



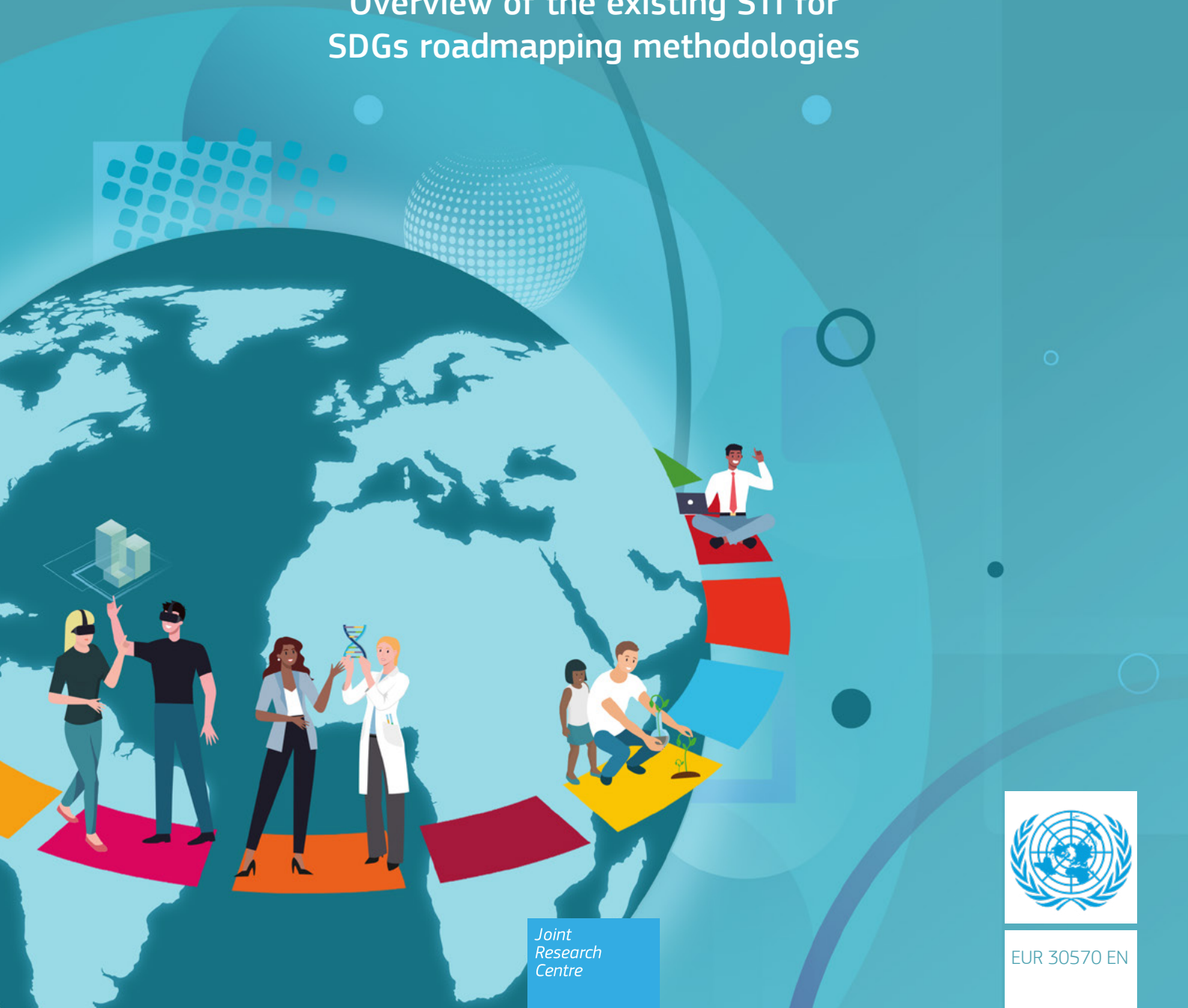
European
Commission

SCIENCE, TECHNOLOGY AND INNOVATION (STI)

for Sustainable Development Goals Roadmaps

■ **BACKGROUND PAPER:** ■

Overview of the existing STI for
SDGs roadmapping methodologies



Joint
Research
Centre



EUR 30570 EN

This publication is a Technical report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication. For information on the methodology and quality underlying the data used in this publication for which the source is neither Eurostat nor other Commission services, users should contact the referenced source. The designations employed and the presentation of material on the maps do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Contact information

Monika Matusiak
European Commission, Joint Research Center
Edificio EXPO, c/ Inca Garcillaso 3, 41092 Seville, Spain
monika.matusiak@ec.europa.eu

EU Science Hub

<https://ec.europa.eu/jrc>

JRC123628

EUR 30570 EN

PDF ISBN 978-92-76-28936-4 ISSN 1831-9424 doi:10.2760/2100

Print ISBN 978-92-76-28937-1 ISSN 1018-5593 doi:10.2760/777325

Luxembourg: Publications Office of the European Union, 2021

© European Union 2021



The reuse policy of the European Commission is implemented by the Commission Decision 2011/833/EU of 12 December 2011 on the reuse of Commission documents (OJ L 330, 14.12.2011, p. 39). Except otherwise noted, the reuse of this document is authorised under the Creative Commons Attribution 4.0 International (CC BY 4.0) licence (<https://creativecommons.org/licenses/by/4.0/>). This means that reuse is allowed provided appropriate credit is given and any changes are indicated. For any use or reproduction of photos or other material that is not owned by the EU, permission must be sought directly from the copyright holders.

Text © European Union 2021

Images page 14, photograph, @gustavofraza0/Depositphotos.com – All rights reserved

Images page 17, photograph, @inacioluc /Depositphotos.com – All rights reserved

How to cite this report: Matusiak, M., Ciampi Stancova, K., Dosso, M., Daniels, C. and Miedziński, M., Background paper: Overview of the existing STI for SDGs roadmapping methodologies, EUR 30570 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-28936-4, doi:10.2760/2100, JRC123628.

SCIENCE, TECHNOLOGY AND INNOVATION (STI)

for Sustainable Development
Goals Roadmaps

■ **BACKGROUND PAPER:** ■

Overview of the existing STI for
SDGs roadmapping methodologies



June 2020

Authors:

Monika Matusiak*, Katerina Ciampi Stancova*, Mafini Dosso*, Chux Daniels** and Michał Miedziński***

** European Commission, Joint Research Centre*

*** Science Policy Research Unit (SPRU), University of Sussex, UK*

**** Institute for Sustainable Resources, University College London*

The work in this background paper was led by Monika Matusiak and Katerina Ciampi Stancova under the management and supervision of Alessandro Rainoldi, Fernando Hervas Soriano, Liliana Pasecinic and Manuel Palazuelos Martinez – European Commission, Joint Research Centre.

The authors of this background paper would like to express their warmest thanks to the colleagues from the United Nations IATT Member Group for taking their time and contributing with their inputs. Without their extremely valuable insights, advice and comments this background paper would not be possible. We are very grateful to (in alphabetical order of the institutions): Mario Cervantes (OECD), Clovis Freire (UNCTAD), Veerle Vandeweerd (former UNDP), Kornelia Tzinova (UNESCO), Fernando Santiago Rodriguez (UNIDO). Particular words of gratitude go to Rui Kotani and Naoto Kanehira (World Bank) who contributed with extensive information on the World Bank's Public Expenditure Review on STI.

Graphic project prepared by Raffaella Manfredi.

Executive Summary

This background paper serves as an Annex to the United Nation's Guidebook for the Preparation of Science, Technology and Innovation (STI) for SDGs Roadmaps. Its purpose is to provide an overview of the existing methodologies and approaches that can be used to develop the Roadmaps. While the first framework for STI for SDGs Roadmaps has been proposed in the UN Guidebook, multiple United Nations (UN) Agencies and other organisations have developed approaches over the years that can successfully support different steps in the new methodology, depending on the capacity and specific needs of interested countries, subnational territories or international partnerships.

The Joint Research Centre of the European Commission (EC-JRC), with the help of international experts, has led the work on this background paper. To ensure the quality and robustness of the materials contained in this paper, in reviewing the methodologies the authors have consulted the respective member organisations of the United Nations Interagency Task Team on STI for SDGs Roadmaps and other international partners, including the Organisation for Economic Co-operation and Development (OECD), United Nations Conference on Trade and Development (UNCTAD), United Nations Educational Scientific and Cultural Organization (UNESCO), United Nations Industrial Development Organization (UNIDO), Transformative Innovation Policy Consortium (TIPC), the World Bank (WB) and G-STIC.

The key messages

1 The transition and adaptation of the roadmapping approaches from the private to public sector and from the main focus on competitiveness to sustainability has brought on the changes in scope and process of the roadmap development. In the case of public authorities at country or subnational level, the specific approach and scope can differ, depending on their needs, the capacities of the STI systems and administrative, political and strategic context. The final shape of any STI for SDGs Roadmap will, therefore, be different but should include the key elements such as an assessment of the current situation, a shared

vision developed in dialogue with stakeholders, a set of priorities, the analysis of alternative pathways and operationalised actions with means for their implementation.

2 Although the final shape and process of any STI for SDGs Roadmap will be different, there are several common elements they should share, including:

- an assessment of the existing challenges, trends and innovation capacities;
- a shared long-term vision developed in dialogue with stakeholders;
- a set of priorities and targets;
- the deliberation and appraisal of alternative innovation pathways;
- an action plan with concrete decisions, commitments and implementation arrangements;
- a monitoring and evaluation framework.

The fact that these methodologies have already been tested in multiple environments over the years and often provide access to online databases, training materials and other resources makes them especially useful.

3 Having the above in mind, this background paper presents an overview of the available methodologies that can be used by the public authorities willing to start the process of the STI for SDGs Roadmap development. The analysis in this paper was based on a central question: How can existing methodologies, tools and information sources be applied in designing, implementing and evaluating STI for the SDGs Roadmaps?

4 The methodologies and practices reviewed in this background paper have been developed over decades with other purposes in mind than the development of STI for SDGs Roadmaps. However, they include useful elements and processes that can help at different stages of the roadmap development, depending on the existing needs – be it the choice of policy instruments, financing of the roadmap, creating the joint vision, etc. The experience from testing and im-

plementing these methodologies in multiple environments over the years has yielded many useful lessons for STI for SDGs Roadmaps. The methodologies have been well described and come with online databases, examples of good practice and training materials.

5 The review findings show that the different methodologies have some distinguishing features and vary in their general approach – some of them can be called systemic as they try to jointly address the economic, societal and environmental challenges of countries or subnational territories, at the same time taking into account the synergies and trade-offs and following most of the steps in the STI for SDGs framework proposed in the UN Guidebook for the Preparation of STI for SDGs Roadmaps. The other group includes sectoral approaches, where STI is applied in the context of a specific policy or programme such as industrial, agricultural, gender, etc. Finally, the modular approaches are best suited to one of the steps in the STI for SDGs framework proposed in the UN Guidebook for the Preparation of STI for SDGs Roadmaps.

How to use this background paper

1 Any country or subnational territory wishing to apply any of the methodologies presented or develop their own approach to STI policy for SDGs needs to reflect on which approach can respond to their challenges as well as reflecting on political commitment and policy capacities needed to engage in the process. The reflection includes questions such as: what are the biggest needs and what is missing in the national policy framework for STI for SDGs, or is there a need for a full roadmapping process from the assessment of the current situation to the implementation framework? Is there a special interest to use STI inputs in another policy? Are there specific steps missing such as an assessment of alternative pathways or a policy mix? Once the answers are known, this paper can help the readers in better understanding the options available and details of each methodology that can support the development of an STI for SDGs Roadmap. The summary table below can be a guide to see in which part of the roadmapping process the different methodologies can be of use.

2 An important consideration for any methodology is

capacity understood as the capability of institutions, actors and organisations to develop and implement STI for SDGs Roadmaps. Most of the methodologies discussed offer some form of capacity building, often with vast knowledge repositories. It is essential to develop this capacity with the STI community, public administration and stakeholders in order to be able to not only develop but also implement and learn from the roadmap implementation.

3 Even well-designed roadmaps will not be useful without implementation, which requires institutional commitment and investment of time and resources. The countries and subnational territories undertaking the important effort of developing STI for SDGs Roadmaps must be ready to implement the solutions agreed with the stakeholders and international partners and devote human, organisational and financial resources for this purpose. In most cases (although not all) the implementation is the mandate and responsibility of national governments. However, some approaches offer support in the design of the implementation frameworks.

4 International partnerships can bring expertise, experience and missing capacities into the roadmapping process. Depending on the need and profile required, international organisations, partner countries and donors can offer help in all the steps of the roadmapping process. It can be a useful learning exercise to enhance the cooperation between different institutions in order to be able to offer more comprehensive approaches.

5 It is worth having in mind that the global community and international organisations are increasingly aware of the importance of SDGs and are working to adjust their methodologies to the new thinking. In particular, the members and partners of the United Nations Interagency Task Team on Science, Technology and Innovation for SDGs (IATT) have been working together to update and further develop their approaches and methodologies. Important learning and conclusions also come from the Global Pilot Programme on STI for SDGs. It can therefore be expected that in the near future, many positive changes will be implemented and new methodological insights for STI for SDGs Roadmaps will emerge.

Summary table.

Matrix of steps and methodologies

METHODOLOGICAL STEPS			
	Focus on STI POLICY	Focus on SECTORAL POLICY	Focus on SOCIAL, ECONOMIC AND ENVIRONMENTAL CHALLENGES
DEFINE OBJECTIVES AND SCOPE			
ASSESS CURRENT SITUATION	<ul style="list-style-type: none"> ■ STI POLICY REVIEW (OECD) ■ GO-SPIN (UNESCO) ■ PERs in STI (WB) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
DEVELOP VISION, GOALS AND TARGETS			<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
DIALOGUE AND CONSULTATION WITH STAKEHOLDERS	<ul style="list-style-type: none"> ■ STI POLICY REVIEWS (OECD) ■ GO-SPIN (UNESCO) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
ASSESS ALTERNATIVE PATHWAYS		SIIG (UNIDO)	<ul style="list-style-type: none"> ■ STIP (UNCTAD)
DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT			<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
MONITOR, EVALUATE AND UPDATE PLAN	<ul style="list-style-type: none"> ■ GO-SPIN (UNESCO) ■ PERs in STI (WB) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)

Table of **CONTENTS**

5	Executive summary
10	1. The context of STI roadmaps: from technology roadmaps to STI roadmaps for the SDGs
12	1.1 What are technology roadmaps?
16	1.2 Beyond technology roadmapping: Using roadmaps to support science, technology and innovation policy addressing societal challenges
18	1.3 STI roadmaps and the challenges of sustainability transitions
20	2. Overview of methodologies to support STI for SDGs Roadmaps
26	2.1 STI for SDGs Roadmaps approach proposed in the UN Guidebook for STI for SDGs Roadmaps
28	2.2 Existing methodologies
29	2.2.1 SMART SPECIALISATION - EUROPEAN COMMISSION (EC)
33	2.2.2 STI POLICY REVIEWS - ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)
36	2.2.3. SCIENCE, TECHNOLOGY AND INNOVATION POLICY REVIEW FRAMEWORK (STIP) - UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (UNCTAD)
40	2.2.4. GLOBAL OBSERVATORY OF STI POLICY INSTRUMENTS (GO-SPIN) - UNITED NATIONS EDUCATIONAL SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)

44	2.2.5. STRATEGIC INDUSTRIAL INTELLIGENCE AND GOVERNANCE (SIIG) - UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)
47	2.2.6. TRANSFORMATIVE INNOVATION POLICY (TIP) - TRANSFORMATIVE INNOVATION POLICY CONSORTIUM (TIPC)
51	2.2.7. PUBLIC EXPENDITURE REVIEWS IN SCIENCE, TECHNOLOGY AND INNOVATION - WORLD BANK
57	2.2.8. OTHER METHODOLOGIES

60

3. Conclusions and main insights for policy makers

65

References



1. The context of STI roadmaps: from technology roadmaps to STI for SDGs Roadmaps

1.1 What are technology roadmaps?

Roadmapping is an essential technique for the management and strategic planning of technology and innovation. Phaal et al. (2004, p. 9) defines roadmapping as ‘a powerful technique for supporting technology management and planning, especially for exploring and communicating the dynamic linkages between technological resources, organizational objectives and the changing environment’. Technology roadmapping (TRM) helps organisations to explore, anticipate, plan and communicate the development of technologies, products and markets. It is also used to support efficiency improvements, technical risk management and planning.

