.

Experimentation. The extent to which policy creates strategic arenas for experimentation and demonstration of transformative system innovation.

Specialization. The extent to which policy encourages STI specialization in the areas where STI policy is likely to achieve high impact and contribute to sustainable development.

Diversity. The extent to which policy encourages diverse forms of STI in order to avoid dependency on a narrow resource base, foster continuous innovation, avoid lock-in to unsustainable pathways, and enhance resilience.

Coherence. The extent to which STI policy mix is coordinated and internally coherent.

Distributional impacts. The extent to which policy enhances the more equitable distribution of costs, benefits and risks associated with innovation, and with wider transformation, including from a gender perspective.

Effectiveness. The extent to which the STI policy mix is effective in achieving impact.

Policy evaluation and learning. The extent to which policy is based on scientific evidence and supported by a learning environment.

Source: Adapted from Miedzinski et al. (2017a); Chataway et al. (2017); Schot and Steinmueller (2018); Weber and Rohracher (2012).

needs to be adapted to the capabilities and engagement of governments requesting the reviews. Moreover, it should be clear that the reviews can only initiate a process of transformative change, of which the scope and depth will depend on the institutional, financial and other resources that the governments can further deploy.

3.4. Methodological approach to the STIP Reviews

STIP Reviews implemented by UNCTAD have relied largely on interviews and surveys to gather quantitative and qualitative data, and interviews and stakeholder workshops as the key methods and tools for understanding innovation systems. There are methodological and process implications (and opportunities) of extending the reviews to embrace challenges of sustainable development and the SDGs. The revised framework for STIP Reviews is based on a mixed methods approach using both qualitative and quantitative indicators. The framework proposes specific review criteria (see above) to make policy appraisal transparent.

The review process can be described as an analytic-deliberative approach (Ely et al. 2014) utilizing formal research methods and participatory approaches to engaging stakeholders and encouraging co-creation and experimentation (e.g. transition arenas, foresight methods). Efforts will be made to build on the local expertise by engaging local experts and academics in the process. This will contribute to building analytical capacity in developing countries.

As discussed under ‘policy appraisal and recommendations’ (section 3.2.7) above, methods should be used in a way that incorporates multiple perspectives and forms of knowledge (‘broadening out’). A number of research methods can be applied in a way conducive to ‘broadening out’ and opening up and several examples have been documented from around the world (STEPS Centre 2018; see also Transition Hub KIC Climate Change⁶). These are highly varied, using quantitative as well as

qualitative approaches.⁷ All of this information can feed into transition arenas, back-casting, transformation labs, or policy labs, in which actors construct pathways for addressing the SDGs and propose experimentation options. All of these and more are candidates for the methods that may be used in STIP Reviews alongside the standard approaches of interviews, surveys and workshops. This list is put forward as a potential tool box, rather than a list of all methods to use. Individually they are not all costly, and a combination of these with interviews could be considered.

The selection of methods and the approach to their implementation is a vital aspect of the inception stage of the STIP Reviews. Methods perform a vital analytical role, but can also help to foster policy learning and transformative agency (Westley et al. 2013) among the groups engaged in the review process. They will need to be selected on the basis of the context of the innovation system, the key priorities and expectations identified in the terms of reference, and the expertise, experience and familiarity with these methods of the membership of the STIP Review team.

4. The STIP Review report and beyond

The previous section described the process, methodology, outputs, outcomes and long-term impacts of conducting a STIP Review. However, one should keep in mind that **the review report and the process behind its preparation are at the core of the whole exercise. It is the key instrument that should nurture the reflection of key actors and of the government in particular, stimulate policy debates and orient STI policy reforms.** This section provides more information on the structure of the report (4.1), including the use of STI indicators (4.2), as well as the strategy and policy roadmaps (4.3), STI policy capacity building and training (4.4), peer-to-peer STI policy learning (4.5) and co-design, experimentation and transformative STI policy actions (4.6).

⁶ Climate-KIC, (2016) Visual toolbox for system innovation. A resource book for practioners to map, analyse and facilitate sustainability transitions, available at <https://www.climate-kic.org/programmes/research-innovation/>.

⁷ They include agency network analysis, concurrent evidence, deliberative mapping, evaluation H, intervention histories/ futures, innovation histories, life histories, multi-criteria mapping, open space technology, participatory impact pathways analysis, participatory rural appraisal, participatory scenarios, photovoice, Q-method, rivers of life, scientometric mapping, sensitivity analysis, socio-technical imaginaries, and transformative learning innovation histories. See STEPS Centre Methods and Methodologies – <https://steps-centre.org/methods/>.

Figure 8. Proposed Structure of the STIP Review Report

Part I. Policy challenges: Looking ahead

1. **The country's development trajectory:** present overall trends and major issues, in relation to economic growth, productivity, structural economic transformation, diversification, poverty reduction and job creation (key elements of economic development), social inclusion and environmental sustainability; the national development strategy (as outlined in government development plans and related documents).
2. **Societal challenges:** document and discuss the country's situation in relation to the SDGs (with indicators) and focus on major challenges, e.g. poverty reduction, energy transition, food security, health improvement, water availability, etc.
3. **STI capabilities:** document STI performance (indicators); map innovation system (key actors, linkages, resources, strengths and weaknesses); discuss potential in relation to sustainable development issues (illustrated with examples of past or possible future scientific, technological and innovation achievements).