TRM addresses fundamental strategic questions such as: where are we now? Where do we want to go? How to get there? (Phaal and Muller, 2009).

The distinctive feature of the approach is ‘the use of a time-based structured (and often graphical) framework to develop, represent and communicate strategic plans, in terms of the co-evolution and development of technology, products and markets’ over time (ibid: 10). The latter are often the layers of the roadmap (see *Figure 1*).

The process for TRM is embedded into specific organisational contexts and aligned with the objectives of the companies. Nevertheless, TRM shows some general or common features or processes across firms (Phaal et al., 2004; Moehrle et al., 2013). The objectives of the roadmaps are often expressed as a vision, strategic priorities and quantitative targets, which are set against a baseline mapping. The baseline mapping combines both evidence-informed diagnostics, qualitative information and experts’ views. TRM combines explicit and structured time-based frameworks or timeframes according to the scale and complexity of the expected mechanisms of change or path-

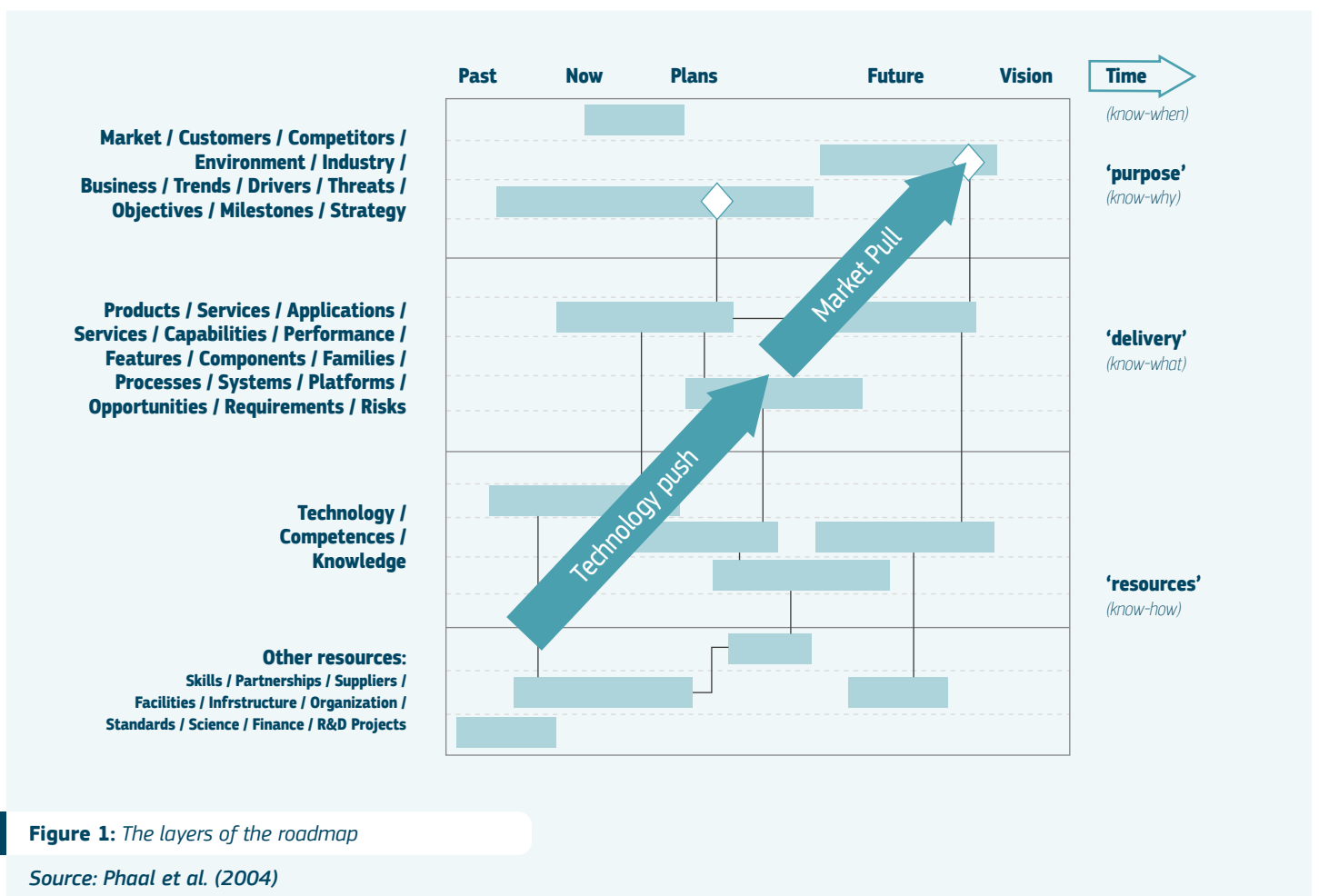


Figure 1: The layers of the roadmap

Source: Phaal et al. (2004)

ways. Alternative pathways are envisaged as different combinations of timelines, targets, scenario and dimensions of changes.

In general, TRM involves key stakeholders with various perspectives on the direction of change and the alternative pathways. The active role of stakeholders in the roadmapping should facilitate a 'common language and structure' to develop and deploy the strategy. The roadmapping process can therefore benefit from multidisciplinary inputs and, at the same time, offer a framework for learning, knowledge sharing and coordination (Phaal and Muller, 2009).

The process for TRM is embedded into specific organisational contexts and aligned with the objectives of the companies. Nevertheless, TRM shows some general or common features or processes across firms (Phaal et al., 2004; Moehrle et al., 2013). The objectives of the roadmaps are often expressed as a vision, strategic priorities and quantitative targets, which are set against a baseline mapping. The baseline mapping combines both evidence-informed diagnostics, qualitative information and experts' views. TRM combines explicit and structured time-based frameworks or timeframes according to the scale and complexity of the expected mechanisms of change or pathways. Alternative pathways are envisaged as different combinations of timelines, targets, scenario and dimensions of changes.

In general, TRM involves key stakeholders with various perspectives on the direction of change and the alternative pathways. The active role of stakeholders in the roadmapping should facilitate a 'common language and structure' to develop and deploy the strategy. The roadmapping process can therefore benefit from multidisciplinary inputs and, at the same time, offer a framework for learning, knowledge sharing and coordination (Phaal and Muller, 2009).

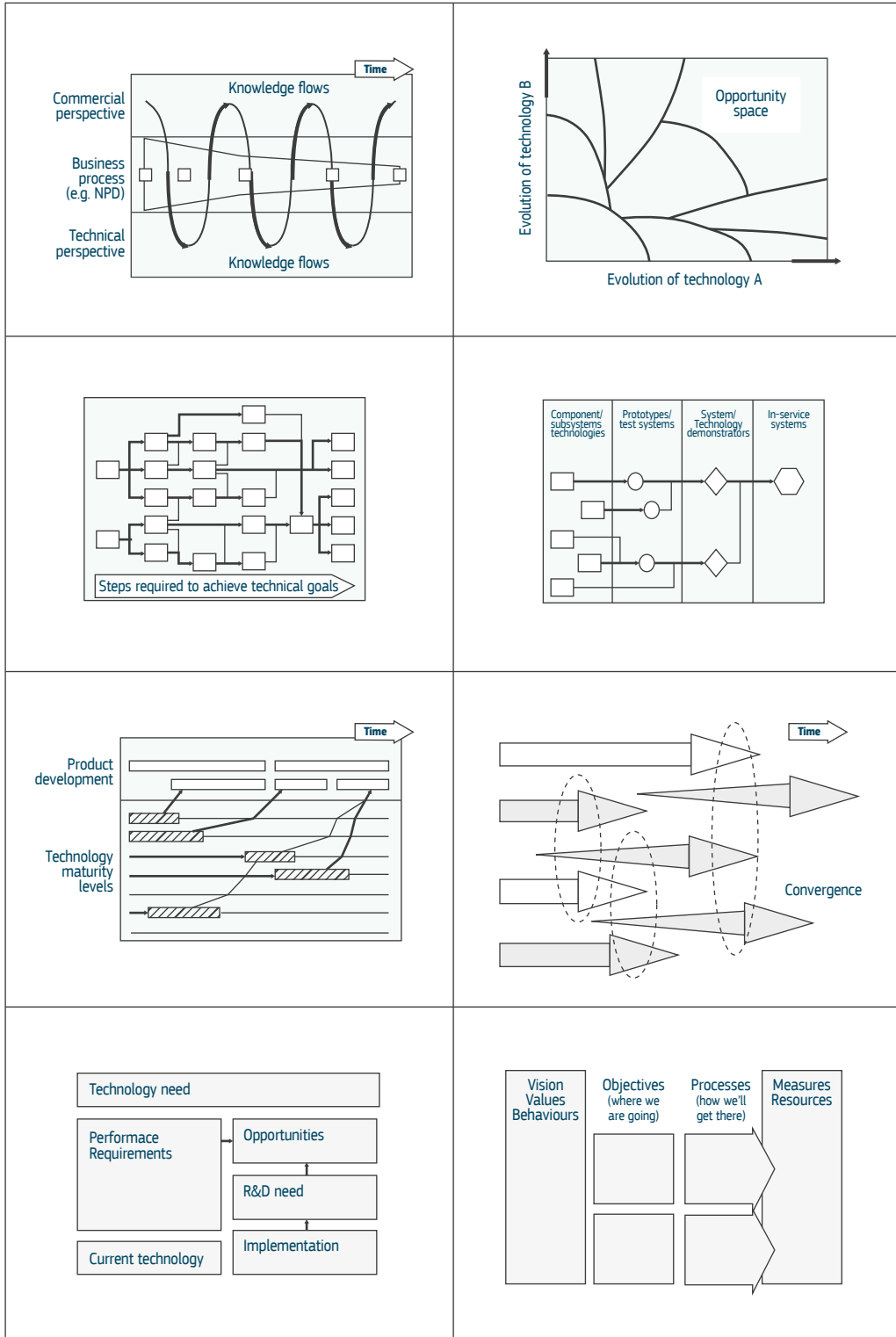
Together with the vision and pathways, TRM builds upon a concrete plan of action. The plan identifies the short- and medium-term actions that will be implemented in order to achieve the vision

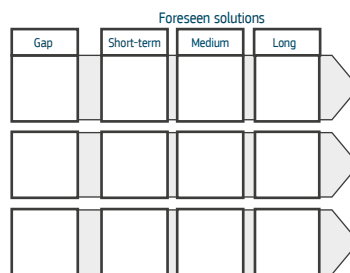
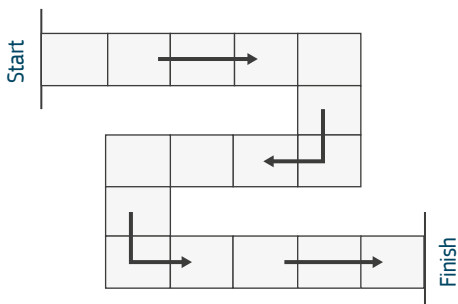
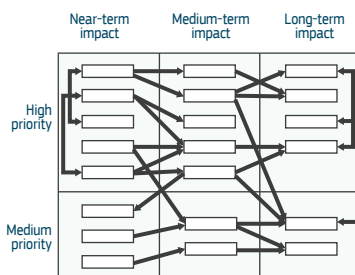
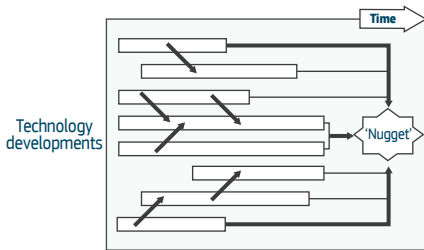
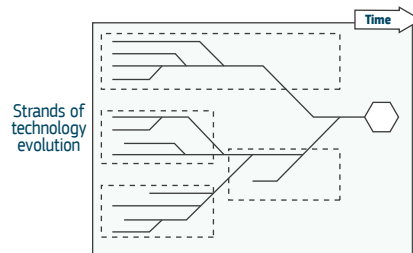
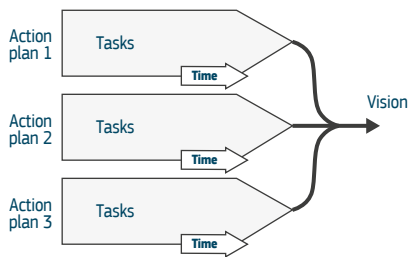
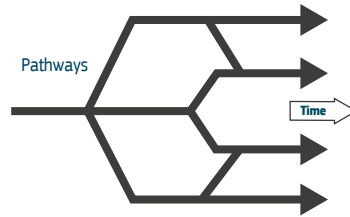
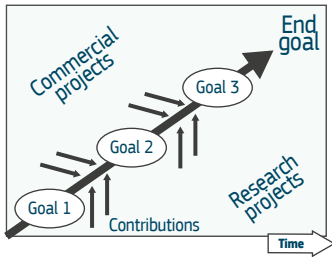
through the chosen pathway(s). Communication regarding the vision, pathways and actions plan is just as important as the TRM process itself. The most common formats synthesise the information through graphical representations such as multiple layers, bars, pictorial representations, flow charts or hybrid forms also underlining the time horizon for the process – see Figure 2 below (Phaal et al., 2004; Phaal et al., 2010).

Figure

2

Forms of TRM graphical representation





1.2 Beyond technology roadmapping: using roadmaps to support science, technology and innovation policy addressing societal challenges

Roadmapping concepts and techniques have been adopted well beyond the areas of innovation and technology management and industry development. The term is commonly used by decision-makers and governments in developed and developing countries in reference to the formulation, design and/or implementation of plans and programmes (Yasunaga et al., 2009; Carayannis et al., 2016). In practice, the term ‘STI policy roadmap’ can refer to technology or sectoral policy roadmaps, blueprints for thematic cooperation but also to narratives that encompass social, economic and environmental challenges or whole-system changes through complex sets of interrelated layers (organisations, industries, markets, etc.) and stakeholder coalitions.¹

STI roadmaps supporting policy design and implementation have different purposes and scope to technology roadmaps developed by private companies. Table 1 introduces an illustrative comparison between company-level and policy roadmaps. It also includes a comparison with the newly proposed STI for SDGs Roadmaps, discussed in detail in *Chapter 2*.

The scope and characteristics of policy roadmaps depend on their objectives and the policy context

in which the roadmapping process is undertaken. Policy roadmaps typically have a broader scope than company-level technology roadmaps, and aim to contribute to a higher-level of societal objectives, even when they have a technology or sectoral focus.

Policy roadmaps can serve a variety of purposes (Miedzinski et al., 2018):

- vision-building and agenda-setting: building a long-term vision of a desired future expressed as statements and images of desired and plausible futures;
- exploration of innovation and technology pathways: exploration and assessments of alternative technology, innovation or policy pathways to achieve a vision, often expressed as scenarios;
- technology advocacy: technology and innovation advocacy supporting technology areas or specific technologies within specific areas, often including research and innovation agendas with priority technology areas;
- stakeholder alignment: building or strengthening, often cross-sectoral, stakeholder alignment to support the vision and technology, innovation or policy pathways;
- support for policy design and planning: providing support for design and planning of policy portfolios or programmes by elaborating selected technological and innovation pathways, often using milestones and quantitative targets;
- support for policy implementation: providing support for the implementation and management of ongoing policy programmes or other initiatives.

Policy roadmaps require action from many actors in the public and private sector. Multi-actor governance arrangements and the key role of coordination mechanisms are among the key distinguishing features of policy roadmapping processes (Miedzinski et al., 2019a; Yasunaga et al., 2009).

¹ See the Annex to ‘The European Green Deal’; document 2 at <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0640&from=EN> and a few examples of sectoral and national roadmaps for Research Infrastructures at https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/esfri_en#roadmap.



STI policy roadmapping as a policy process can therefore be seen as an integrated strategic framework encapsulating visioning and priority-setting as well as multi-level and multi-stakeholder governance mechanisms needed to support ambitious societal missions and objectives such as the SDGs (Miedzinski et al., 2019a). Embedding strategic prioritisation and ongoing monitoring in STI policy roadmapping is critical to help achieve the pre-defined goals, even more so considering the limited STI budgets and changing environments.

1.3 STI roadmaps and the challenges of sustainability transitions

The full adoption of strategic roadmapping to support public policy comes with important challenges for governments in terms of the organisation and management of the roadmapping processes. Several shortcomings are worth underlining from the current practices at national and sectoral level in the field of STI policy, especially in the context of sustainability challenges or SDGs.

Among the key concerns for STI roadmaps are a 'vague' formulation of visions or desired future states, limited reflection on alternative innovation pathways, a lack of clear or feasible milestones and timeframes and the design of action plans based on promises without clear actor mandates and a governance structure supporting the implementation (Miedzinski et al., 2018). Such roadmaps are often non-actionable and do not trigger participation, stakeholder alignment nor ownership of the strategy. Furthermore, learning and revision mechanisms are often poorly developed and the lessons from the monitoring and evaluation are rarely integrated.

STI for SDGs Roadmaps need to be designed taking into account the complex nature of STI systems and the characteristics of sustainability transitions. Sustainability transitions require

systemic approaches mobilising multiple stakeholders across governance levels. Transformative STI often involves high-risk and experimental approaches, which needs to be underpinned by collective learning processes and social mediation that mobilises a variety of stakeholders, including underrepresented and excluded communities.

STI roadmaps for sustainability transitions can be led by any level of geopolitical administration, but broad ownership is essential not only to ensure continue implementation, but also shared accountability. This also means that the plurality and variety of stakeholders should be recognised and engaged in the early stages and all throughout the roadmapping processes, the follow-up and the revisions phase(s).

Table

1

Overview of the differences between company and policy roadmaps and STI for SDGs Roadmaps

	COMPANY ROADMAP	POLICY ROADMAP	STI FOR SDGS ROADMAPS
Purposes	Technology management, forecasting and planning.	Support for design and implementation or planning, vision-building, stakeholder alignment, etc.	Objectives and scope defined based on needs and capacities.
Vision	Company-level vision.	Collective vision at international, country, sectoral, technological or local level.	Collective vision based on the assessment of the current situation. The vision shows science, technology and innovation inputs necessary to achieve one or more prioritised SDGs.
Pathways <i>(scenarios, timeframes, targets, etc.)</i>	Quantitative objectives and structured timeframes (typically short to medium term).	High-level desired achievements or descriptions for medium- and long-term states. High-level theory of change and consideration of alternative scenarios and innovation pathways.	The vision is translated into goals and targets, with an additional analysis of alternative pathways based on forecasting, future studies and similar exercises.
Implementation	Internal company processes. Sometimes engagement of value chain partners.	Mix of policy instruments deployed by government and its agencies (importance of coherence and coordination mechanisms). Sometimes partnerships with external stakeholders (joint projects).	Operationalisation – definition of concrete steps on linking vision, analysis, priority setting and implementation.
Governance	Internal coordination by dedicated department(s) or high-level corporate stakeholders. Limited involvement of external stakeholders and experts.	Multi-stakeholder processes and governance arrangements during design and implementation of the roadmap (e.g. importance of ensuring inclusivity and avoiding capture).	Co-creation and shared ownership of priorities and the STI roadmap between a wide variety of stakeholders. Stakeholders should be involved during the design, implementation and monitoring of the roadmap.
Risk management	Integrated in corporate strategy for technology, product- and market-related risks.	Plurality and variety of approaches due to different stakeholders, social and organisational structures.	Plurality and variety of approaches due to different stakeholders, social and organisational structures.
Monitoring and evaluation	Corporate performance indicators, KPI.	Plurality of tools and systems co-exist and often difficult to relate to the high-level policy goals.	Monitoring and evaluation should lead to the revision of the STI roadmap and stimulate knowledge management and learning – reflexivity between stakeholders and implementation bodies.

Source: Authors based on Miedzinski et al. (2018)



2. Overview of methodologies to support STI for SDGs Roadmaps

The Addis Ababa Action Agenda of the Third International Conference on Financing for Development (Addis Ababa Action Agenda), adopted in July 2015,² put forward the idea that Science, Technology and Innovation (STI) together with capacity building are among the key means to achieve the Sustainable Development Goals (SDGs). To that end, the 2030 Agenda for Sustainable Development put forward the Technology Facilitation Mechanism (TFM), an action built on the collaboration, partnerships and expertise of a large variety of stakeholders from the United Nations entities, international organisations, research community, private sector and civil society. TFM is composed of three parts that are interlinked: (1) a United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs (IATT) including a 10-Member Group; (2) the Multi-stakeholder Forum on STI for the SDGs (STI Forum); and (3) an online platform.³

Within this framework, IATT members including the United Nations programmes and agencies, the European Commission, Organisation for Economic Co-operation and Development and the World Bank have been exchanging experiences and operationalising STI frameworks with the objective of helping countries and territories at different administrative levels deliver inclusive and sustainable growth for citizens and the planet.

The objective of this section is to provide a review of existing approaches to STI roadmap development. A number of approaches and methodologies for STI roadmaps have been developed, tested and deployed in countries around the world. The methodologies have not necessarily been developed within the framework of SDGs because they had been conceptualised and operationalised before the adoption of the 2030 Agenda. However, there is ongoing expert work aiming at updating and modifying the STI roadmap methodologies to

make them relevant and practical for the government representatives to achieve SDG objectives.

Based on the earlier IATT assessment, we have selected a limited number of methodologies that have been developed and deployed by seven international organisations and programmes: the European Commission (EC), Organisation for Economic Co-operation and Development (OECD), United Nations Conference on Trade and Development (UNCTAD), United Nations Educational Scientific and Cultural Organization (UNESCO), United Nations Industrial Development Organization (UNIDO), Transformative Innovation Policy Consortium (TIPC) and the World Bank (WB).⁴ These methodologies have been developed theoretically and then tested and applied in specific contexts. This means that each selected methodology has found its practical application at national and/or subnational level.

We acknowledge that reviewed methodologies are not the only existing methodologies, and that other methodologies exist which have been developed by international organisations, academia and research organisations or by countries and subnational authorities. However, due to a number of constraints such as the space limits of this paper, we are not able to include and review all existing methodologies. Therefore, we have selected a sample of methodologies, mainly those developed by IATT members, and one from a research consortium to illustrate the variety of approaches and practices.

For each of the international organisations, we identified one key methodology that enables the countries and territories at different levels of governance to explore, analyse and understand their STI strengths, potential, opportunities and alternative pathways, and consequently draft their STI for SDGs Roadmaps. Identified methodologies are the following: the EC's Smart Specialisation, OECD

² Addis Ababa Action Agenda available at: https://sustainabledevelopment.un.org/content/documents/2051AAAA_Outcome.pdf.

³ More information about TFM at: <https://sustainabledevelopment.un.org/tfm>.

⁴ We acknowledge that this is not an exhaustive list. Nevertheless, the objective is to examine a representative set of methodologies that covers the UN bodies and related agencies, the European Union, World Bank and research/academia.

STI Policy Reviews, UNCTAD's STIP Review Framework, UNESCO's Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN), UNIDO's Strategic Industrial Intelligence and Governance, the Transformative Innovation Policy Consortium (TIPC), the World Bank's Public Expenditure Reviews (PERs) on Science Technology and Innovation.

It emerged from the methodology review that the methodologies can be grouped into three broader categories according to their features and approaches:

- **the systemic approach** that sees STI as a means to address societal, economic and environmental challenges. In this group, one can include the European Commission's (EC) Smart Specialisation Strategy (S3), UNCTAD's STI Policy (STIP) Review Framework and the Transformative Innovation Policy (TIP) (by TIP Consortium). The Innovation for Sustainable Development Network methodology mentioned in Section 2 also belongs to this category.
- **the sectoral approach** where STI is a part of another policy such as SIIG by UNIDO, where STI contributes to the development of sustainable industrial policies. ITU's ICT Centric Innovation Ecosystem Country Review, the UNEP technology needs assessment and approaches used by FAO for innovation in agricultural policy and food systems, the IEA for energy, UNESCO for gender or WIPO for intellectual property mentioned in Section 2 also belong to this category.
- **the modular approach** that focuses particularly on specific steps of the methodology, such as UNESCO's GO-SPIN, the OECD's STI Policy Reviews and the World Bank's PER in STI focused on specific STI topics, instruments and frameworks. For example, G-STIC and UN Technology Innovation Labs exercises mentioned in Section 2 also belong to this category.

Information on the methodologies is provided in the form of a comprehensive summary building on the 'Six key steps in the development of STI

for SDG roadmaps' defined in the Guidebook for the Preparation of STI for SDGs Roadmaps⁵. Each summary comprises a description of the objectives of the methodology, data and information gathering, vision, goals and targets development, dialogue with stakeholders, assessment of alternative pathways, policy instruments, implementation, monitoring and evaluation. The objective is to provide a comprehensive overview of multiple approaches, methods and policy proposals developed by international organisations and programmes. We are not comparing or assessing different methodologies because each methodology differs in scope, approach, analytical methods and tools. The information provided is practical and useful to policy makers and practitioners who seek advice on the development, implementation and revision of the STI roadmap. References are provided in order to allow readers to learn more about each methodology and approach. A quick overview of the main methodologies can be found in *Table 2*.

⁵ *Guidebook for the Preparation of STI for SDGs Roadmaps* available at: https://sustainabledevelopment.un.org/content/documents/22724Guidebook_STI_for_SDG_Roadmaps_Draft_for_STI_Forum.pdf

Table

2

METHODOLOGICAL STEP/ ORGANIZATION	SMART SPECIALISATION (EC)	STI POLICY REVIEWS (OECD)	STIP REVIEWS (UNCTAD)
DEFINE OBJECTIVES AND SCOPE	Systemic approach: STI in the context of economic, societal and environmental challenges.	Modular approach: focus on STI policy data collection, analysis, reporting and dissemination.	Systemic approach: STI in the context of economic, societal and environmental challenges.
ASSESS CURRENT SITUATION	Based on existing policy frameworks, requires inter-institutional cooperation. Quantitative and qualitative analysis of economic, STI and SDG indicators.	Detailed analysis of the STI performance in the macroeconomic context and societal needs. Quantitative STI indicators plus in-depth analysis of specific sectors.	STI policies instrumental for economic growth and development. Large collection of qualitative data supported by overviews of literature and quantitative analyses.
DEVELOP VISION, GOALS AND TARGETS	Vision for sustainable socio-economic development of territories jointly developed by external and internal stakeholders.	Vision individually developed by each country based on the analysis and recommendations.	Synergic vision for transformative change jointly developed by internal and external stakeholders.
DIALOGUE AND CONSULTATION WITH STAKEHOLDERS	Entrepreneurial Discovery Process requires permanent involvement of public and private sector, academia and civic society in the development, implementation and monitoring of the strategy and associated activities.	Stakeholders are interviewed during the fact-finding missions. International community involved in reviews.	Multiple stakeholders involved in the STIP review process.
ASSESS ALTERNATIVE PATHWAYS	Recommended foresight and similar exercises, yet not obligatory.	Countries can develop scenarios for the enhancement of national STI ecosystems.	Technology foresights are strongly recommended.
DEVELOP DETAILED STI FOR SDGs ROADMAP DOCUMENT	Clear intervention logic with implementation action plan; policy mix and instruments; and financing instruments are required.	Not explicit, recommendations provided.	Specific guidance on implementation, policy instruments and financial instruments is provided.
MONITOR EVALUATE AND UPDATE PLAN	Monitoring and evaluation frameworks are essential in the S3 approach, with clearly defined matrices and indicators.	Monitoring and evaluation considered very important but not included. Post-review analyses are possible on request.	Monitoring and evaluation frameworks are strongly recommended and additional support is possible on request.

GO-SPIN (UNESCO)	SIIG (UNIDO)	TIP (TIPC)	PERS IN STI (WB)
Modular approach: focus on STI governance, legal frameworks, policy instruments and indicators.	Sectoral approach: focus on the STI component in the industrial policy. Includes social inclusion, economic competitiveness and environmental protection.	Systemic approach using innovation to address societal, economic and environmental challenges.	Modular approach: main focus is on STI policy expenditure and its impact.
Focus on policy instruments for evidence-based and inclusive policy-making: contextual factors, analyses of explicit STI policies (such as research and innovation policies for education, agriculture and health) indicators, STI governance bodies, legal frameworks, issues, operational policy instruments and SWOT analyses.	Based on existing development plans and strategies. Includes in-depth quantitative and qualitative analyses of the industrial landscape in the context of country's development goals.	Based on an extensive qualitative process and review of existing policies. Case study approach and learning histories are used.	The quality of public spending on STI and R&D is assessed based on a mix of qualitative and quantitative indicators with the objective of improving the impact of STI expenditures on economic development.
Looking at impact of the existing STI policies and based on a survey allowing the creation of country profiles with comprehensive assessments of STI policies.	Vision individually developed by each country with the large-scale participation of stakeholders.	Wide vision for transformative change achieved with STI policies and other elements of systemic change.	The development of vision for change can result from the PERs.
Internal and external stakeholders involved in providing the survey responses and discussing the results.	Stakeholders are involved in a participatory policy-making process throughout the policy cycle.	Large-scale stakeholder participation, including the local and grassroots innovators.	Stakeholder involvement is foreseen as a part of data collection, in the form of interviews, access to data, etc.
This step can be included but is optional.	Possibility of developing scenarios for industrial policy.	Foresight and future studies activities are considered valuable but optional.	Based on the analysis, the team discuss different options.
The methodology provides an overview of STI policy instruments but does not prescribe specific solutions – they can be developed at a country's request.	Individually developed by governments but based on recommended policy instruments.	Strong focus on experimentation. The policy mix is a part of TIP development and the guidance on financing can be provided.	The assessment results in a set of recommended policy instruments and a results-oriented framework.
The regularly updated country profile can be a useful monitoring tool.	Monitoring and evaluations are a part of the methodology.	Monitoring and formative evaluation are required with the focus on learning and improvement.	PER is a review of STI programmes and the whole STI system with embedded monitoring and evaluation models, and can thus be considered an evaluation.

2.1 STI for SDGs Roadmap approach proposed in the UN Guidebook for STI for SDGs Roadmaps

The description of each methodology follows the logic of the six stylised key steps proposed by the international community and described in the Guidebook for the Preparation of STI for SDGs Roadmaps. The authors deconstructed the STI roadmapping process into a series of 15 steps and actions. The complexity of steps and the terminology used in this background paper is the result of the expert discussions between the authors of this background paper and the representatives of international organisations and knowledge institutions. The steps proposed are not in chronological order, and they should rather be seen as activities and actions that constitute a toolbox that can be adapted to meet each country and territory's needs.

The objective is to inform the readers about the options and support that exist in terms of STI roadmap development. For example, one country needs to identify bottlenecks or inefficiencies in their research and innovation system while another needs to develop a comprehensive, system-focused strategy, and yet another country is looking for specific advice on financial instruments or a policy mix. Each country can identify different needs and problems, and in order to make an informed decision and choose the institution that can help them address those problems, they need comprehensive information on methodologies and advice/support services available for STI roadmapping. In other words, if a country or subnational authority, during the development of their STI for SDGs Roadmaps, needs advice on specific key steps, e.g. how to assess the current situation including data analysis and evidence gathering or the development of visions and goals, they can use the information

provided in this background paper to identify the best methodology available and the international organisation that could help them address the issues.

This background paper covers the steps below.

DEFINE OBJECTIVES AND SCOPE

- Defining rationale and objective – brainstorming and understanding of the need for STI for SDGs Roadmaps, capacity assessment and capacity building. This also includes the understanding of synergies with other policies and political and financial endorsement of the roadmap by respective authorities. Roadmap should be embedded in the strategic framework of the country and implementation ensured.

ASSESS CURRENT SITUATION

- Evaluation of current situation and understanding of current mandates – diagnosis of existing STI objectives, policies and instruments. This includes benchmarking and positioning vis-à-vis targets, as well as comprehensive identification of economic, societal and environmental challenges.
- Gathering data and evidence for STI roadmaps – definition of available sources of data, methods and approaches. This step includes in-depth analysis of opportunities and challenges: gap mapping, identification of threats and bottlenecks. The analysis should lead to a better understanding of each territory's capabilities, strengths, potential and opportunities.
- Outward-looking dimension and exploration of existing and potential international partnerships and collaboration.

DEVELOP VISION, GOALS AND TARGETS

- Elaboration of shared vision for the future – definition and consensus on the vision that needs to be inspiring, motivating and widely shared. The vision statement needs to be complemented with the definition of feasible goals and targets.

DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

- Co-creation and shared ownership of priorities and the STI roadmap between a large variety of stakeholders. The challenges identified are further explored and a limited set of priorities is identified.

ASSESS ALTERNATIVE PATHWAYS

- Foresight, future studies and similar exercises.

DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT

- Operationalisation – definition of concrete steps on linking vision, analysis, priority setting and implementation.
- Definition of policy mix – finding the most suitable policy instruments.
- Definition of financial tools – finding the most suitable financial instruments.
- Implementation (execution) stage – endorsing the STI roadmap and taking necessary steps for the implementation.