Part II. Policy components: Evaluating government action

1. **Framework conditions:** survey key dimensions of the framework conditions, document them with available indicators, and discuss how they help or hamper STI activities, policies and achievements, including factors related to: the macro-economic situation (monetary, fiscal, exchange rate, interest rates and balance of payments), trade and foreign investment etc.), governance (bureaucracy, corruption, etc.), infrastructure (ICT, transports, energy, etc), and education structures and performances.
2. **STIP institutions and governance** (description, critical analysis and policy orientations): major STI institutions (ministries, departments, agencies, programmes and activities); coordination mechanisms; links with sector ministries, etc.; the STIP local and regional dimension: decentralization processes, and local capabilities and initiatives.
3. **STIP instruments:** make a critical review in a "socio-technical system change" perspective, with a view not only to identifying the availability of instruments, but more importantly to discuss the capability of the government to use them effectively and efficiently. Instruments to be analysed pertain to a large number of categories – see for instance those mentioned in figure 5 and also OECD (2015): regulations and standards, economic and tax incentives, demand support (public procurement), education and training (skill upgrading), information (awareness raising actions), and innovation programmes, etc.

Part III. Policy experiments: Building the future

Select three key societal challenges identified in part I. (e.g. for food, health, energy, water, poverty reduction, etc.), in which plans for system change will be developed. Socio-technical systems on which to focus should be clearly identified. Questions to be documented and analysis to be provided are detailed in figure 10, and include: State of play – key indicators, progress made over time, targets for the future, etc.; technology opportunities, market niches, etc.; key actors, main challenges, resistance to change, lock-in situations, etc.; proposed policy mix (packages) to stimulate system change; pilots, experimental sites, etc.

Annex: detailed indicators

Policy roadmap: Moving to action

1. **Strategy for STI-based transformative change:** summarize priority reforms (part II) and experimentation initiatives (part III), expected results. Action sequencing: short term, medium term, long term.
2. **Monitoring and evaluation tools**
3. **Training plans and peer review learning exercises**

4.1. Structure of the Review Report

The report should respond to the objectives of the review, i.e. improving the STI contribution to the country's development strategy, with a transformative change towards sustainable development at its core. Moreover, it is addressed primarily to policymakers. That should orient its content in terms of information, analyses, and recommendations, and should resonate with their needs and capabilities for action. Defining the structure of the STIP Review is therefore an essential element of the preparatory dialogue with the policymakers that formulate the request for a national review.

For STIP Reviews fully implemented under the revised framework it is proposed that their reports should be **organized in three main parts**, entering gradually into more detailed objectives and policy actions from one part to the other. This organization may not be suitable for contexts in which policymakers opt for a STIP Review closer to earlier implementation modalities.

In the new structure, the first part sets up major issues for the long-term development of the country and related government plans.

It identifies key societal challenges in connection with the country's performance relative to its development goals and diverse SDGs. And, finally, it discusses STI capabilities, and the national innovation system, more particularly in relation to the identified challenges.

The second part analyses in depth the role and policies of government to strengthen STI capabilities and orient them towards sustainable development objectives.

Firstly, key elements of the broad framework conditions are documented. In the context of the report, "framework conditions" refer to those broad factors, such as the macro economic conditions, governance situation, and education structures, which are somewhat out of the direct reach of the STI policy making communities, but still important in influencing STI performance. Then there is a focus on STI policies, with analysis of responsible institutions and coordination mechanisms among them, as well as of sector ministries, departments and agencies, and regional and local powers. Finally, the spectrum of the diverse

policy instruments available to promote STI are critically reviewed, in order for socio-technical system changes to be made within appropriate policy packages.

The third part is devoted to future-oriented actions for selected system changes in relation to priority societal challenges.

The objective is to initiate a process of focused experiments involving motivated sets of actors. It is, in general, not possible to durably maintain a nation-wide debate and involvement in changes of growth and related technology trajectories. But it is possible to mobilize specific communities on issues of direct relevance to them. The objective is to design experiments to be developed over several years with a view to accelerating the country's transformation towards a sustainable development path. It is important to design such experiments and include related plans in the review report to give enough consistency to the participatory and experimentation process that would be a prominent feature of the UNCTAD review. So, it is proposed, for a few selected societal challenges, to initiate the design of plans for system change, including well-defined pilot projects, focused on new technologies and organizations leading to such change. Key aspects of concerned actors, linkages, niches, obstacles and possible policy initiatives (with timelines) need to be documented in a participatory approach.

Finally, as an action-oriented conclusion, **an additional document sets up a roadmap** to guide the government, and other concerned actors, in identifying and sequencing key actions derived from Part II and III above, establishing monitoring and evaluation tools, and indicating possible training and peer learning exercises.

This structure (figure 8) is a blending of key elements of policy reviews already undertaken by UNCTAD, and of new elements responding to the new concerns related to sustainable development and the SDGs. This structure would be considered as a standard pattern to be used in a new series of reviews. Of course, the content of each part could be subject to adaptation in line with the country's particular context and the preferences of countries requesting a STIP Review.

Information elements addressing specific socio-technical systems that will serve as experiments to promote transformative change (Part III of the

Figure 9. Approach to sections (Part III of proposed structure of figure 8) focusing on transformative innovation policy

1. Societal challenge/SDGs

- Overview of societal challenge (as captured in one or more, or in a combination of SDGs) facing the country.
- Role of STI in tackling the challenge, transforming socio-technical systems (energy, mobility, healthcare, food and agriculture, water, industrial base, etc) and contributing to the SDGs.