- Governance – formal (legally-based) and informal coordination of the STI roadmap.

MONITOR, EVALUATE AND UPDATE PLAN

- Monitoring.
- Evaluation and revision of the STI roadmap.
- Knowledge management and learning – reflexivity between stakeholders and participating countries.

2.2

Existing methodologies

2.2.1. SMART SPECIALISATION - EUROPEAN COMMISSION



DEFINE OBJECTIVES AND SCOPE

Smart Specialisation (S3) is a research and innovation policy approach based on systemic insights and recognising the interlinkages between innovation, social and economic systems from the perspective of a territory – a country, state, province or local community. Science, technology and innovation are seen as potentially transformative activities answering social, economic and environmental needs. S3 requires the identification of a limited number of STI priorities resulting from the evidence and stakeholder dialogue.

S3 promotes sustainable and inclusive growth by supporting economic, societal and environmental activities with highly transformative potential. In this context, S3 takes a roadmap approach as it leads to the identification of concrete actions and projects with the accompanying financial and organisational frameworks. Smart Specialisation Strategies (S3 strategy) are place-based, territory-relevant, innovation-led transformation agendas for growth and sustainability. They valorise existing assets and local specificities while mobilising local stakeholders as main players of socio-economic sustainable growth. They support technological as well as practice-based social innovation and respond to societal, business and environmental needs. The methodology is constantly developed, and presently focused on Smart Specialisation Strategies for Sustainability.⁶



ASSESS CURRENT SITUATION

- Current situation and mandates

The Smart Specialisation approach is based on the idea of government ownership of the policy design, implementation and monitoring and evaluation. It is voluntarily adopted by countries and subnational territories, which in the European Union (EU) can receive dedicated funding for implementation as a part of the EU Cohesion Policy. Beyond the EU, the cooperation is based on the expression of interest by the countries and needs to be linked to their existing national development plans/strategies and the science, innovation and technology, strategies and policies. They also decide on how the S3 strategy will be adopted and coordinated with other national and subnational strategies and policies. The responsible authorities are advised on how to perform an evaluation of existing policies and their relevant instruments to better understand current economic, scientific and innovation priorities. The updated Smart Specialisation methodology includes SDG mapping that allows for the STI roadmapping process to be directly linked to the 2030 Agenda.

- Data and evidence for STI Roadmaps

S3 provides tools to identify the socio-economic and environmental innovation engines of local growth, competitive advantages, opportunities and weaknesses. This is completed based on quantitative and qualitative analyses performed at international level (benchmarking), national level and subnational ones (using disaggregated datasets). The quantitative analysis and mapping of STI areas include the

⁶ More information about the Smart Specialisation concept and the S3 Platform: <https://s3platform.jrc.ec.europa.eu/home>

gathering and analysis of economic, innovation and societal data. Data comes from domestic or international statistical offices and can be complemented with qualitative surveys and interviews with stakeholders. Data should cover industrial activities, export, employment, companies, patents, public/private investments in STI, scientific publications, student population, graduates, graduate employment rates, etc. Statistical data can be gathered from e.g. the national statistical office, EUROSTAT, OECD, OR-BIS, bibliometric data (SCOPUS), Cordis. SDG mapping is completed based on national and international indicators for goals and targets. Quantitative data should be complemented with an analysis of societal needs and grand challenges that the society is and will be facing in the future.

■ International partnerships and collaboration

International cooperation in smart specialisation across countries and regions is strongly supported because it can lead to faster integration in global value chains, identify new opportunities for investments, unlock new business opportunities locally and internationally, set up economies of scale, share resources to achieve joint goals more efficiently, as well as allow for more knowledge exchange and learning. The cooperation is encouraged (via specific platforms and activities managed by the European Commission – JRC) both at the design and monitoring stage (via peer reviews and mutual learning workshops) and during the implementation (via thematic cooperation of territories with similar STI priorities). The S3 Platform provides support on how to explore and set up international collaboration in Smart Specialisation. More information: <https://s3platform.jrc.ec.europa.eu/thematic-platforms>.



DEVELOP VISION, GOALS AND TARGETS

Smart Specialisation advocates for the development of a vision for sustainable socio-economic development of the territory that is shared and endorsed by internal and external stakeholders. The vision is a combination of features and characteristics of each specific territory and economic, social and environmental needs and challenges for the territory and people. The vision can be deduced from a matrix with the following two axes: place-specific characteristics based on in-depth analysis and sustainable development goals. The vision needs to be translated into priorities (deep dives) and specific policy goals, objectives and targets. The S3 approach requires providing a sound implementation and financial framework for the identified vision.



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

Stakeholder engagement and dialogue is one of the essential pillars of Smart Specialisation, and it is called Entrepreneurial Discovery Process (EDP). Actors holding some type of STI knowledge, from businesses to research institutions, NGOs and representatives of civic society and the public administration, participate in the discussion leading to the identification of a limited set of priorities for development and where to concentrate public STI investments. Stakeholders not only discuss results of the quantitative analysis but also reflect upon the societal needs and how to address them. The EDP is effective and impactful only when supported by an implementation strategy (Action Plan), policy and tools, and it has a real impact on the distribution of public funds. It is expected that the stakeholders not only take part during the policy design phase, but also during the implementation and monitoring of activities (via innovation councils, working groups, monitoring committees, etc.). More information on the EDP concept: <https://s3platform.jrc.ec.europa.eu/entrepreneurial-discovery-edp>.



ASSESS ALTERNATIVE PATHWAYS

Relevant information on alternative pathways can be gathered through foresight studies, including expert panels, system analysis, agent modelling, scenario building, cross-impact analysis, etc. The responsible authorities carry out the data collection and analysis with help of researchers and experts. Based on scientific evidence, policy makers decide on possible development trajectories. The assessment of the alternative pathways is a recommended, although not obligatory, part of the S3 approach.



DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT

■ Operationalisation

The shared vision and goals need to be operationalised via specific actions, projects and viable policy instruments (for the latter, see below). The whole operationalisation process should be designed with large-scale stakeholder engagement and a clear commitment from the public sector to the visible implementation options (including financing and available programmes and policy instruments).

■ Policy mix

The policy mix is developed by responsible authorities, including inter-ministerial and inter-departmental cooperation. Policies should be considered in a holistic way, encompassing not only policies on research and innovation, but also creating synergies with other policies affecting similar target groups/stakeholders such as industrial policies, social policies, labour-market policies, educational policies, digital policies, environmental policies and territorial development policies, among others. Breaking down silos within the ministries and departments is a pre-condition for the development of efficient and impactful policies that can deliver on jointly agreed objectives.

■ Financial tools

Financial instruments are designed and implemented by responsible national and local authorities and supported by international programmes. Different funding sources and streams exist: in the European Union (EU) the public stream includes EU-level sources such as the European Structural and Investment Funds and European R&I competitive funds supporting STI activities in research organisations, private sectors and clusters, as well as national STI funds and local funds. The private stream includes FDIs and investments in STI by private companies. Beyond the EU, the European development aid and support from other donors is mobilised to ensure implementation, but the investment by national governments is also required.

■ Implementation (execution)

Implementation is carried out by responsible public authorities designated by the national government. The implementation system should include a clear division of responsibilities between different ministries and other public bodies. Each country and subnational authority nominates managing authorities responsible for the implementation of the S3 strategies through the Action Plans and dedicated financial tools.

■ Governance

The governance structure is established based on the administrative system of different countries but should always include a coordination body in the national or subnational government (e.g. inter-minister-

rial working group) and the measures to meaningfully involve external stakeholders such as quadruple helix⁷ working groups for the identified priorities (deep dives into specific topics). The stakeholders need to be engaged not only in designing the roadmap but also its implementation and monitoring.



MONITOR, EVALUATE AND UPDATE PLAN

■ Monitoring

Monitoring and evaluation systems are required elements of the S3 strategies. Countries and subnational authorities working on their Smart Specialisation Strategies are advised on how to develop a set of monitoring tools enabling an early-warning mechanism that is able to detect and pinpoint critical aspects in the policy implementation, which may call for prompt corrective action. Monitoring can also help the authorities understand if more in-depth analysis and assessment is needed and how to design the evaluation process and objectives.

■ Evaluation and revision of the Roadmap

Evaluation helps the authorities understand to what extent and how policy interventions designed for Smart Specialisation address challenges identified at the beginning of the policy cycle. The evaluation aims also to resynchronise public intervention with current challenges in confirming or refusing strategic choices and intervention modes decided by the policy makers and consequently contributes to the design of the new generation of policies and programmes. It is a legal obligation for EU Member States and subnational authorities to monitor the implementation of their S3 strategies and carry out an evaluation at the end of the policy cycle. The reports are shared with the European Commission services. In the context of EU support to candidate and neighbouring countries, the monitoring and evaluation system is required in order to achieve the positive assessment of the strategy by the European Commission.

■ Knowledge management and learning – reflexivity between stakeholders and participating countries

Smart specialisation provides countries and regions with an added benefit of collective learning and institutional innovation. To that end, the EC JRC developed, tested and deployed a number of KM and learning approaches:

- **knowledge repository** containing all publications as a result of knowledge codification;
- **online tools**: Eye@RIS3, ESIF Viewer, ICT Monitoring Tool, Regional Benchmarking, EU Trade, R&I Regional Viewer, Digital Innovation Hubs;
- **S3 Guidance**;
- **a Guide to Research and innovation Strategies for Smart Specialisation**;
- **Implementing Smart Specialisation Strategy: A Handbook**;
- **peer-review workshops**, Peer eXchange and Learning (PXL) workshops, thematic workshops, innovation labs;

⁷ Quadruple helix innovation framework recognises interactions by actors representing four innovation groups: private sector (industry and companies), public sector (government and administration at different levels of governance), science (university, research centres and knowledge institutions) and society (non-governmental organisations, etc.).

- *S3P Thematic Platforms on Agri-food, Energy and Industrial Modernisation;*
- *Smart Specialisation for Sustainable Development Goals.*

2.2.2. STI POLICY REVIEWS – ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT (OECD)



DEFINE OBJECTIVES AND SCOPE

STI policy data collection, analysis, reporting, management and dissemination is one of the main activities of the OECD. In fact, the OECD is the author of the universal methodology for collecting and reporting R&D statistics. The methodology is explained in the guidelines for collecting and reporting data on research and experimental development: Frascati Manual⁸ and Oslo Manual⁹. The European Commission and OECD also manage STIP Compass¹ that is the tool for policy makers, experts and practitioners interested in STI policies. It contains self-reported quantitative and qualitative data on STI trends, policies and approaches. Furthermore, the OECD conducts Country Reviews of Innovation Policy at the request of interested member and partner countries. The purpose and focus of the Country Reviews of Innovation Policy differ in function for each country's needs, objectives and visions. In general, the reviews provide an assessment of innovation system performance, analysis of the system's and its components' strengths and weaknesses, the role of public policies and policy institutions and provide a set of specific tailored policy recommendations.



ASSESS CURRENT SITUATION

- Current situation and mandates

The OECD Country Reviews of Innovation Policy are characterised by the broad comprehensive perspective – together with the whole-of-government approach – that bring into play the advantages that distinguish the OECD reviews from other comparable methodologies offered internationally. These distinctive advantages include a strong in-house analytical review team of OECD experts that essentially span all major policy areas relevant for innovation; a strong data infrastructure; accountability to and feedback from policy makers and experts in committees and working parties; and strong involvement in high-level national policy processes, including national STI strategy development. In almost all cases, country demands relate broad aspects of their innovation policy even if the review may have a particular focus such as strengthening links between research and the production systems.

The function of the Reviews of Innovation Policy is to help the country in developing its policies through specific recommendations based on a comprehensive and in-depth analysis of the strengths and weaknesses of the respective innovation system. The reviews thus cover the macroeconomic context, framework conditions for innovation and entrepreneurship, assessment of innovation performance, as well as

8 Frascati Manual available at: <https://www.oecd.org/sti/inno/frascati-manual.htm>.

9 Oslo Manual available at: <https://www.oecd.org/science/oslo-manual-2018-9789264304604-en.htm>.

specific elements such as production growth, diversification, internationalisation and societal needs in each analysed country. Additional features of the reviews include:

- a comprehensive perspective (open, interlinked innovation systems);
- being demand-driven, with scope for customisation to specific country needs;
- providing a holistic diagnosis of the country's STI system and policy;
- taking an evidence-based approach, combining quantitative and qualitative analysis;
- drawing on the STI knowledge base, notably policy reports completed by the OECD's Committee for Scientific and Technological Policy (CSTP);
- collaborating with international experts with specific knowledge of the reviewed country;
- the approach is a whole-of-government, multidisciplinary approach to STI policy.

■ Data and evidence for STI Roadmaps

Within an OECD analytical framework, the Reviews of Innovation Policy provide a detailed analysis of Science and Technology performance, achievements and challenges. In particular, numerous indicators and statistics are provided including expenditure on research and experimental development (R&D), R&D personnel and researchers, intellectual assets such as patents, trade in R&D intensive industries. The data is analysed and put in a broader national and international context. Detailed analysis of some specific sectors, industries and higher education systems is included on a case-by-case basis.

■ International partnerships and collaboration

Reviews of Innovation Policy strongly recommend interconnecting a wide range of actors (consumers, users, producers, knowledge agents, boundary spanners and other innovation actors) locally and internationally to address technical, industrial and social innovation.



DEVELOP VISION, GOALS AND TARGETS

Country vision, goals (e.g. national development goals) and targets are set by each country and can be modified based on the results and recommendations provided by the OECD. Country Reviews of Innovation Policy can provide an analysis and recommendations on how the national development goals can be achieved through an improved R&I ecosystem (actors, policies and processes).



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

During the fact-finding missions, OECD experts carry out interviews with numerous stakeholders representing all major STI sectors and stakeholders. The OECD also helps countries to organise stakeholder workshops to discuss findings emerging from the diagnostic and preliminary assessment of the review. The OECD also supports countries in engaging with international stakeholders through the process of reviewing and discussing the country reviews in the OECD committees and working parties.



ASSESS ALTERNATIVE PATHWAYS

Based on analysis and recommendations, each country can develop scenarios for the enhancement of a national ecosystem. This includes structural change, expansion, increased performance, improved system capabilities and enhanced attractiveness of STI institutions.



DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT

The operationalisation, detailed design of the policy mix and roadmap implementation (execution) are not explicit objectives of the OECD Reviews of Innovation Policy that instead identify strategic actions to take in response to weaknesses or dysfunctions in the country's innovation system. Each review contains a large set of policy recommendations and advice on how to further develop and implement an innovation ecosystem and policies. For example, Reviews of Innovation Policy can contain recommendations regarding the adaptation of the policy mix to support business innovation as well as ways to improve governance structures and processes. An increasing focus of the reviews, reflecting the demand from countries, is identifying policy actions to improve the responsiveness of the country's innovation system to better address societal and global challenges such as the SDGs.



MONITOR, EVALUATE AND UPDATE PLAN

■ Monitoring

Monitoring is important but not specifically addressed in all the Country Reviews of Innovation Policy. The OECD offers to revisit the country to take stock of developments since the review (e.g. China, Chile, Luxembourg, New Zealand, South Africa).

■ Evaluation and revision of the Roadmap

Similarly, monitoring, evaluation and revision of R&I strategies are important but not systematically addressed in all the Country Reviews of Innovation Policy. The revision of existing innovation policies in light of findings by OECD experts is desirable and relies on buy-in at the highest political level. At the request of countries, the OECD conducts follow-up reviews to assess the implementation of initial country review recommendations; this has been the case in Finland, Sweden and Korea, for example.

■ Knowledge management and learning – reflexivity between stakeholders and participating countries

OECD methodology, tools, diagnostics and reports are available online on the webpages:

- *STIP Compass*
- *OECD Country Reviews* of Innovation Policy
- *OECD Science*, technology and innovation policy.

2.2.3. SCIENCE, TECHNOLOGY AND INNOVATION POLICY REVIEW FRAMEWORK (STIP) - UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT (UNCTAD)



DEFINE OBJECTIVES AND SCOPE

As a Science, Technology and Innovation (STI) Policy (STIP) concept, UNCTAD's STIP approach, based on the new framework (UNCTAD, 2019¹⁰), focuses on the structural transformation of economies and societies towards sustainable development goals (SDGs). It promotes sustainable and inclusive growth that covers three important dimensions: economic, social and environmental. The rationale is based on the thinking that harnessing innovation for sustainable development (SD) is essential to realising the transformative potential of countries. Against this backdrop, the objective of the STIP review activities is to provide expert technical support to countries in assessing their national STI systems in ways that help to harness opportunities for transformative change. Such technical support is useful for the countries for formulating and implementing their national STI policies, strategies and plans.