2. STI system performance

- Evidence on current STI performance, key strengths and weaknesses in addressing a selected set of challenges and SDGs, including innovation outcomes and impacts. This includes identifying and analysing examples of innovations that are currently contributing to SDGs.
- Framework conditions and barriers and drivers of change in socio-technical systems relevant for addressing specific SDGs.
- Key actors and collaboration patterns for transforming a socio-technical system. This can be done at national as well as regional or urban levels but should be embedded in the international context and include issues such as participation in global value chains.
- Overall assessment of STI potential for tackling selected societal challenges, including SWOT (strengths, weaknesses, opportunities, threats) analysis, and transform socio-technical systems.
- Scope includes policy mix appraisal, public (government and civil society) and private involvement in experiments and pilots for transforming socio-technical systems.

3. Policy recommendations

- Recommendations on specific policy instruments.
- Vision and roadmap for transformative STI policy, including possible future experiments and pilot projects.
- Key indicators, monitoring and evaluation of the STI roadmap relating to specific socio-technical system changes (for example, introduction and diffusion of renewable energy). Resource efficient processes leading to socio-economic (material energy and water savings, new jobs) and environmental benefits (reduction of environmental pressures).

proposed structure) are presented in figure 9. These will thus form the basis of a more 'transformative' STIP Review in which greater emphasis is also placed on public and stakeholder engagement (see section 3.2.6), national STI dialogues, follow-up actions on pilot projects and possible scale-up of successful cases (mainstreaming).

4.2. Overview of STI indicators that can be used in STIP Reviews

Quantitative and qualitative indicators offer a way to characterize and analyse a country's policies,

rules and regulations, institutions, infrastructure and capabilities, as part of their national innovation system, and the extent to which it is set up to address sustainable development and selected SDGs. At the same time, all indicators are limited and present a partial picture. Data collection can also be resource intensive, especially in contexts where national statistics are not routinely captured or readily available. The STIP Review Framework recommends the use of multiple, diverse quantitative and qualitative indicators as a way of building up a clearer understanding of the innovation system. The preference for a broader variety of indicators

must be weighed up against the expertise and resources available to meet the need for indicators and cater to the specific context and needs of the country under review. Figure 10 presents examples of the kinds of indicators that might be drawn upon, according to data availability and resource constraints.

In some cases, indicators are collected routinely at the international level by organizations such as the World Bank, the UNESCO Institute of Statistics and the UN Statistics Division. Reviews should be aware of the limitations of international databases (which prejudice the English language), particularly in bibliometric indicators (Wagner and Wong 2012). In many cases, indicators will be lacking in developing countries or will rely on country-specific statistical agencies or databases. In others, new data will need to be collected for the purposes of the STIP Review, to the extent allowed by available budgets and time.

Whenever relevant data is available, the revised STIP Review reports can use new STI indicators and data visualization methods to contextualize STI performance (e.g. dashboards, rather than in the style of the Organisation of Economic Co-operation and Development (OECD) benchmarking). Reviews will benefit from alignment with existing SDG indicators and, whenever needed, can add additional STI indicators relevant to the SDGs. These may be derived from disaggregating statistics that are already being collected as part of the SDGs process. For example, applying a gender lens, disaggregating gender statistics in the figures for SDG indicator 9.5.2 (R&D workers per million population), helps to understand the degree to which SDG 5 ('achieve gender equality and empower all women and girls') is reflected in investment in human capital.⁸ Similar approaches might be possible for other vulnerable groups in order to bring the principle of 'leave no-one behind' into the STI assessment.

Where available, bibliometric data can be analysed for keywords to investigate whether it is addressing the SDGs and national priorities (Ciarli and Rafols 2017). Patent databases can be used to explore not only the rate of patenting but importantly directional aspects, such as the sectors in which patent applications are made. Patents in environmentally-relevant sectors can be adopted as a focus, for

example by using a list of International Patent Classification (IPC) classes compiled by the OECD (OECD-ENVTECH) (Consoli et al. 2016) and/or the OECD Patent Quality Indicators Database (Squicciarini et al., 2013), or both (Barbieri et al. 2018). These may be relevant to all SDGs, but in particular SDGs 2, 3, 6, 7, 8, 9, 11 and 12.

Indicators not only fulfill the role of characterizing the innovation system (aiding analysis) but also provide a basis for the STIP policy strategy and roadmap, and for ongoing monitoring and follow-up. The indicators for monitoring the STI policy mix are obviously very experimental and often not available, but they can usefully be built up in the post review monitoring process.

The availability of indicators differs between countries and can be highly challenging in developing countries. The STIP Review process is designed to adapt to the data available and open to alternative sources of data and indicators relevant for specific contexts. Proxies provided by the country can be used in the process. Expert and stakeholder views elicitation methods can be employed to source relevant data and to situate available evidence in the local context.

4.3. The STI policy strategy and roadmap

The need to address broad sustainable development challenges links STI policy to existing strategic reflection and strategic documents identifying the overall sustainable development goals of a country, notably the national development plans.

The process of deliberation of STI priorities for sustainable development should be evidence-based, but remains essentially a political process, which should engage a wide range of stakeholders with different interests. The process should lead to selecting areas with innovation potential in which common goals can be established and new partnerships built.

The STI policy roadmap is a strategic tool integrating various policy strategies and instruments into one strategic document and setting forth an implementation process. It comprises the key STI policy issues and suggested policy orientations, and

⁸ Ongoing work by UNESCO's 'STEM and Gender Advancement' (SAGA) is relevant here – see UNESCO (2017), *Measuring Gender Equality in Science and Engineering: the SAGA Toolkit*, United Nations Educational, Scientific and Cultural Organization.

Figure 10. Examples of quantitative and qualitative indicators used in STIP Reviews^a

	Indicators	Data sources	
STI performance	Inputs	Gross Expenditure on R&D (GERD) and Business Expenditure on R&D (BERD) ^b (if possible by technology areas or sector) ^c	World Bank/ UNESCO Country-specific/UNESCO
		Seed, venture capital, equity investments (if possible by technology areas or sector)	Country-specific
		FDI in knowledge-intensive sectors	Country-specific
	Activities and short-term outcomes	Share of companies involved in innovation activities (if possibly by sector and size)	Country-specific
		R&D personnel (sometimes considered an input) ^d	Country-specific/UNESCO
		Technology adoption and diffusion (focus on technologies relevant for the SDGs)	Country-specific
		Scientific publications	Bibliometric databases (e.g. SCOPUS)
		Patents	National or international patent databases (e.g. PATSTAT/OECD RegPat)
	Longer-term outcomes and impacts	Informal sector activity	National databases
		Level of various forms of innovation including social innovation, frugal innovation and grassroots innovation	National databases/ qualitative examples
Aggregate and industry-level productivity trends (labour, energy, resource)		Country-specific	
Sales of products new to the market (by sector and by size of company)		Country-specific	
Exports of medium- and high-tech products		Country-specific	
Employment in knowledge-intensive sectors, employment in green economy sectors		Country-specific	
Innovation system	Actors and capabilities	Impacts of innovation on regional and social inclusion and exclusion patterns	National databases
		Impacts of innovation on SDGs objectives and targets	Voluntary UN reporting activity
		Share of companies with process standards implemented (ISO)	International Standards Organization (ISO)
	Linkages and networks	Share of informal economy	National databases
		Share of start-ups and NGO involvement in innovation	Country-specific
		Qualitative evidence on networks (e.g. movements, associations or partnerships relevant for the SDGs)	Country-specific
		Labour mobility	ILO/ Country-specific
	Scientific publications (co-publications and citations)	Bibliometric databases (e.g. SCOPUS)	
	Patent citations	National or international patent database (e.g. PATSTAT/ OECD RegPat)	
	Industry-university links	Country specific	
	Science for Society activities	Country specific	

		Indicators	Data sources
Innovation system	Framework conditions and enabling environment	Indicators on relevant dimensions of enabling environment e.g. level of education of society (e.g. share of population with higher education degrees, share of education with vocational education), regulatory activity and institutional capacity, ICT infrastructure,	UNESCO/ITU, national data
	Strategic objectives	Existence of strategy dedicated to STI Existence of specific objectives and targets dedicated to STI Existence of strategy dedicated to STI for sustainable developments Existence of specific objectives and targets dedicated to STI for SDGs and sustainable development	Country-specific Country-specific Country-specific Country-specific
STI policy mix	Transformative directions	Existence of strategy dedicated to STI for transformative change (e.g. for key socio-technical systems) Existence of specific targets dedicated to STI for specific SDGs SDG indicators signifying the direction of system transformation ^e	Country-specific Country-specific Country-specific
	Policy instruments	Existence and lifetime of various types of STI policy measures (mapping) ^f	Country-specific
	Policy actors	All relevant policy actors (ministries and agencies) involved in policy design and implementation	Country-specific
	Policy design	Engagement of non-policy stakeholders in policy design (e.g. existence and level of participation in public consultations, innovation)	Country-specific
	Policy implementation	Evidence on enforcement of regulations	Country-specific
	Policy coherence ^g	Existence of mechanisms to ensure policy coherence (e.g. number of meetings, ministries and agencies involved, level and nature participation, etc.)	Country-specific
	Policy evaluation	Share of operational/technical assistance budget dedicated to policy monitoring and evaluation Types and number of evaluation studies Evidence of the use of monitoring and evaluation studies in policy design (e.g. citations)	Country-specific Country-specific Country-specific

Source: UNCTAD.

- ^a Wherever possible, a gender lens should be applied to ensure that STI policies benefit both men and women equally.
- ^b See SDG target 9.5.
- ^c It is unlikely that such data will be in existence (referring to NACE or SIC sectors), so original research would be needed in this case.
- ^d See SDG target 9.5.
- ^e Beyond the STI-focused indicators outlined in the table, the SDG indicators provide a benchmark against which progress towards some aspects of sustainable development is being made at national levels. With regard to prioritized socio-technical systems, some of these indicators offer evidence of the directions of system change and the degree to which innovation is addressing societal challenges. UNCTAD (2016) provides an overview of some of these targets and indicators.
- ^f See SDG target 9.b.
- ^g See SDG target 17.14.

lists instruments to be improved and developed. It indicates intended effects over time of proposed actions and reforms. It will present also a number of areas that are ready to experiment with new ways to address the SDGs. The STI strategy and roadmap should come with a dedicated monitoring and evaluation system enabling the measurement of progress in achieving the objectives. The roadmap is a process: it should be updated based on information on policy implementation, and it should make clear the responsibilities of actors in the short-, medium- and long-term. Implementation of the roadmap can only be achieved when these actors have been engaged throughout the STIP Review and show ownership and commitment to its process and recommendations.

4.4. STI policy capacity building and training

Effectiveness of STI policy hinges on the capacity of the public sector to design and implement policy instruments, and entire policy mixes. The implementation of STI for sustainable development poses additional challenges due to the need to consider new approaches which are not typically applied in STI policy (e.g. environmental and health regulation), or new actors. STI policy for sustainable development may require setting up new specialized agencies, or engaging NGOs or social entrepreneurs in policy delivery. An example would be the social technologies network in Brazil (Fressoli and Dias 2014). These approaches may require new knowledge, capacities and competences in public administration, especially in the STI policy domain, as well as new collaborations across ministries and agencies.