ASSESS CURRENT SITUATION

■ Current situation and mandates

The current situation that gave the mandate to review the STIP review framework stems from the realisation that there is an urgent need to address sustainable development (SD), as articulated in the United Nations 2030 Agenda (UN, 2015¹¹). The previous version of the framework (UNCTAD, 2011¹²), although useful, did not emphasise the SD component strongly enough, but rather focused on the role of STI in economic growth and development. The 2019 STIP review framework, in expanding the role of STI in economic growth and development, therefore stresses the importance of addressing environmental and social challenges in efforts to achieve SD. The process of achieving these three dimensions of SD must focus on 'locally-defined societal challenges' (UNCTAD, 2019, p. 14) and strategic reflection. The methodology enables participating countries to identify key societal challenges, opportunities, weaknesses and strengths, alongside innovation and policy questions to be addressed¹³ – all of which helps in the development of a roadmap of STI for SDGs at country level. For this identification to be successful, the framework encourages the exploration of alternative pathways for STI and STI policies.

■ Data and evidence for STI Roadmaps

The objective of the review is to support countries in different development contexts and levels of growth

¹⁰ UNCTAD (2019), A Framework for Science, Technology and Innovation Policy Reviews – Harnessing innovation for sustainable development, Geneva: United Nations (Also available at: https://unctad.org/en/PublicationsLibrary/dtlstict2019d4_en.pdf (accessed: 30 March 2020)).

¹¹ United Nations (2015), Transforming our world: The 2030 Agenda for Sustainable Development, United Nation, New York.

¹² UNCTAD (2011), A Framework for Science, Technology and Innovation Policy Reviews, Geneva: United Nations (Also available at: https://unctad.org/en/Docs/dtlstict2011d7_en.pdf (accessed: 30 March 2020)).

¹³ '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, 2019, p. 16).

in formulating and implementing STI policies that could inform roadmaps and future strategic directions. It is therefore essential that the data and evidence that support the operationalisation of the framework can be readily obtained, regardless of the development state of the country. To this end, the framework adopts a mixed methods approach that involves the collection of data and evidence via sources that include the review of literature, country and site visits, field missions, workshops, secondary interviews and surveys and focus group meetings that help to ensure context-specificity issues are adequately identified and examined during the review. The interviews focus group meetings and workshops produce qualitative data, which complements the quantitative data sets. The STIP review is evidence-based, robust and flexible. The flexible approach also serves to ensure that the data and evidence gathered are needs based and relevant in the context of individual STIP review countries.

■ International partnerships and collaboration

The framework recognises that agenda/priority setting for STI involves a wide range of STIP actors working within the context of a political process. This requires partnerships and coalition-building in ways that call for coordination, collaboration and good governance. In addition, partnership is viewed as a possible source of expertise, skills and knowledge. Partners can offer support with conducting the STIP review. Agenda-setting for STI (or innovation for short), transformative change and for achieving the SDGs can result in tensions and conflicts between actors and stakeholders. Whilst one stakeholder group might be seeking to promote innovation and drive change, other stakeholders, i.e. incumbents, might resist such change, preferring to maintain the status quo. To help manage and resolve this tension, the STIP advocates partnership, strategic leadership and capabilities from ecosystem actors – policy makers, industry, academia and other actors. Experience of partnership management and collaboration is essential to the effective operationalisation of the STIP review.



DEVELOP VISION, GOALS AND TARGETS

The development of the new framework is based on the shared global vision of the SDGs. The goal is, through the review of STIPs, to help countries set an ambitious vision for transformative change through STI, STI policies and policy-making. In this context, the vision at national level must seek to advance the global sustainable development agenda that calls for inclusive growth, reduced inequality, better care for the environment and other goals. The framework advocates the participation of a broad range of actors and stakeholders in setting development agendas, priorities and targets. This requires flexibility, coordination and collaboration, and relies on a shared vision between all stakeholders.



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

The STIP framework places a strong emphasis on active stakeholder engagement, consultation and communication between actors. Rooted in the systems of innovation thinking, this framework takes the position that innovation involves multiple actors. Stakeholder involvement is encouraged from the start of the process. In operationalising the framework, the UNCTAD team commence stakeholder engagement prior to the STIP review, thereby enhancing the prospects of greater levels of participation from the national actors¹⁴.

¹⁴ For example, the framework recommends that the request for the STIP review '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



ASSESS ALTERNATIVE PATHWAYS

The STIP review framework strongly advocates the use of (technology) foresights for various reasons: (1) as policy instruments to foster innovation and environmental sustainability, creating shared vision and commitments and for the development of roadmaps (UNCTAD 2019, p. 11); (2) ‘encouraging co-creation and experimentation’ (ibid, p. 22) and tools for the identification and assessment of technology for possible use. Foresight, future studies, technology assessments and similar exercises are therefore important components of the STIP review process and approach to roadmapping.



DEVELOP DETAILED STI FOR SDGs ROADMAPS DOCUMENT

■ Operationalisation

The operationalisation of the framework starts with letters of request from the relevant ministry or government in the interested country. This is followed by consultations with relevant actors, the development of terms of references, team setup, stakeholder mapping, scoping interviews, mission trips at preparatory stages but also for data collection, focus group meetings and workshops, desk research and in-country capacity building exercises for relevant stakeholders. The output of the STIP review, a report, can inform the (re)formulation and implementation of a national STI policy or the development of a roadmap.

■ Policy mix

The application of a carefully articulated policy mix is essential to the success of the STIP framework. The framework includes policy instruments that provide examples but also a starting point for the respective participating countries in designing their policy mix. With the inability of many developing countries to design an effective policy mix/instruments¹⁵, examples provided in the framework can serve as a useful knowledge source. The proposed policy instruments are grouped into regulatory, economic, fiscal, demand support, education and others. Although various (a long list of) policy instruments are proposed, there is a need for improved clarity on the selection criteria and procedure.

■ Financial tools

From the wide group of policy instruments available for use in STIPs, fiscal or financial instruments belong to the groups that are most commonly used. Fiscal policy instruments proposed in the framework include tax credits for R&D, tax incentives for technology adopters and the removal of tax credits from businesses or policy activities, projects and programmes that are unsustainable. It is important to emphasise that aside from financial instruments, the STIP methodology outlines other policy instruments that should be included as part of the mix (see Section 5.2 above).

■ Implementation (execution)

The UNCTAD team and external consultants, in collaboration with the relevant in-country STI agencies designated by the national government, for example the Ministry of Science and Technology, carry out the implementation of the STIP framework. Although UNCTAD leads the implementation process, coun-

at cabinet level prior to launch’ (UNCTAD, 2019, p. 16). This helps to ensure effective engagement of stakeholders at high levels of government, ‘buy-in’, shared vision and ownership.

¹⁵ Often due to weaknesses in capabilities and skills.

tries play very important roles. For example, the participating country's agency can support the processes involved in mapping STI capacities and gaps, national development goals and SDG challenges. Where possible, UNCTAD provides training and technical support. The countries are also responsible for the eventual implementation of resulting policies and instruments.

■ Governance

Although the implementation process is led by UNCTAD, the governance structure is designed to include active participation by the designated national agency/agencies which might be responsible for coordinating the national actors, for example in the agenda-setting, consultation and data collection processes. This helps to ensure optimum participation by innovation systems actors within the country. The governance of the actual policies is the mandate of national governments.



MONITOR, EVALUATE AND UPDATE PLAN

■ Monitoring

An important component of the STIP review framework is the emphasis on effective monitoring, evaluation and follow-up processes. This is essential for various reasons including accountability, learning, supporting the processes involved in policy experimentation and as a source of intelligence for policy makers. The recommendation is to 'adopt a "broad" and "open" approach' and help to identify 'acceptable pathways for moving forward' (UNCTAD 2019, p. 19).

■ Evaluation and revision of the Roadmap

In line with the monitoring above (see Section 6.1), the STIP framework recommends that 'subject to negotiation with the national government and the funding body', a preferred approach will be to establish a monitoring commitment between UNCTAD and the participating country. This will enable continuous tracking of 'progress and change against the baseline established in the STIP Review' (ibid, p. 20).¹⁶ Consequently, the role of monitoring, evaluation and follow-up is taken very seriously and carefully articulated in the STIP review.

■ Knowledge management and learning

Learning and knowledge sharing are important components of the STIP review process. The process in itself is a capacity building activity that strengthens the capacity of the main actors of the NIS involved in the review. The findings and recommendations of the STIP review inform the policy-making at national and subnational levels. These findings also inform the analytical work of UNCTAD and contribute to the preparation of knowledge products such as UNCTAD's Technology and Innovation Report and Reports of the UN Secretary-General. The STIP Reviews are also presented and discussed at the annual sessions of the United Nations Commission on Science and Technology for Development (UN CSTD), which is an opportunity for dissemination and knowledge sharing among the member states.

¹⁶ Source: UNCTAD's long-term engagement, post-STIP review and less about governance per se. But it can be argued to be related to governance.

2.2.4. GLOBAL OBSERVATORY OF STI POLICY INSTRUMENTS (GO-SPIN) - UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO)



DEFINE OBJECTIVES AND SCOPE

The aim of UNESCO's Global Observatory of STI Policy Instruments (GO-SPIN) is to 'generate reliable, relevant information about the different landscapes of science, engineering, technology and innovation (SETI) policies' (UNESCO, 2014, p. 3). The rationale derives from the notion that STI are increasingly important for social and economic development and for the achieving the 2030 Agenda for sustainable development. It also advocates that STI policies and policy-making¹⁷ are essential to achieving the SDGs. Nevertheless, the lack of, or weaknesses in, data, information, indicators and capabilities to formulate, analyse and monitor STI policies and instruments continues to be a major challenge in many countries. Consequently, the objective of GO-SPIN is to fill these gaps by providing useful data and information on STI governance, frameworks, policy instruments and indicators that can underpin evidence-based policy-making and foresight studies.



ASSESS CURRENT SITUATION

■ Current situation and mandates

An example of a guiding question that informs GO-SPIN work is 'Are we using the "appropriate indicators" to understand how STI policies generate effects on societies or to understand how "National Research and Innovation Systems" work?'¹⁸ The underlying assumption and current situation is that we are either not using the appropriate data, information and indicators, or what we are doing is not to the best standard that it ought to be. To this end, Go-SPIN focuses on policy instruments for evidence-based and inclusive policy-making, implementation, monitoring and evaluation of (existing) STI policies. To reiterate, the focus on policy instruments is based on the belief that effective STI policies and policy-making is essential to addressing pressing development challenges and for achieving the 2030 Agenda. And in order for STI policies to be effective, policy instruments, including legal frameworks, funding and coordination mechanisms, and operational instruments such as competitive grants and public subsidies are required.

■ Data and evidence for STI Roadmaps

The data and evidence collection is based on an online survey and upload of information onto an online platform that prioritises Africa, Arab States, Asia Pacific, Latin America and the Caribbean. Data and information for GO-SPIN is 'based on replies to the national GO-SPIN surveys, combined with desktop research, government reports and statistical data from the UIS¹⁹ and other international sources' (UNES-

¹⁷ Agenda-setting or priority-setting, formulation, implementation, evaluation or review and governance.

¹⁸ Presentation on GO-SPIN by Guillermo A. Lemarchand (2018). Available at: https://en.unesco.org/sites/default/files/gospin_platform_presentation.pdf (accessed: 10 February 2020).

¹⁹ UNESCO Institute for Statistics.

CO, 2014, p. 3). The data obtained is used to build a comprehensive country profile that contains aspects such as contextual factors²⁰ and analyses of explicit STI policies (such as research and innovation policies for education, agriculture and health) indicators, STI governance bodies, legal frameworks, issues, operational policy instruments and SWOT analyses. The approach includes capacity building in the form of training of policy makers in the formulation, implementation and evaluation of STI policy instruments. The training may be conducted at national or regional level. The uptake of the comprehensive output by national actors feeds into decision-making and the development of the roadmap, in cooperation with international and regional partners.

The GO-SPIN framework is operationalised by UNESCO, in partnership with national actors. Available evidence²¹ indicates that international partners and collaborations are not fully exploited, except for the role of international actors as a source of data and information. There is paucity of information in the methodology. Further work will be necessary to adequately uncover the international partnerships and collaborations.



DEVELOP VISION, GOALS AND TARGETS

GO-SPIN promotes the development of STI policy instruments as a means to improve the effectiveness of STI policies, which are key to achieving the SDGs. Against this backdrop, the goal is for GO-SPIN to act as a monitoring tool for explicit STI policies. As a methodology for roadmapping, GO-SPIN compiles data, information and evidence on STI policies, national STI ecosystems and relevant organisations, legal frameworks, policy instruments and indicators. Alongside the capacity strengthening activities, the data and information gathered on national STI policies and ecosystems provides a strong basis for evidence-based policy analyses and for improving knowledge and understanding of the impact of STI policies on SDGs.



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

Stakeholder involvement and dialogue is not explicitly expressed as an essential pillar of the GO-SPIN framework, possibly because the methodology is primarily operationalised by UNESCO, in partnership with national actors. Although dialogue with actors and stakeholders may not be essential to the delivery of the methodology, except for actors providing data in the form of survey responses, the GO-SPIN methodology recognises the role of: (1) interest groups (including statistics offices, parliamentary groups, brokers, INGOs, NGOs) and (2) individuals (decision-makers, intermediate users, researchers and the general public). These groups of stakeholders discuss and review the GO-SPIN results and outputs and, based on their assessment, decide on what next steps to take – that is, the implementation of the outcome of the GO-SPIN comprehensive country profile, which might be a roadmap or foresight exercise. Therefore, the impact of the GO-SPIN exercise depends on the extent to which the country/stakeholders are able and willing to implement the results. Stakeholder engagement is therefore essential to the GO-SPIN approach.

²⁰ Include political, social, educational and economic.

²¹ See, for example, UNESCO, 2011, 2013 and 2014, and additional sources available at: <https://en.unesco.org/go-spin>.



ASSESS ALTERNATIVE PATHWAYS

The GO-SPIN methodology starts with an expression of interest by a country, based on specific development needs or an envisioned future. The data that informs the expression of interest can be gathered through foresight studies, future studies or similar exercises including workshops, consultations, stakeholder engagement sessions, expert panels, system analysis, agent modelling, scenario building and impact analysis. It is also possible that the activities involved in achieving the GO-SPIN methodology can result in the collection of relevant data, information and evidence on alternative pathways or the gathering of evidence that can inform alternative pathways to sustainable development.



DEVELOP DETAILED STI FOR SDGs ROADMAPS DOCUMENT

■ Operationalisation

As stated above, the expression of interest by a country triggers the GO-SPIN process. This leads to the compilation of a national inventory of the country's science, research and innovation system. The process involves UNESCO sending out a survey to the country for completion. In partnership with UNESCO, the country builds a narrative, description and analysis of the components of its science system as described above. The output, country profile²², is shared online via an open-access database managed by UNESCO. The country profile is also published in book form. Regular updates of the country profile help to ensure that it serves as a monitoring tool, thereby supporting improvements in research, STI, governance and capacity strengthening.

■ Policy mix

The GO-SPIN methodology places strong emphasis on the need for policy instruments, for example laws, competitive grants and public subsidies, in order for policies to be effective. However, it does not develop or prescribe a policy mix/instruments for countries. Rather, it analyses existing or operational policy instruments and 'provides standard setting instruments²³' as guidelines that countries might adopt. However, the methodology has been adjusted in order to provide guidelines and advice for the development of policy instruments and resultant policy mix.

■ Financial tools

The GO-SPIN framework provides examples of financial (such as R&D tax credits, loans and interest rates) and fiscal (such as taxation, exchange rates and exchange controls) instruments. The mapping exercise helps to reveal the financial tools and to what extent they are operational. Initially, the task of the design and/or selection and implementation of the financial instruments (or tool) for use by a country remained the responsibility of the country, but the most recent country support was also provided in terms of designing key policy instruments.

■ Implementation (execution)

Implementation is carried out at two levels: by UNESCO and by a designated agency at country level.

²² For Country Profiles, see: <https://en.unesco.org/go-spin/country-profiles>. Eight volumes of country profiles have been published; the next two volumes will be published by May 2020.