One of the major challenges can be found in the way existing policies in various domains may in fact stifle innovation for transformation. This implies that STI policy may temporarily seek to open a space for experimentation in order to address sustainable development and the SDGs. Policy experimentation can offer opportunities to learn from new approaches that may seem inconsistent but have potential to address SDGs. An example would be the space afforded to mobile-enabled pay-as-you-go solar home system providers such as M-KOPA in Kenya, which are to some extent inconsistent with an overarching strategy of grid extension.

An additional important component to the STIP Review process that should be considered at the stage of defining the terms of reference is the provision of training and capacity building on STI policy design, implementation, and monitoring and evaluation (including indicators). Depending on the available budget and timeframe, the review process could engage in the identification of priority training needs among key ministry staff. Such an exercise can provide an additional benefit from the engagement of UNCTAD staff and the STIP Review team.

Beyond the traditional approach of time-limited training courses, opportunities for more innovative approaches exist within the STIP Review process. Staff placements and exchanges between ministries or agencies may be considered during the review process. They can enable co-ordination and collaboration within and across priority areas and exchanges between the actors to build and enhance linkages in the national innovation system. Beyond the timeframe of the review itself, opportunities exist for online learning and periodic training sessions that may take place as part of monitoring and follow-up, including programmes by UNCTAD and the joint activities of the Inter Agency Task Team on Technology Facilitation, as well as academic organizations. An option to consider is to develop a dedicated training programme for transformative innovation policy, with the guidance of UNCTAD experts, which would assist in the implementation of STI policy for addressing sustainable development and the SDGs.

4.5. Peer-to-peer STI policy learning

Policy should be evidence-based, with monitoring and evaluation and relevant metrics as an integral part of the policy process. Collecting relevant STI indicators and building monitoring databases is key to improving the implementation of STI policies. Developing countries should first establish their basic monitoring and evaluation capabilities and data infrastructures.

Monitoring and evaluation systems should encourage policy learning on how to address the SDGs throughout the policy process, from policy vision building to evaluation. This includes applying a gender lens to STI policy-making (UNCTAD 2011).

A shift of STI policy towards sustainable development and the 2030 Agenda has considerable implications for methodologies and evidence needed to support design and implementation of policy instruments and policy mixes. For example, to assess the environmental impacts of innovation, policymakers and evaluators need to combine methodologies and data used to assess the technological and the economic impacts of innovation with environmental impact assessments.

To tap into the potential of new and emerging technologies and their implications for sustainable development, governments may consider developing capacity to engage in foresight or technology assessment. Foresight methods, including ex-ante impact assessments, can help to identify technologies that the country may prioritize in the short-, medium- and longer-term and to reflect on the potential effects of emerging technologies on the country. Broadening out and opening up technology assessments (Ely et al. 2014) can enable enhanced legitimacy, co-ordination in policy processes and aid subsequent policy learning.

Governments in developing countries may also consider peer-to-peer mutual STI policy learning to enhance the capacity of analysts and decision-makers at the national level. A number of approaches are available at national and international levels.

National STI policy dialogues offer an opportunity for officials to connect and share experiences across sectoral divides, also allowing for the extension of policy learning to key stakeholders. Peer-to-peer learning between different regions in countries that are undertaking STIP Reviews are also to be encouraged. These should be organized by the national government, but could be designed with guidance from UNCTAD and the STIP Review team.

Further opportunities exist for policy learning at the international level. Exchanges between countries (e.g. officials from other developing countries or UNCTAD experts or officials) and study visits can foster peer-to-peer learning. This is particularly relevant where countries share priority areas and where experimentation in one country (see

below) has led to improved outcomes. Countries in which STIP Reviews have taken place and are in the process of being implemented/ followed-up present particularly relevant candidates for international exchanges or study visits. International collaboration can also aid policy benchmarking, with a focus on comparing policy instruments and policy mixes between countries with similar innovation systems and targeting similar societal challenges and SDGs.

Activities within UNCTAD and other UN agencies also offer opportunities for peer-to-peer learning. Completed national reviews can be presented at CSTD meetings, with the potential for identifying lessons and policy experiments that may be applied in other member countries, whether or not they are undertaking STIP Reviews. The review could thus help develop a knowledge base that could assist in benchmarking policies for the promotion of innovation for sustainable development.

Where appropriate, and in keeping with the established scope and methodology, national level lessons can also be fed into the annual STI Forum, especially where the SDGs in question are going to be a focus for review.

4.6. Co-design, experimentation and transformative STI pilot actions

An outcome of more transformative STI policy review processes is the identification of areas for experimentation. These are outlined in the STIP Review report (Part III), as the process of generating the vision behind the STIP policy strategy and roadmap, and emerging ideas for novel policy approaches, are important. This highlights the need to bring a broad range of stakeholders into the review process.⁹

In practice, each STIP Review process is shaped in the interaction of multiple groups of stakeholders with the STIP Review team. This presents trade-offs in terms of the breadth of the review and the actors engaged, as well as considerations regarding the involvement of normatively aligned and non-aligned groups (Marin et al. 2016). Broadening

⁹ As suggested above, one approach is to involve all major groups in the STIP review process – Business and Industry, Children and Youth, Farmers, Indigenous Peoples, Local Authorities, NGOs, Scientific & Technological Community, Women, Workers and Trade Unions, Persons with Disabilities, Volunteers (Volunteer Groups Alliance), (Stakeholder Group on) Ageing, Education and Academia (Stakeholder Group).

out such processes (Ely et al. 2013) and adopting variants of stakeholder workshops – transition arenas (Frantzeskaki et al. 2016), social innovation labs (Westley and Laban 2015), transformation Labs (Ely and Marin 2017; Pereira 2017), policy labs (Williamson 2015) – can potentially yield experiments and pilot actions that can be taken forward during and beyond the review.