²³ https://en.unesco.org/sites/default/files/gospin_platform_presentation.pdf

At country level, individuals (or stakeholders) complete the national surveys, which are combined with government reports, statistical data from the country and other data from international sources. It is essential that key individuals who are knowledgeable in the subject areas of STI are selected to complete the surveys. The process is managed by UNESCO (headquarters and field offices) in conjunction with the responsible national agency.

- Governance

The GO-SPIN framework recognises the importance of governance. The guideline states that governance requires coordination, which should operate at various levels – national, regional, local and international. With UNESCO leading the operationalisation of GO-SPIN, governance at the barest minimum thereby operates at two levels – international and national government.



MONITOR, EVALUATE AND UPDATE PLAN

- Monitoring

As stated above, the country profile, which is updated on a regular basis, helps UNESCO and the country to monitor progress. The monitoring of progress supports improvements in research, STI, governance and capacity strengthening.

- Evaluation and revision of the Roadmap

As determined by UNESCO and the participating country, not explicitly addressed in the methodology guideline.

- Knowledge management and learning

GO-SPIN provides an online, open-access platform that interested parties – policy makers, individuals, decision-makers, information and knowledge-brokers, researchers and educators, mass media and the general public – can access and obtain useful information on SETI policies.

- **Access GO-SPIN platform** – this open-access platform offers an innovative database with graphics and analytical tools for use by interested parties and stakeholders.
- **Country profiles** – which represent a comprehensive study of all the GO-SPIN STI policies by UNESCO and published in the online series of ‘Mapping Research and Innovation’.
- Website - <https://en.unesco.org/go-spin>.
- **Training and resources** – workshops and relevant materials.

2.2.5. STRATEGIC INDUSTRIAL INTELLIGENCE AND GOVERNANCE (SIIG) - UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)



DEFINE OBJECTIVES AND SCOPE

The STI component of industrial policy (IP) is one of the drivers of inclusive and sustainable industrial development (ISID), as promoted by the United Nations Industrial Development Organization (UNIDO). ISID advocates industrial development balancing social inclusion, economic competitiveness and environmental protection (UNIDO, 2019, p. 7)²⁴. If well-planned and implemented, STI can play a vital role in achieving the SDGs. Less developed countries face challenges in terms of weak institutional capacity, lack of information and poor interconnectedness between innovation actors. UNIDO seeks to address these weaknesses by providing capacity building, access to diagnostics and support with the development of an industrial strategy. As part of the SIIG programme, UNIDO and the German development cooperation (GIZ) developed the 'EQuIP - Enhancing the Quality of Industrial Policy' toolkit. The EQuIP diagnostic toolbox, together with the accompanying training and capacity building package, aims to support industrial policy practitioners to undertake a thorough industrial diagnosis and to design evidence-based strategies for ISID. It aims at the development of tailor-made, context-specific industrial policies with a strong STI component. More information on EQuIP is available at: <http://www.equip-project.org/>.



ASSESS CURRENT SITUATION

■ Current situation and mandates

Governments first decide upon the development goal(s) they wish to address. These may include increasing diversification in terms of product or market or both, improving domestic competition, enhancing export performance, etc. (United Nations Industrial Development Organization and Deutsche Gesellschaft für Internationale Zusammenarbeit, 2017, p. 16).²⁵ EQuIP provides policy makers with a set of analytical tools to help them consider industrial policies supportive of strategies to achieve their desired goals. The analysis of existing development plans and strategies and their links with industrial policies leads to the identification of possible bottlenecks, complementarities and areas of strengths where a new/updated IP can play a significant role and deliver on ISID. At times, however, policy objectives can be in conflict or contrast with other objectives. Through different diagnostic activities, and with the help of pertinent EQuIP and other UNIDO tools, UNIDO supports counterparts by navigating the technical and often political process underpinning the identification of options to support the structural transformation of their manufacturing sector, taking into consideration social inclusiveness and the environment. EQuIP offers tools to integrate into the analysis considerations around productive

²⁴ UNIDO (2019), Programme for Country Partnership – Accelerating Inclusive and Sustainable Industrial Development. Available at: <https://www.unido.org/sites/default/files/files/2020-01/Programme%20for%20Country%20Partnership%202019%20October.pdf>

²⁵ United Nations Industrial Development Organisation and Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GMBH (2017), EQuIP: Enhancing the Quality of Industrial Policies – Designing a transformative industrial policy package, v.1.0, May 2017. Available at <http://www.equip-project.org/wp-content/uploads/2017/09/E-Industrial-Policy-Design-July-2017.pdf>

activities, global market integration, productive employment, inclusive production, resilient economies and environmental aspects.

- Data and evidence for STI Roadmaps

The in-depth analysis and diagnosis of local and global industrial aspects serve as a starting point. These quantitative and qualitative analyses help to better understand a country's assets, capacities, opportunities, threats and bottlenecks, and result in a complete industrial diagnosis. EQUiP offers a tool for governments to explore and assess various performance indicators including export, employment and investments that help to identify where the country stands in terms of productivity and competitiveness. It also considers barriers to trade, education and human capital, climate change, material efficiency (greener industry), energy sufficiency, social and gender equality, poverty alleviation, global value chains, the impact of the Fourth Industrial Revolution as well as industrial organisation and firm profiling.

- International partnerships and collaboration

International partnerships play an important role in terms of connecting national governments with international experts. As part of the work of the SIIG, there are opportunities for UNIDO and the counterpart country to engage in South-South collaboration through field visits and other activities that facilitate knowledge exchanges as part of the IP review or at the stage of designing a new policy. While the two approaches operate independently from one another, the SIIG is also part of a suit of interventions offered through UNIDO's Programme for Country Partnership (PCP) launched to help countries achieve SDG 9. It focuses in particular on multidisciplinary technical assistance, the stimulation of multi-stakeholder partnerships and leverage of public and private investments. More information on the PCP is available at: <https://www.unido.org/programme-country-partnership>



DEVELOP VISION, GOALS AND TARGETS

UNIDO supports governments in developing strategic industrial policies and realistically-costed action plans to guide resources allocation, priority-setting and implementation plans to drive structural transformation. It does so by strengthening the in-house capacities of governments to design, manage and implement industrial policies in an effective manner.



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

Stakeholder engagement is key to the development of IP that is transformative for society. They need to be involved throughout the entire IP policy cycle – from strategy formulation to implementation to M&E. They can be valuable sources of information and intelligence at the beginning of the policy cycle, while providing feedback on the implementation and results at the end of the cycle. UNIDO supports governments in designing policies using a highly participatory approach that facilitates multi-stakeholder engagement throughout the policy design process so that there is widespread buy-in and support for the industrial policies.



ASSESS ALTERNATIVE PATHWAYS

Different IP scenarios can be developed based on diagnostics. UNIDO puts an emphasis on the prioritisation and the strategic allocation of resources. However, governments remain responsible for the development of an action plan that fits each country's available budget and resources.



DEVELOP DETAILED STI FOR SDGs ROADMAPS DOCUMENT

- Operationalisation

Based on in-depth diagnosis and scope definition, each country takes full responsibility for the operationalisation and implementation of the strategy. In order to implement the strategy it needs to be fully endorsed by all relevant national authorities and developed and implemented in collaboration with technical teams (e.g. development agencies). It is each country's responsibility to operationalise the scope of the Roadmap through processes such as diversification, increased export and technological content of exports, increased employment, enhanced technology complexity, improved well-being and a focus on a circular economy. Each country Roadmap includes specific programmes and actions with budgets, non-financial resources, target groups, indicators, means of verification and governance (implementation bodies).

- Policy mix

EQuIP offers examples of IP instruments that may be considered for each policy intervention area with the intention to inform policy makers' exploration of more concrete means of implementation.

- Financial tools

Examples of existing financial tools are included in the parts/modules dedicated to policy instruments.

- Implementation (execution)

Implementation and governance are not in UNIDO's mandate. These are competences of the national governments. It should be possible, however, particularly through PCPs, to conduct follow-up activities by drawing on UNIDO's extensive portfolio of technical cooperation expertise and programmes.



MONITOR, EVALUATE AND UPDATE PLAN

- Monitoring

Monitoring is important and is included in the EQuIP project together with evaluation (M&E). The project offers a battery of indicators that can assist countries in following up on the progress of interventions intended to address drivers and barriers to competitiveness, diversification and other indicators dependent on the policy goals selected by governments.

- Evaluation and revision of the Roadmap

Monitoring and evaluation stages (M&E) complete the entire IP cycle and they are important steps towards a better understanding of the efficiency and impact of a policy. M&E informs policy makers about the appropriateness of the adopted policy instruments and the implementation process. It helps

to identify insufficient and incoherent policy actions that could lead to unwanted outcomes. Performance indicators and the calculation of baseline values are predominantly defined at the beginning of the cycle to ensure the appropriateness of the intervention logic, collection of data and evaluation method.

- Knowledge management and learning

EQuIP methodology, tools, diagnostics and reports are available online on the UNIDO's webpages:

- *The EQuIP Project*
- repository of *industry reports* under the policy advisory services.

2.2.6. TRANSFORMATIVE INNOVATION POLICY (TIP) – TRANSFORMATIVE INNOVATION POLICY CONSORTIUM (TIPC)



DEFINE OBJECTIVES AND SCOPE

The defining rationale of Transformative Innovation Policy (TIP) by the Transformative Innovation Policy Consortium (TIPC), a global network of research and innovation policy spread across the world, is based on the notion of a world in transition. The objective of the TIP approach is to ensure that innovation policies address social and environmental challenges, alongside economic objectives; focus on transformative (i.e. systems) change; and address directionality. TIP advocates transitions in multiple socio-technical systems, arguing that changes at sector level would be inadequate in addressing the pressing challenges that the world faces or in achieving the SDGs. The defining rationale of the TIP approach is the need to fix transformational system failures. The argument is that investments in science and R&D and regulations (Frame 1), and strengthening innovation systems (Frame 2), will not necessarily address the pressing development, social and environmental challenges that the world faces, as articulated in the SDGs. A move to transformative change (Frame 3) is needed (Schot and Steinmueller, 2018). More information on the TIPC and the TIP approach is available at: <http://www.tipconsortium.net/>.



ASSESS CURRENT SITUATION

- Current situation and mandates

The TIP approach is driven by SDG concerns and the global focus on societal goals (impacts). The criteria for transformation as defined by this approach include the need to address directionality, a focus on societal goals, systems-level impacts from STI and inclusion. Inclusion in this sense argues that policy-making and priority-setting must include grassroots communities and innovators alongside main actors, such as the government, industry and academia. The dominant theoretical frameworks that guide TIP are Strategic Niche Management (SNM) and Sustainability Transitions. Challenges are mapped by focusing on the socio-technical systems. Similarly, potentials and opportunities for transformation are assessed in line with the ability to initiate, accelerate and manage niches (based on SNM thinking) with the possibility to disrupt incumbents.

■ Data and evidence for STI Roadmaps

Data and evidence of TIP are collected via mixed methods involving secondary (review of literature and analysis of policy documents) and primary (interviews, focus groups and workshops). The workshops with stakeholders are used to construct transformative innovation (policy) learning histories (TILH). Use of the TILH methodology helps to ensure that although the case studies in the portfolio may be diverse, there is value in comparing the various transformative innovation attempts in different countries with a view to the formulation and implementation of Frame 3 policy and innovation approaches. The transformative innovation policy approach has been used across the world (Daniels et al., 2020), including in four African countries. The TIP insights from African countries case studies – Ghana, Kenya, Senegal and South Africa – and results of the mapping exercise are articulated in Daniels et al. (2020) and Daniels and Ting (2019). Outcomes of other mapping exercises and case study reports (or TILHs) are available from the TIPC website at <http://www.tipconsortium.net/>.

■ International partnerships and collaboration

TIP research and policy engagements are deeply embedded in the notion that international partnerships and collaboration are essential to research, innovation and mutual learning. This is evidenced by the use of the consortium approach which brings together researchers and policy makers from 12 countries across the globe: <http://www.tipconsortium.net/members-and-associates/>. In addition to the research and policy activities conducted in each of the member countries, each year TIPC organises a conference that helps to progress the research agenda and provide a platform for mutual learning. In 2018, for example, TIPC instigated an inter-network dialogue, represented by four research networks: *EU-SPRI* (European Forum for Studies of Policies for Research and Innovation), *Globelics*, Sustainability Transitions Research Network (*STRN*) and *TIPC*. The inter-network research dialogue is a unique space for engagement between academics, research funders and policy makers.

DEVELOP VISION, GOALS AND TARGETS

The TIP approach groups STI or innovation policy into three frames. According to this approach, Frame 1 (R&D & Regulation), which was dominant from the 1960s to 1980s, is focused on addressing market failures. Frame 2 (National Systems of Innovation and Entrepreneurship), dominant from the 1990s to the present day, focused on addressing systems failures. Frame 3 (Transformative Change), which is still emerging, focuses on addressing social and environmental needs failure (such as inequality and climate change) as articulated in the UN's Agenda 2030 (Daniels et al., 2020; Schot and Steinmueller, 2018). The goal of the TIP approach is to change the narrative and focus STI policy on Frame 3 policy activities²⁶ and instruments.

DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

Stakeholder involvement and engagement of a wide range of actors is one of the essential pillars of the

²⁶ These include: policy experimentation, for example, around the creation, acceleration and scale-up of niches and socio-technical transitions; fostering grassroots, social, inclusive, and frugal; bridging science and engineering, with social sciences and humanities in the education system (Daniels et al., 2020; Schot and Steinmueller, 2018).

TIP approach. The assessment of transformative change in the TIP is based on six criteria, one of which is inclusion. TIP goes beyond the traditional actors of government, academic and industry engagement and ensures the involvement of actors such as research and innovation (R&I) funders. Grassroots innovations and local actors also form a central part of TIP mapping exercises. Active engagement is key. This necessitates the involvement of local actors, including grassroots innovators, informal economy actors, civil society and city actors and multiple government ministries.



ASSESS ALTERNATIVE PATHWAYS

The TIP approach, in line with Frame 3 thinking, acknowledges the use of foresight future studies and related studies as sources of data, information and evidence that can help support policy experimentation and ideas on alternative pathways to progress. Foresight activities can play multiple roles, including as a means to develop policy agenda/priorities that are bottom-up, and pluralise the selection process of development priorities in order to ensure that societal considerations are factored into the decision-making process, enhance coordination, develop consensus and improve communication.



DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT

- Operationalisation

An essential component of the TIP approach is policy experimentation. Experimentation implies less focus on policy formulation but rather more emphasis on policy implementation, which then informs formulation. Operationalising the shared vision and goals agreed at national level involves actors creating new or strengthening existing niches within protected spaces where different approaches (including, for example, different actor combinations and governance) to policy-making are explored via specific selected projects, programmes and Frame 3 policy instruments and policy activities (Daniels et al., 2020; Schot and Steinmueller, 2018). The operationalisation process starts with carefully selected national/societal challenges designed with large-scale stakeholder engagement and a commitment from the policy makers/government that are part of the research. Implementation of the TIP approach involves the selection of several development (socio-technical) challenges to focus on, with policy experimentation at the core of the process.

- Policy mix

Policy mix is developed by the TIP and the responsible national government policy makers and researchers. The TIP approach separates STI policy instruments/mix into three categories: STI policy instruments for Frame 1, STI policy instruments for Frame 2 and STI policy instruments for Frame 3 policies. Frames 1, 2 and 3 coexist. However, the TIP methodology focuses on STI policy instruments for Frame 3 policies. Policy instruments and some examples of policy activities in TIP (Frame 3) relate to the ability to stimulate experimentation, accelerate socio-technical transitions, foster new institutional and governance arrangements that enhance coordination, address directionality, promote inclusive innovation and bridge STEM, social sciences and humanities in education systems.

- Financial tools

Although financial instruments are designed and implemented by the national government agencies, the

TIP approach emphasises the role of finance and funding institutions in addressing SDGs and societal challenges. Many of the TIPC member institutions are funding agencies at national level. Funders at regional level are also involved in the TIPC's work. Finance and funders are viewed as key actors in fostering socio-technical transitions and systems change, and essential for achieving the SDGs. Funding for the mapping is borne by the national agency. In cases where this is not feasible, different funding sources and streams exist to support in-country TIP work. The TIPC advocates domestic funding where possible but, if not, supports countries in seeking external funding to implement their mapping exercises. This is important for countries in low- and middle-income countries where resources might be scarce.

■ Implementation (execution)

Implementation of TIP methodology is carried out by the TIPC team in conjunction with the relevant country government agencies and designated by the national government and researchers. The implementation process is coordinated by the TIPC. It involves a clear division of responsibilities between the TIPC team, which carries out the core research components, while the national agencies, ministries, other public bodies and research teams focus on in-country activities, with support from the TIPC core. As discussed above, experimentation, learning and space for reflexivity are essential components of the implementation process.

■ Governance

The governance structure is based on all TIPC member countries represented in the governing board. This arrangement provides a management and administrative system that is truly inclusive and with the different countries operating on an equal status. Overall coordination is handled from the Science Policy Research Unit (SPRU) at the University of Sussex, UK, while government policy makers and researchers carry out the activities at national and regional level. The involvement of external stakeholders in the development of research agenda, mapping exercises, implementation and monitoring is achieved through policy engagement meetings, national and regional learning events, conferences, workshops and data collection activities.



MONITOR, EVALUATE AND UPDATE PLAN

■ Monitoring

The TIP approach prescribes real time monitoring and formative²⁷ evaluation (discussed further below). Monitoring is based on contextual and qualitative assessments that helps ensure that directionality concerns are addressed. In addition, monitoring exercises should help to address reflexivity failure. Where necessary, there may be the need to strengthen the capacity of national agencies to monitor and engage with a broad range of actors as required in the TIP approach. Furthermore, effective coordination and governance processes – that involve bottom-up and top-down approaches – for transformative change are essential.

■ Evaluation and revision of the Roadmap

Evaluation is central to the TIP methodology, alongside research, experimentation and implementation.

²⁷ Kerr, R. and Giachi, S. (2018), *A formative approach for Transformative Innovation Policy*. Available at: <http://www.tipconsortium.net/a-formative-approach-for-transformative-innovation-policy-evaluation/>

The TIP methodology is premised on the argument that Frames 1 and 2 are inadequate to address the pressing societal challenges facing the world, as articulated in the SDGs. As a result, the introduction of the notion of Frame 3 therefore necessitates active and on-going evaluation to ensure that it truly addresses the gaps identified in Frames 1 and 2, thereby fulfilling the objectives of the TIP/Frame 3 approach.

The TIP approach adopts a formative approach to evaluation, which focuses on improving policy-making by involving relevant policy stakeholders in the evaluation process. To achieve this objective, it is necessary to develop specific capabilities in the relevant implementing agencies at national level in collaboration with the TIPC core team. An important aspect of the TIP formative evaluation process is the integration of evaluation with capacity building, policy experimentation, research, reflexivity and deep (or second order) learning. In this approach, evaluation can be conducted at project, policy or programme level. Finally, the evaluation process adopts a Theory of Change approach underpinned by the socio-technical transitions theory.

- Knowledge management and learning
- Knowledge management takes place at various levels – TIPC/global, regional and national.
- The *Transformative Innovation Policy (TIP) in Action* – a repository of projects, country cases studies and activities.
- *Publications* – conference reports, journal papers, research briefs, policy briefs, blogs.
- *Resources for policy makers*
- *TIP and the SDGs*
- *TIP in Africa*
- *Training and Capacity Building in TIP Policy Engagement Events and Past Conferences*
Website – <http://www.tipconsortium.net/>

2.2.7. PUBLIC EXPENDITURE REVIEWS IN SCIENCE, TECHNOLOGY AND INNOVATION – WORLD BANK



DEFINE OBJECTIVES AND SCOPE

The World Bank (WB) Public Expenditure Reviews (PERs) in Science, Technology and Innovation (STI), PERs in STI for short, are driven by the overarching rationale that developing countries (DCs) are not fully harnessing the potentially high returns from innovation and entrepreneurship. The argument is that in DCs, if properly mobilised, STI can help accelerate economic growth. The WB approach recognises that policy makers in DCs are ‘increasingly aware of this untapped potential’ (WB, 2014²⁸). And that one way countries are trying to harness this untapped potential is to increase investment in STI, or, more specifically, investments in R&D funding and innovation. In spite of the efforts to increase public spending in

28 Public Expenditure Reviews in Science, Technology and Innovation – A Guidance Note, *Foreword*, p. 9. Available at: <http://documents.worldbank.org/curated/en/561851468165876446/pdf/93076-REPLACEMENT-Public-Expenditure-Reviews-in-Science-Technology-and-Innovation.pdf>

STI, ‘few governments can answer with confidence basic questions such as how much is spent on STI, by whom, and to what end²⁹’; hence, the ability of (developing) countries to verify or assess the impacts of STI investments on economic development, sustainable development (SD) and policies remains weak. Against this background, the WB PERs in STI aim to help governments assess the quality, efficiency and effectiveness of public spending on STI, and support policy formulation and implementation. This WB methodology is designed to take a close look at how consistently the country’s policy mix³⁰ responds to the identified developmental challenges.³¹ The PERs in STI methodology does not focus on SD challenge identification, but rather evaluates the extent to which investments in national innovation system and development (economic growth/innovation) policies are consistent with priorities already set by national governments. In this process, it pays particular attention to business innovation: the introduction of new products, services, or adoption of new processes by firms, regardless of whether these occur as a result of formal R&D activities or in collaboration with research institutions and universities. Detailed information on the methodology can be found at: World Bank Documents and Reports, PERs in STI: A Guidance Note.



ASSESS CURRENT SITUATION

■ Current situation and mandates

The WB uses its PER methodology to understand how governments can improve the quality of STI spending or how they can improve the impact (contribution) of STI expenditures on economic development.

The PERs in STI are based on a logical framework, using the input-output-outcome-impact (IOOI) model, which decomposes the process between policy intervention (‘inputs’) and the high-level policy goals (‘impact’). The PER in the STI approach seeks to establish a link between the policy ‘inputs’ (e.g. public spending in the enterprise sector and public research organisations (PROs)) and the overall policy ‘impact’ (e.g. improved productivity, competitiveness and economic growth via innovation and new/better products/services) by identifying ‘intermediate outcomes’³² (events that are immediate prerequisites for impact – second-order effects) and ‘outputs’³³ (results derived directly from the intervention that may or may not contribute to the intermediate outcome – first-order effects).

29 *Ibid.*

30 *Policy mix is defined as the combination of policy instruments that interact to influence the quantity and quality of STI investments in the public and private sectors.*

31 *In conducting STI PER, the WB assumes that STI policy priorities reflect a country’s developmental challenges (i.e. technical opportunities) and policy makers’ policy aspirations.*

32 *Examples of immediate outcomes include the following:*

- non-R&D based innovation, technology adoption and diffusion: *quality certification for computer use by firms;*
- business R&D and R&D-based innovation: *IPs licensed; survival of knowledge-based start-ups; number of firms with new product and ISO certification;*
- expenditure for technology transfer and science-industry collaboration: *number of spinoff companies; revenues from services provided to market;*
- Research Excellence: *numbers of publications/co-publications; citation impact.*

33 *Examples of outputs include the following:*

- outputs from programmes in the enterprise sector: *number and value of knowledge-based start-ups; share of company investment; value of disbursement and number of firms;*
- outputs from programmes and other spending in Public Research Organisations (PROs): *number of projects funded, completed and collaborated with the private sector.*

The WB PER in STI is carried out in four stages. The first two are primarily concerned with ‘inputs’: 1) quality of the policy mix and 2) functional analysis. At the end of the first stage, the client government has a profile of its spending for STI programmes and an assessment of consistency and coherence of the policy mix in relation to the country’s needs and demand for innovation policy or business support policies more generally. The second stage, functional and governance analysis, assesses the quality of the design and implementation of STI programmes and the inter-institutional integration of policies, highlighting gaps and areas for improvement to achieve good practices. In the third stage, efficiency analysis, programme budgets are analysed to understand the cost structure of various instruments and the efficiency with which inputs (budgets) are translated into outputs (patents, new products, etc.). In the final effectiveness stage, programme impact is assessed using impact evaluation methodologies. Based on the results in the different stages of the analysis, the WB provides a set of specific recommendations to address identified gaps, improve the quality, coordination, efficiency and impact of programmes, and build institutional capacity for evidence-based policy-making in the area of STI.

■ Data and evidence for STI Roadmaps

Through PERs in STI, data and information are consolidated to create a map of the outputs, outcomes and the developmental impact of public expenditures on STI, with a particular focus on instruments that support business innovation (e.g. grants, vouchers, loans, tax incentives, technology extension, open innovation, etc.). The gathering of data, information and evidence for the PERs in STI follows a mixed methods approach that combines primary data sources (surveys, interviews and focus groups) and secondary sources of data (policy records and data sets). Analyses of data gathered focus on three main sources of deficiencies: (i) programme design/implementation, (ii) institutional conditions and (iii) the composition/level of public expenditure.

■ International partnerships and collaboration

The role of international partnerships in operationalising the PERs in STI methodology is not explicitly stated. However, cooperation and contribution to data source(s) by partners is explicitly outlined. For example, the guidance notes articulate the role of partners such as the OECD, UN COMTRADE and UNESCO UIS as data sources that contribute to the wealth of the micro and macro data that constitute the WB database³⁴. Furthermore, the PERs in STI methodology recognise sources such as UNCTAD’s STIP Reviews, ERAWATCH and INNOTREND Country Reports as useful sources of information that help inform the PERs in STI exercise.



DEVELOP VISION, GOALS AND TARGETS

The WB PERs in STI methodology may be used to help countries set specific targets through a detailed country needs assessment. Typically, the assessment includes a relative comparison (benchmark) of the country’s performance (outcomes)³⁵ and National Innovation System (NIS)³⁶ vis-à-vis regional/structural

³⁴ Available at: <https://data.worldbank.org/topic/science-and-technology>

³⁵ Examples include productivity growth, export performance, competitiveness indicators and diversification measures.

³⁶ Examples includes universities and PROs (Top 500 universities, publications in the top journals), R&D and innovation in firms (trademarks, Top 500 Corporate R&D investors), network clusters and transfers (industry-financed public R&D expenditures, patents fielded by universities and public labs, international co-authorships, international co-patenting), skills for innovation (doctoral graduation rate in science and engineering, ease of entrepreneurship index).

peer countries. These metrics can help establish the baseline and new targets before implementing an STI for SDGs Roadmap.



DIALOGUE AND CONSULTATION WITH STAKEHOLDERS

Stakeholders involved or consulted include the government (policy makers); implementing bodies and beneficiaries (e.g. public research institutions, higher education institutions, industry associations and firms, including start-ups); actors with access to data; and individuals (e.g. beneficiaries of public spending on STI). The WB PERs in STI methodology recognise the importance of stakeholders in at least three important stages: source of quality information, implementation and M&E. The role of stakeholders as a source of quality data was discussed above, under international partnerships and collaboration. With respect to implementation, for example, the role of government officials in communicating the process and outputs to the public, in addition to facilitating access to the PERs in STI outputs, is key. M&E on the other hand requires transparency, which calls for participation from stakeholders and beneficiaries alike, for example in the provision of, or access to, relevant data and information to support the exercise and M&E. Other relevant stakeholders recognised include regional and local authorities, parliaments and citizens.



ASSESS ALTERNATIVE PATHWAYS

To examine the quality of the policy mix, WB's PERs in STI: 1) evaluate the coherence between the country's strategic priorities and the composition of the portfolio of instruments (policy mix); and 2) assess the internal consistency of policy instruments in terms of resource allocation – size, scale effects and redundancies, and the alignment between policy objectives/outcomes departments' mandates, instruments used and types of beneficiaries. The results often reveal an incoherent (i.e. insufficient/volatile) allocation of funding to policy targets/goals, skewed resource allocation for innovation policy, a failure to directly address market failures and significant duplicity and programme overlap across different agencies. The WB task team then discusses with the client country the appropriate options, including the pros and cons of various policy instruments.



DEVELOP DETAILED STI FOR SDGs ROADMAPS DOCUMENT

- Operationalisation

Countries can put together a plan (or 'STI for SDGs Roadmap') based on specific recommendations provided by the WB team, as WB PERs in STI assist countries in improving their capacity and the quality of their STI policies. PER recommendations help countries reform their policy mix by withdrawing some programmes and introducing others, consolidating budgets, improving the flow of information across agencies and introducing key results metrics in the process of allocating budget to STI programmes.

- Policy mix

As mentioned earlier, an analysis of the policy mix is the first step in the WB PERs in STI. The assessment of the quality of the policy mix compares the STI policy priorities with the set of policy instruments currently in use. Three components of the first stage of analysis are: 1) country needs assessments; 2)

the composition of the policy mix; and 3) the coherence and consistency analysis. A sample (if not all) of identified policy instruments goes through a functional analysis, which evaluates the three main dimensions in public management: design, implementation and inter-institutional integration. The outcome of the PERs in STI exercise is a set of measures and recommendations for the country to implement. The measures combine ‘institutional reforms with changes in the policy mix (the composition and level of public spending) and strategic investments’ (WB, 2014, p. 19).

■ Financial tools

Financial tools and the approach for financing the WB PERs in STI can be designed/implemented by the responsible line ministry, e.g. Ministry of Development, Economy, Industry/Trade, Education or STI, in coordination with the finance ministry or central supervisory authority as the main counterpart of the WB. A PER is conducted as part of the WB’s Advisory Services and Analytics (ASA) product, often financed by the WB’s donor funding (such as through a trust fund) but could be requested and paid for by the client countries (i.e. in the form of Reimbursable Advisory Services (RAS)) and/or the WB’s administrative budget.

■ Implementation (execution)

The output from the WB’s PER in STI is a set of recommended measures for the country to implement, focusing on institutional reforms, proposed changes to the policy mix and improvements in the design and implementation of individual programmes. Based on the recommendations, countries assisted by the WB generally embark on:

- the consolidation and/or withdrawal of poorly performing programmes and instruments;
- the introduction of new policy instruments, consistent with national development priorities;
- the alignment of the design and implementation of policy instruments with global good practice through knowledge transfer and capacity building;
- improvements in the budgeting, monitoring and evaluating of STI policy instruments, including improved reporting of line ministries to the Ministries of Finance or Planning, collection of data on programme inputs and outputs (including surveys of beneficiaries).

These efforts can be supported by the WB through its development policy or investment policy lending, through its trust fund resources or by other development agencies.

■ Governance

Governance in the WB PERs in STI methodology features at least two dimensions: governance of the PER process, which is overseen by the WB; and governance as a section of work in the PER assessment, with a specific chapter of the final report dedicated to it.



MONITOR, EVALUATE AND UPDATE PLAN

■ Monitoring

As discussed above, evaluation is a core component of this methodology. WB PERs in STI emphasise the importance of continued learning and the adaptation of STI policies and programmes through the frequent collection of data from beneficiaries, monitoring the efficiency of spending and ensuring that the policy mix continues to correspond with the national development priorities.

- Evaluation and revision of the STI roadmap

As discussed above, the evaluation is well addressed under this methodology. Meanwhile, the WB assesses and therefore encourages that relevant programmes have a formal system to adopt lessons and learning to make programmes more efficient.

- Knowledge management and learning

The World Bank has developed various platforms for knowledge management. They include:

- *WB Website - <https://www.worldbank.org/>*
- *The World Bank's S&T Databases*
- *PERs in STI Guidance Note.*

The WB has conducted PERs in STI/SMEs in nearly twenty countries, and some of the reports, such as the following, are available in the WB Open Knowledge Repository or on client governments' websites. The WB is also in the process of preparing a synthesis note which collects findings from various PERs and extracts cross-country lessons.

- *Chile - Public Expenditure Review (English), Chapter 4, Innovation and Entrepreneurship*
- *Philippines: Assessing the Effectiveness of MSME and Entrepreneurship Support*
- *Ukraine - Science, technology and innovation public expenditure analysis*
- *Colombia: Análisis Funcional y de Gobernanza del Gasto Público en Ciencia, Tecnología e Innovación en Colombia*
- *Croatia Public Expenditure Review in Science, Technology and Innovation: Analysis of the Quality and Coherence of the Policy Mix*
- *Czech Republic: Assessment of the SME Policy Mix*
- *Return on Investment of Public Support to SMEs and Innovation in Poland*
- *Ukraine - Science, technology, and innovation public expenditure analysis*

2.2.8. OTHER METHODOLOGIES

In this section, we briefly describe some other methodologies that have been developed and in some cases also operationalised and tested in real environments. Again, we would like to stress that the list is not exhaustive, and that other methodologies exist that we have not analysed in this paper due to limitations that include space and time. Some of the methodologies that are not covered by this background paper have been developed by local or national authorities with the objective of defining their own development and innovation pathways and associated tools. Others were designed, tested and deployed by international institutions.