The role of experimental actions and experimentation forms a vital component of the Frame 3 perspective of transformative innovation policy. Rather than suggesting policy evaluations on the basis of randomized clinical trials, experimentation here refers to broader processes of policy engagement, with forms of innovation that address societal challenges and the SDGs. These types of innovations may need protection and careful development into niches, through facilitating networking, visioning, learning. The aim is empowering these innovations in such a way that they can challenge unsustainable dominant practices (Torrens and Schot 2018; Raven and Smith, 2012; Chataway et al. 2017; Torrens and Schot 2018). Niches can emerge at national or sub-national levels and involve a combination of actors from across the innovation system. A vital aspect of experimental actions and pilots is ensuring learning is enhanced through a process of monitoring and follow-up (Luederitz et al. 2017).

4.7. Monitoring, evaluation and follow-up

The current STIP Review framework suggests that changes should be assessed after five years through an impact study (based on indicators proposed during the exercise). The 2030 Agenda and the more complex and ambitious nature of the revised STIP Review framework necessitate an approach to monitoring and follow-up that goes beyond a bureaucratic ex-post impact

assessment, and integrates multi-stakeholder action with ongoing national policy processes.

Indicators for monitoring and evaluation of STI policy form an important basis for accountability and learning. These may draw upon the indicators outlined in 4.2 above and include measures to evaluate STI performance, innovation system and policy mix. At the same time, relevant SDG targets and indicators should also be integrated into a monitoring and evaluation system that includes an integrated policy database with evidence on effectiveness and efficiency of key STI instruments (with responsibility housed within an identified governmental agency). Periodic evaluation is important for policy coherence and continuity, political accountability and international benchmarking. Looking toward the horizon of 2030, however, monitoring and evaluation should go beyond output measurement and act as a basis for learning, adapting, fine-tuning and reformulating innovation policies for transformation.

Indicators for transformation processes are in their infancy but, beyond outcome metrics (e.g. SDG indicators), qualitative changes in institutional logics, expectations, and everyday practices can act as signposts to the fact that socio-technical systemic changes are underway. Monitoring and evaluation systems can use these to feed intelligence to policymakers and stakeholders. Such data can help to inform ongoing democratic processes to improve policy design and implementation, identify policy needs (including capacity building and training), share emerging insights within and beyond the national context, and foster ongoing experimentation.

By adopting a broader, longer-term and open-ended approach through to 2030, STIP Reviews can contribute to the shift towards STI policies with the potential to ‘transform our world,’ addressing sustainable development and the SDGs in both substance and spirit, while supporting national development strategies.

Annex 1. Illustrative research questions for STIP Reviews

The table below provides a detailed list of questions that can help in analysing innovation systems, government policies and relations with SDGs, as explained in section 3.3.

<p>Innovation system</p>	<p>Actors and capabilities</p> <ul style="list-style-type: none"> Are all key STI actors active in the system? What do they bring? (see chapter 2 for list) What are basic key capability gaps and needs? What are existing capabilities and capability gaps relevant for addressing SDGs? Are actors open to experimentation, piloting of new developments? How well do available skills match industry needs What is the role of the informal sector in the innovation system? How to build capabilities of actors with limited learning and absorptive capabilities? How to support new actors in areas of need? How to encourage start-ups in areas relevant for SDGs? How to scale up and upgrade local and regional innovation activities which address SDGs? How to strengthen the learning capabilities of actors? How to encourage start-ups and spin-offs in areas relevant for SDGs? How to connect activities in advanced sectors with social innovation, frugal innovation, grass roots innovation activities and the informal economy? How to ensure renewal and new specializations of technologically advanced actors? How to enable growth of start-ups and spin-offs in areas relevant for sustainable development? How to disrupt and destabilize innovation systems based on unsustainable sectors? <p>Linkages and networks</p> <ul style="list-style-type: none"> What are the key connections and collaboration dynamics in the system? Do these dynamics lead to learning among actors? How inclusive are these dynamics? Are these connections focused on achieving transformation of socio-technical systems and addressing SDGs? Who are the networking capabilities and who are the most active actors in the innovation networks? What are the key needs and gaps in terms of networking (inclusion), learning, enabling transformation and addressing SDGs? What are the drivers and barriers of knowledge flows, learning, innovation collaborations and exclusion? What are the main sources of technology acquisition from abroad? How to ensure learning and knowledge flows, including technology, between local and foreign actors, North-South and South-South collaboration? How to keep these flows focused on transformation and SDG challenges? How to build appropriate networking capabilities for identified key societal challenges (SDGs)? How to ensure knowledge flows between innovative actors and regions and peripheral and underdeveloped regions in the country?
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Innovation system	Framework conditions and enabling environment Key specialization areas	What are the key systemic drivers and barriers of innovation, notably with respect to innovation fostering sustainable development and the SDGs? What is the role of institutions in enabling sustainable innovation? What are key areas of STI specialization in the country? How does the country's specialization profile compare with its neighbours and other comparator countries? What are existing innovation areas that have the high potential to address sustainability challenges? What are emerging innovation areas that have the high potential to address sustainability challenges? What are the key factors underpinning existing and emerging areas of specialization? What are regional patterns of innovation specialization? How can STI policy contribute to consolidation and emergence of new specialization areas relevant for SDGs? What is the position of the country in global value chains relevant for the key specialization areas? What are the levels, sources and trends of investments in STI and R&D? What are the levels of public and private investments in STI and R&D? What are the main areas of R&D efforts? What is the type of innovation finance available in the country (e.g. public or private seed capital, venture capital, private equity, public R&D funding, etc)? What is the state of R&D and innovation infrastructure? To what extent are investments and infrastructures tailored to support key specialization areas for sustainable development? What is the share of firms involved in innovation activities? What are the types of innovation activities the firms and other actors are involved in (referring to figure 1)? What is the nature and level of involvement of other innovation actors in innovation activities? What are the economic, social and environmental impacts of innovation? What are the impacts of innovation on different social groups (e.g. by gender, age, educational level)? What are the impacts of innovation on different geographic areas of the country, including peripheral regions? What is the contribution of public policy to enable impacts of STI, notably in areas relevant for sustainable development?
STI performance	Inputs Activities and outputs Outcomes and impacts	How can STI policy contribute to consolidation and emergence of new specialization areas relevant for SDGs? What is the position of the country in global value chains relevant for the key specialization areas? What are the levels, sources and trends of investments in STI and R&D? What are the levels of public and private investments in STI and R&D? What are the main areas of R&D efforts? What is the type of innovation finance available in the country (e.g. public or private seed capital, venture capital, private equity, public R&D funding, etc)? What is the state of R&D and innovation infrastructure? To what extent are investments and infrastructures tailored to support key specialization areas for sustainable development? What is the share of firms involved in innovation activities? What are the types of innovation activities the firms and other actors are involved in (referring to figure 1)? What is the nature and level of involvement of other innovation actors in innovation activities? What are the economic, social and environmental impacts of innovation? What are the impacts of innovation on different social groups (e.g. by gender, age, educational level)? What are the impacts of innovation on different geographic areas of the country, including peripheral regions? What is the contribution of public policy to enable impacts of STI, notably in areas relevant for sustainable development?
STI policy mix	Strategic objectives	What are the priority development challenges that must be addressed? Does policy framework recognize STI as a relevant policy field for sustainable development? What are key objectives of STI policy? To what extent do they consider sustainability challenges and SDGs? What are policy milestones and targets relevant for STI? Do they take into account sustainability challenges?