Among the methodologies deployed by the United Nations is UN Technology Innovation Labs, a platform proposed and managed by the UN Office of Information and Communications Technology (OICT)³⁷. The platform proposes a number of licensing frameworks and models in areas of artificial intelligence, blockchain, internet of things, machine learning, fintech, peace and security, development, human rights, international law and humanitarian affairs. The objective is to enable technology solutions to be transferable between the countries, within and across the ecosystems and between large varieties of actors.

The World Intellectual Property Organization (WIPO) of the United Nations set up the Technology and Innovation Support Centres with the objective to assist the R&I actors in developing countries and facilitate their access to technology information and Intellectual Property Rights (IPRs) services.³⁸ This specifically includes access to patent databases, training, awareness raising as well as the sharing of practices and experiences. In addition, WIPO has established a methodology for the development of national Intellectual Property (IP) strategies with a central focus on innovation and SDGs. WIPO thus assists countries in designing their national IP systems to strength-

en the national innovation ecosystem, to produce economically valuable IP assets and to achieve SDGs. This is completed through the national IP strategies and plans (NIPS) and supported by a methodology aimed at the identification of intersections between IP and STI policies. Similar to other methodologies, the dialogue and engagement of a large number of relevant stakeholders is strongly encouraged with the objective to create a well-functioning STI ecosystem and effective IP management and technology transfer.

The United Nations Environment Programme (UNEP) is leading Technology Needs Assessment (TNA)³⁹ that encompasses a number of actions aimed at developing countries. Specific support includes the assessment, identification and deployment of environmentally friendly technologies, as well as the development of Technology Action Plans (TAPs). TAPs identify climate change technology needs and capacities as well as available options in terms of technology transfer, market systems, diffusion and uptake. Eventually, the results of TNAs and TAPs contribute to the Nationally Determined Contributions (NDCs) under the United Nations Framework Convention on Climate Change (UNFCCC) and to the UN 2030 Agenda on Sustainable Development Goals. Furthermore, UNEP together with UNIDO run the Climate Technology Centre and Network⁴⁰ that provides technical assistance and capacity building in a large variety of technology sectors as well as related governance and financial planning.

The International Telecommunication Union (ITU) is the United Nations' agency for Information and Communication Technologies (ICT). The ITU conceptualised and implemented the ICT Centric Innovation Ecosystem Country Review with the objective to support countries in developing their roadmaps for digital transition. The concept of an ICT centric innovation ecosystem is central to the country reviews, and it refers to the notion of ICT being the driver of innovation. The country reviews

³⁷ <https://until.un.org>

³⁸ <https://www.wipo.int/tisc/en/>

³⁹ <https://tech-action.unepdtu.org>

⁴⁰ <https://www.ctc-n.org>

start with evidence collection and analytical work at the request of interested countries. The work is further complemented with evidence collected through the interactions with numerous stakeholders in the country. A multi-stakeholder approach is adopted to ensure a comprehensive and inclusive approach to the Roadmap development. On the basis of in-depth analysis and consultations with stakeholders, ITU prepares tailored-made, country-specific recommendations to underpin the transition to a digital economy, digital entrepreneurship and ICT-led innovation.

Another approach for the assessment of alternative pathways was proposed by the Global Sustainable Technology and Innovation Community Conference (G-STIC). G-STIC offers an annual gathering for policy makers, technology researchers, business and industry representatives as well as civil society. The objective is to discuss, explore and identify distributed technological solutions that can help achieve SDGs in an integrated manner.

Alternatively, the Innovation for Sustainable Development Network has proposed a comprehensive theoretical methodology for the development of STI for SDGs Roadmaps.⁴¹ The methodology was developed by a consortium of 13 international partners including universities and research and technology organisations within the context of an EU project funded by the EU research fund Horizon 2020. The proposed methodology includes a baseline analysis (present and past data) and future-oriented actions: definition of the vision, examination of alternative pathways and the action plan for the execution. Firstly, the definition of the vision comprises the analysis of trends and the definition of targets and milestones to achieve SDGs. Secondly, innovation and transition pathways include the exploration of key innovations and innovation pathways to achieve the targets as well as system conditions enabling and accelerating innovation (legislation, business environment, market rules and finance). Finally, the policy action plan is about the definition and deployment of pol-

icy instruments, governance, evaluation and policy learning as well as capacity building (Innovation for Sustainable Development Network, 2019, p. 18).⁴²

Finally, we would like to provide a short overview of approaches and studies that policy makers might find useful while working on different steps:

- **step 1** (Define objectives and scope): Global Sustainable Development Report 2019 from the Sustainable Development Goals Knowledge Platform⁴³, The World in 2050 initiative and reports (TWI2050)⁴⁴, United Nations Development Programme (UNDP's) Rapid Integrated Assessment⁴⁵;
- **step 2** (Assess current situation): Sustainable Development Solutions Network (SDSN) and the Bertelsmann Stiftung 2019 Interactive SDG Dashboards⁴⁶, OECD's Measuring Distance to the SDG Targets⁴⁷ and Policy Coherence for Sustainable Development 2018⁴⁸, UNESCO's STEM and Gender Advancement (SAGA)⁴⁹;
- **step 3** (Develop vision, goals and targets): UNCTAD's Strategic foresight for the post-2015 development agenda⁵⁰, Digital tools for

42 *Innovation for Sustainable Development Network, STI Policy Roadmap for SDGs, March 2019. Available at: <https://www.inno4sd.net>*

43 <https://sustainabledevelopment.un.org/gsd2019>

44 <https://iiasa.ac.at/web/home/research/twi/TWI2050.html>

45 <https://www.undp.org/content/undp/en/home/librarypage/sustainable-development-goals/rapid-integrated-assessment---mainstreaming-sdgs-into-national-a.html>

46 <https://www.sdgindex.org>

47 <https://www.oecd.org/sdd/measuring-distance-to-the-sdgs-targets.htm>

48 <http://www.oecd.org/about/sge/policy-coherence-for-sustainable-development-2018-9789264301061-en.htm>

49 <https://en.unesco.org/saga>

50 https://unctad.org/meetings/en/SessionalDocuments/ecn162015d3_en.pdf

41 <https://www.inno4sd.net>

foresight⁵¹, UNESCO's Transforming the Future: Anticipation in the 21st Century⁵², UNDP's Foresight Manual⁵³;

■ **step 4** (Assess alternative pathways): International Environmental Agency's (IEA) Energy Technology Roadmaps⁵⁴, Pathways for Prosperity Commission: Technology and Inclusive Development and its final report on the Digital Roadmap⁵⁵.

As this brief summary shows, each of these methodologies has its areas of focus, strengths and weaknesses. While some methodologies tend to emphasise IPRs or ICTs, others focus on technology or SDGs. In the concluding section that follows, we explain why these differences are important, outline the main insights from the review and how the choice of methodology depends on the needs and context specificities of a country or region.

51 <https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1910>

52 <https://unesdoc.unesco.org/ark:/48223/pf0000264644>

53 <https://www.undp.org/content/undp/en/home/librarypage/capacity-building/global-centre-for-public-service-excellence/ForesightManual2018.html>

54 <https://www.iea.org>

55 <https://pathwayscommission.bsg.ox.ac.uk/digital-roadmap>



3. Conclusions and main insights for policy makers

There is a growing global understanding of the need to consider development in all its dimensions, including economic, social and environmental aspects. Mobilising science, technology and innovation to achieve the development goals of territories allows governments to move faster and find new ways of solving complex problems and addressing challenges. Sustainable Development Goals are a framework allowing for the consideration of the interlinked aspects of any development and transformation process, but with 17 goals and 169 targets can be difficult to simultaneously channel into national or sub-national policies where administrative, financial and human resources are limited. This calls for evidence-informed choices and prioritisation, but also for the operationalisation of development plans in order to achieve faster progress.

The STI for SDGs Roadmaps are a useful tool that should help achieve the national or subnational level priorities through the mobilisation of a knowledge base, creativity and a wide range of stakeholders. The STI policy stops being a silo but is mobilised to answer the key challenges faced by different communities. This background paper presents a number of methodologies that can be used for the roadmap development, depending on the specific needs of each territory. The STI roadmaps must be integrated into a broader landscape of other existing policies, including the development plans and STI strategies that are already adopted. The step-by-step approach used in this paper and the United Nation's Guidebook for the Preparation of Science, Technology and Innovation (STI) for SDGs Roadmaps is designed to facilitate practical choices of national and subnational authorities interested in developing STI for SDGs Roadmaps.

Depending on the policies already existing and the specific needs, a country might look for a more systemic and comprehensive approach where the roadmap covers the socio-economic and environmental aspects and their interlinkages, and where an all-of-government approach and the mobilisation of actors/resources are needed. In

such a case, following the entire roadmapping process described by the 6-step logic used in this paper will be most useful. In other cases, the STI roadmaps or strategies already exist but a specific issue, such as the effectiveness of STI policy instruments or the entire STI policy might need special attention – here the STI-focused methodologies will be of special use. Finally, there may be a need for deep-dives into specific topics and the mobilisation of STI for industrial, agricultural or other policy. The sectoral approaches will serve this best (see [Table 3](#)).

In this context, the ownership and agency by the interested authorities is essential, as they are the ones who need to make such choices, which are limited not only to the type of the roadmap but also to the process itself. The roadmap development process needs to be adapted to the state of play too. If an in-depth analysis of an STI potential was performed recently, perhaps there is a need to focus on the stakeholder dialogue or implementation means. The methodologies described in this paper offer a choice of possible methods and approaches for each step of the roadmapping process.

Looking at the country experiences and the scope of available methodologies, the implementation stage and monitoring and evaluation of roadmaps seem to be a weaker point. As the roadmap development is a process engaging significant resources, it should be remembered that it is not a goal in itself. The transformative change can be brought about only through action and consequent implementation of evidence-informed choices. This will require further efforts from both the international organisations and the interested countries and subnational territories.

There is no place that can solve all the challenges by itself. The STI for SDGs Roadmaps should be developed and implemented in the context of a multilevel governance and partnership principle, where international partners and expertise might be mobilised to support the roadmapping process at different stages. This is particularly important

Table

3

Matrix of steps and methodologies for the STI for SDGs Roadmaps

METHODOLOGICAL STEPS			
	Focus on STI policy	Focus on SECTORAL POLICY	Focus on SOCIAL, ECONOMIC AND ENVIRONMENTAL CHALLENGES
DEFINE OBJECTIVES AND SCOPE			
ASSESS CURRENT SITUATION	<ul style="list-style-type: none"> ■ STI POLICY REVIEWS (OECD) ■ GO-SPIN (UNESCO) ■ PERs in STI (WB) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
DEVELOP VISION, GOALS AND TARGETS			<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
DIALOGUE AND CONSULTATION WITH STAKEHOLDERS	<ul style="list-style-type: none"> ■ STI POLICY REVIEWS (OECD) ■ GO-SPIN (UNESCO) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
ASSESS ALTERNATIVE PATHWAYS	G-STIC	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ STIP (UNCTAD)
DEVELOP DETAILED STI FOR SDGS ROADMAPS DOCUMENT			<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)
MONITOR, EVALUATE AND UPDATE PLAN	<ul style="list-style-type: none"> ■ GO-SPIN (UNESCO) ■ PERs in STI (WB) 	SIIG (UNIDO)	<ul style="list-style-type: none"> ■ SMART SPECIALISATION (EC) ■ STIP (UNCTAD) ■ TIP (TIPC)

as the overview of existing methodologies shows that none of the current approaches is fully comprehensive. A suggested way forward is to explore synergies and complementarities between the methodologies based on this background paper and set up collaborations between the international organisations and agencies. Thanks to the combination of different approaches, the capacity building effect and new collaborations between different organisations can bring additional benefits.

References

- Carayannis, E., Grebeniuk, A. and Meissner, D. (2016), 'Smart roadmapping for STI policy', *Technological Forecasting and Social Change*, Vol. 110, pp. 109-116.
- Daniels, C. and Ting, B. (2019), 'Transforming science, technology and innovation policies in Africa: Insights from Ghana, Kenya, Senegal and South Africa', *TIPC Policy Brief*, November 2019.
- Daniels, C., Schot, J., Chataway, J., Ramirez, M., Steinmueller, E. and Kanger, L. (2020), 'Transformative Innovation Policy: Insights from Colombia, Finland, Norway, South Africa and Sweden'. In: *Innovation policy at the intersection – Global debates and local experiences*, Cele, M. B. G., Luescher, T. M. and Fadji, A. W., HSRC Press.
- Foray, D., Goenaga, J. G. X., Landabaso, M. B., McCann, P., Morgan, K., Nauwelaers, C. and Ortega-Artilés, R. (2012), *Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3)*, Luxembourg, Publications Office of the European Union.
- Gianelle, C., Kyriakou, D., Cohen, C. and Przeor, M. (eds) (2016), *Implementing Smart Specialisation: A Handbook*, Brussels: European Commission, EUR 28053 EN, doi:10.2791/610394.
- Innovation for Sustainable Development Network, STI Policy Roadmap for SDGs, March 2019, <https://www.inno4sd.net>.
- Miedzinski, M., McDowall, W. A. S. and Fahnestock, J. (2018), *Paving the pathways towards sustainable future? A critical review of STI policy roadmaps as policy instruments enabling sustainability transitions*, International Sustainability Transitions Conference. Manchester.
- Miedzinski, M., Mazzucato, M. and Ekins, P. (2019a), 'A framework for mission-oriented innovation policy roadmapping for the SDGs', UCL Institute for Innovation and Public Purpose Working Paper (IIPP WP 2019-03). Access: <https://www.ucl.ac.uk/bartlett/public-purpose/wp2019-03>.
- Miedzinski, M., McDowall, W., Fahnestock, J., Muller, G. and Diaz Lopez, F. J. (2019b), *Science, technology and innovation policy roadmaps for the SDGs – A guide for design and implementation*, Inno4SD.net, Innovation for Sustainable Development Network.
- Moehrle, M. G., Isenmann, R. and Phaal R. (2013), *Technology Roadmapping for Strategy and Innovation*, Springer, New York.
- Phaal, R. and Muller, G. (2009), 'An Architectural Framework for Roadmapping Towards Visual Strategy', *Technological Forecasting and Social Change*, Vol. 76, pp. 39-49.
- Phaal, R., Farrukh, C. J. P. and Probert, D. R. (2004), 'Technology roadmapping – A planning framework for evolution and revolution', *Technological Forecasting and Social Change*, Vol. 71 (1-2), pp. 5-26.
- Phaal, R., Farrukh, C. J. P. and Probert, D. R. (2010), *Roadmapping for strategy and innovation – Aligning Technology and Markets in a Dynamic World*, Cambridge: University of Cambridge, Institute for Manufacturing.
- Schot, J. and Steinmueller, W. E. (2018), 'Three frames for innovation policy: R&D, systems of innovation and transformative change', *Research Policy*, Vol. 47, pp. 1554–1567.
- UNCTAD (2019), *A Framework for Science, Technology and Innovation Policy Reviews*. Available at: <https://unctad.org/en/pages/PublicationWebFlyer.aspx?publicationid=2450>
- UNESCO (2011), 'UNESCO 's Global Observatory on Science, Technology and Innovation Policy Instruments (GO-SPIN)' (Concept paper, 2011).
- UNESCO (2013), 'GO-SPIN: Towards better governance of STI'.

UNESCO (2014), *Proposed Standard Practice for Surveys on Science, Engineering, Technology and Innovation (SETI) Policy Instruments, SETI Governing Bodies, SETI Legal Framework and Policies*, Paris: UNESCO.

WB (2014), *Public Expenditure Reviews in Science, Technology, and Innovation – A Guidance Note* (English), Washington, DC: World Bank Group. <http://documents.worldbank.org/curated/en/561851468165876446/Public-expenditure-reviews-in-science-technology-and-innovation-a-guidance-note>

Yasunaga, Y., Watanabe, M. and Korenaga, M. (2009), 'Application of technology roadmaps to governmental innovation policy for promoting technology convergence', *Technological Forecasting and Social Change*, Vol. 76(1), pp. 61-79.

GETTING IN TOUCH WITH THE EU

IN PERSON

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

ON THE PHONE OR BY EMAIL

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: **00 800 6 7 8 9 10 11** (certain operators may charge for these calls),
- at the following standard number: **+32 22999696**, or
- by electronic mail via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

ONLINE

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU PUBLICATIONS

You can download or order free and priced EU publications from EU Bookshop at: <https://publications.europa.eu/en/publications>. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub
ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



EU Science, Research and Innovation



EU Science Hub