STI policy mix	
Policy instruments	<p>What are the key STI policy instruments, notably with respect to fostering sustainable development and the SDGs?</p> <p>What are the policy instruments, including regulatory measures, directly or indirectly influencing an STI system?</p> <p>What are key STI policy instruments which would allow experimentation and piloting of new solutions?</p>
Policy actors	<p>Who has the formal competence and mandate to lead STI policy in the country?</p> <p>Who are main actors active in the STI policy process, from agenda setting and policy design to policy evaluation?</p> <p>Who are the main policy actors bringing the sustainable development perspective into STI debate and policy?</p>
Policy design	<p>How is the process of selecting and scoping STI policy priorities and objectives organized?</p> <p>To what extent are processes such as technology assessment or foresight 'broadened out' to include multiple stakeholders?</p> <p>How are alternative options for STI policy designed, assessed and compared?</p> <p>How inclusive is the process of policy design?</p> <p>What are the capacities of government to design policy instruments and policy portfolios?</p> <p>To what extent is experimental policy design and failure acceptable?</p>
Policy implementation	<p>What is the overall implementation capability of STI policy?</p> <p>Who are the main implementation bodies and implementation mechanisms of main STI policy instruments?</p> <p>What are the competences and responsibilities of bodies responsible for policy implementation?</p> <p>What is the capacity and resources of bodies responsible for policy implementation? What are the needs in terms of capacity and resources in the context of STI for SDGs?</p> <p>What role is there for policy learning and experimentation during implementation?</p>
Policy coherence	<p>To what extent is the STI policy mix internally consistent and coherent? To what extent is STI policy coherent with other areas of public policy relevant for sustainable development?</p> <p>What are the processes and organizational arrangements to ensure internal consistency and coherence of STI policy?</p> <p>What are the processes and arrangement to manage processes of abandoning certain policies that are no longer consistent with achieving transformation and SDG targets?</p> <p>What are the processes and organizational arrangements to ensure coherence between STI instruments and other areas of public policy relevant for sustainable development, notably the long-term development goals?</p>
Policy evaluation	<p>What are the key characteristics of evaluation culture and policy learning in STI policy?</p> <p>How is the STI policy monitoring and evaluation system organized in the country?</p> <p>To what extent is the monitoring and evaluation system tailored to inform design and implementation of STI policy for sustainable development and the SDGs?</p> <p>What is the capacity to conduct and learn from monitoring and evaluation in STI policy, notably in the context of sustainable development challenges and the SDGs?</p> <p>What are the key STI indicators collected and used in analysis of the overall STI performance and impact assessments of STI policy? Do STI indicators include the metrics relevant for sustainable development and the SDGs?</p> <p>What is the accessibility and quality of evidence on outcomes and impact of public policy on STI, notably in terms of impact on sustainability?</p>

Annex 2. Further reading on the STIP Reviews

STIP Reviews implemented by UNCTAD

See [http://unctad.org/en/pages/publications/Science,-Technology-and-Innovation-Policy-Reviews-\(STIP-Reviews\).aspx](http://unctad.org/en/pages/publications/Science,-Technology-and-Innovation-Policy-Reviews-(STIP-Reviews).aspx).

Other relevant UNCTAD materials

See <http://unctad.org/en/Pages/analysis.aspx>.

Academic references

The following references constitute a useful resource for science, technology and innovation policy-makers who are interested in applying innovation to sustainable development challenges, particularly in introducing concepts around transformative innovation policy and sustainability transitions. They also include practical guides that can inform the analytical and participatory processes involved in the STIP Review. Each reference is annotated with a brief description of its relevance.

Adebowale, B., Diyamett, B., Lema, R., and Oyelaran-Oyeyinka, B. (2014). Innovation research and economic development in Africa. *African Journal of Science, Technology, Innovation and Development*, 6(5), v-xi.

- Introduction to a journal special issue exploring innovation policy in African countries.

Andersen, A. D., Johnson, B. H., Marín, A., Kaplan, D., Stubrin, L., Lundvall, B-Å. and Kaplinsky, R. (2015). *Natural resources, innovation and development*. Aalborg Universitetsforlag. DOI: 10.5278/VBN/MISC/NRID.

- Explores how innovation systems in natural resource-endowed developing countries can enable upgrading, diversification and structural change.

Climate-KIC, (2016). *A visual toolbox for system innovation. A resource book for practioners to map, analyse and facilitate sustainability transitions*, available at <https://www.climate-kic.org/programmes/research-innovation/>.

- Although restricted to European countries it provides many practical tools and examples which are applicable in developing countries too.

Grin, J., Rotmans, J. and Schot, J. (2010). *Transitions to Sustainable Development: New Directions in the study of Long Term Transformative Change*, New York: Routledge.

- Provides a summary of basics of how sustainability transitions work.

Hanlin, R. and Andersen, M. H. (2016). *Health Systems Strengthening: Rethinking the Role of Innovation*. (1. Edition ed.) Aalborg: Aalborg Universitetsforlag. Globelics Thematic Report, No. 4, DOI: 10.5278/241620502.

- Explores the role of innovation and capabilities in enhancing health.

Kraemer-Mbula, E. and Wunsch-Vincent, S. (Eds.) (2016). *The Informal Economy in Developing Nations: Hidden Engine of Innovation?* Cambridge: Cambridge University Press.

- Shows the importance of the informal economy for innovation and explores its role.

Lema, R., Johnson, B., Andersen, A. D., Lundvall, B-Å. and Chaudhary, A. (2014). Low-Carbon Innovation and Development. Aalborg Universitetsforlag. DOI: 10.5278/VBN/MISC/LCID.

- Applies an innovation capabilities lens to the challenge of low carbon development.

Lundvall, B.-Å., Joseph, K. J., Chaminade, C. and Vang, J. (Eds.) (2009). Handbook of innovation systems and developing countries: building domestic capabilities in a global setting, Cheltenham: Edward Elgar.

- Provides a good introduction to the national systems of innovation approach for developing countries.

Johnson, B., and Andersen, A. D. (2012). Learning, Innovation and Inclusive Development: New perspectives on economic development strategy and development aid. Aalborg: Aalborg Universitetsforlag. Globelics Thematic Report, Bind. 2011/2012.

- Explores the potential and limitations of innovation capabilities for inclusive development.

OECD (2015) System innovation: Synthesis report, OECD Publishing, Paris.

- Important report on socio-technical system change.

Sarewitz, D. and Pielke Jr, R.A. (2007). The neglected heart of science policy: reconciling supply of and demand for science, *Environmental Science & Policy*, 10, 5-17.

- Shows how knowledge production can be coupled with societal challenges.

Schot J and Steinmueller W. E. (2018). Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change, *Research Policy*.

- Argues that there is a need for transformative innovation policy.

Schot, J, Boni, A., Ramirez, M., and Steward, F. (2018). Addressing SDGs through Transformative Innovation Policy, TIPC Research Brief 2018-01.

- Provides a transformative innovation policy lens on the Sustainable Development Goals.

Scoones, I., Newell, P. and Leach, M. (Eds.) *The Politics of Green Transformations*, Abingdon: Routledge

- Explores the political aspects of transformations with reference to grassroots innovation, finance, political economy and the use of scientific evidence.

Wieczorek, A. J. (2018). Sustainability transitions in developing countries: major insights and their implications for research and policy, *Environmental Science and Policy* 84, 204-216.

- Provides a systematic review of 115 publications and discusses methodological and conceptual lessons.

World Bank (2010). *Innovation Policy. A guide for developing countries*.

- Provides a framework for designing innovation policy strategies and instruments with numerous examples.

Annex 3. Participants at the Ad Hoc Expert Meeting of November 2017

Title	Name	Family name	Work title	Organisation
Mr.	Ludovico	Alcorta	Research Fellow	UNU-MERIT, the Netherlands
Mr.	Andrea	Bassi	CEO	KnowlEdge Srl and IISD, Switzerland
Ms.	Elenita	Daño	Asia Director	Action Group on Erosion, Technology and Concentration (ETC Group), the Philippines
Mr.	Adrian	Ely	Deputy Director	STEPS Centre, UK
Mr.	George	Essegbey	Director	Science and Technology Policy Research Institute (STEPRI), Council of Science and Industrial Research, Ghana
Ms.	Erika	Kraemer-Mbula	Senior Lecturer and Research Fellow	Institute for Economic Research at Tshwane University of Technology, South Africa
Mr.	Mehdi	Mohammadi	Advisor	Vice Presidency for Science and Technology, Iran I.R.
Mr.	Martin	Schaaper	Senior ICT Analyst	International Telecommunication Union (ITU), Geneva
Mr.	Johan	Schot	Director	Science Policy Research Unit, University of Sussex, UK
Mr.	Xiaoyong	Shi	Associate Professor	National Center for Science and Technology Evaluation (NCSTE), China
Mr.	Andreas	Stamm	Senior Researcher	German Development Institute, Germany
Mr.	Fred	Steward	Professor Emeritus of Innovation and Sustainability	University of Westminster, Policy Studies Institute, UK
Mr.	Taffere	Tesfachew	Independent Consultant	
Ms.	Kanchana	Wanichkorn	Assistant Secretary General	National Science Technology and Innovation Policy Office, Thailand
Mr.	Alfred	Watkins	Chairman	Global Solutions Summit, USA

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