Pre-STI Forum Final Draft, June 1

IATT Background Paper

Science, Technology and Innovation for SDGs Roadmaps

June 2018

United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs (IATT)'s Roadmaps Sub-Group, Programming and Analytics Cluster, conducted the study. Feedback to this paper may be directed to Naoto Kanehira (nkanehira@worldbank.org) and Wei Liu (liuw@un.org). Views expressed in this paper are of the authors and do not represent official positions of the United Nations, the World Bank Group or their Member States.

List of Abbreviations

AAAA	Addis Ababa Action Agenda
AU	African Union
EC JRC	European Commission Joint Research Centre
EGM	Expert Group Meeting
EU	European Union
HLPF	High Level Political Forum
IATT	United Nations Interagency Task Team on STI for the SDGs
ICSU	International Council for Science
INGSA	International Network for Government Science Advice
OECD	The Organization for Economic Co-operation and Development
SDGs	Sustainable Development Goals
STI	Science, Technology and Innovation
STI Forum	Multi-stakeholder Forum on Science, Technology and Innovation for the SDGs
TFM	Technology Facilitation Mechanism
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UN ECA	United Nations Economic Commission for Africa
UNECE	United Nations Economic Commission for Europe
UN ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UN ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UN ESCWA	United Nations Economic and Social Commission for Western Asia
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNIDO	United Nations Industrial Development Organization
VNR	Voluntary National Review
WBG	World Bank Group
WEF	World Economic Forum

Table of Contents

1. Introduction

1.1 Background

The 2030 Agenda, adopted at the United Nations Sustainable Development Summit in September 2015, positioned Science, Technology and Innovation (STI) as key means of implementation of the SDGs, and launched the UN Technology Facilitation Mechanism (TFM). The Annual Multi-stakeholder Forum for Science, Technology and Innovation (STI Forum), supported by the Inter-Agency Task Team on Science, Technology and Innovation for the SDGs (IATT), has been the main fora for TFM to discuss topics of common interests of Member States and STI stakeholders in context of the 2030 Agenda.

STI roadmaps and action plans have been among the key topics through the first two STI Forums. In the Addis Ababa Action Agenda, Member States had committed to "adopt science, technology and innovation strategies as integral elements of our national sustainable development strategies" (para 119). In the 2017 STI Forum, participants highlighted that *"… the STI roadmaps and action plans are needed at the subnational, national and global levels, and should include measures for tracking progress. These roadmaps incorporate processes that require feedback loops, evaluate what is working and not working, and produce continual revisions that create a real learning environment.*

With a view to produce action-oriented outcomes toward the third and fourth STI Forums in 2018/19, IATT established a workstream dedicated to support the discussions and initiatives on STI Roadmaps. The objective of the workstream is to outline an inter-sessional work program to inform and enrich STI Forum discussions on STI Roadmaps, focusing on tangible impact to be achieved over 2018-2019.

For 2018, the primary focus is to shape consensus on a common guidance, principles and possible frameworks/methodologies for country level STI roadmaps. A second priority is to initiate discussions on possible elements of a global initiative or international assistance mechanisms to facilitate development of such roadmaps. To these ends, the workstream supports a collective effort by a group of volunteering countries and facilitate a multi-stakeholder collaborative approach among the IATT and other UN, non-UN partners and stakeholders.

1.2 Objective and structure of the paper

As a key deliverable of the Roadmap workstream of IATT to STI Forum 2018, this paper aims to present an overview of country level STI Roadmaps, with a view to arrive at a common understanding to respond to countries' demands, addressing the below three questions:

- What is the "supply side" landscape of relevant methodologies and assistance mechanisms used by UN agencies and other organizations for country-level STI Roadmaps?
- What is the "demand side" landscape of current state of STI Roadmaps, and underlying circumstances, realities and challenges countries face?
- How best can TFM/IATT's collective effort support countries on STI Roadmaps over the two-year timeframe, respecting and accommodating realities faced by countries at different maturity levels of STI Roadmap development/implementation?

To address these guiding questions, the paper is structured as follows. Chapter 2 summarizes relevant discussions during the first two STI Forums to propose a framework for analysis. Chapter 3 examines relevant methodologies used by UN and other organizations to assist countries' STI Roadmaps. Chapter 4 provides an overview of country circumstances and policy contents, from literature and with an overview of select country examples. Chapter 5 identifies questions for further discussions on international facilitation and cooperation. Chapter 6 concludes with recommendations on the next steps if IATT's inter-sessional work program based on the findings and observations.

2 Framework for discussions

The first two STI Forums discussed and reached consensus on criteria for effective STI roadmaps, which can be grouped into broad 10 elements under three categories: i) methodologies; ii) policy contents; and iii) process and implementation. These are also broadly in line with the rich literature on STI policy mix and roadmap development (see Box 1).

- Methodologies:
  1. Diagnostics, assessments and policy reviews of STI needs and gaps
  2. Foresight and horizon scanning, prospective analysis, participatory technology assessment
  3. Deep dives for each Goal, for roadmaps to help prioritize and promote cross-sectoral collaborations; integrated assessment tools to find desirable pathways that resolve trade-offs and maximize synergies
- Policy contents:
  4. Coherent science, technology and innovation policy mix, addressing enabling conditions (e.g. robust legal environments, trade and investment policy, intellectual property protection), through a whole-of-economy, integrated, multidisciplinary approach
  5. Addressing potential socioeconomic effects of accelerating technological change and impacts of rapid technological technologies
  6. Linking STI to national development challenges and development strategies; address SDGs universality principle while respecting national STI priorities and realities; coherence between STI policies in general and those focused on supporting the 2030 Agenda
- Process and Implementation:
  7. Capacity: human and institutional capacity building for STI policymaking
  8. Governance and coordination: open, inclusive, multi-stakeholder engagement such as across government entities and with private sector, academies of science, indigenous communities
  9. Learning: tracking progress, evaluating what's working, feedback and learning loops
  10. Resource: adequate funding for implementation and investment

These 10 points can be summarized as a "three-tiered" approach to STI Roadmaps, each corresponding to first, second and third in above methodologies and policy contents (as elaborated in Table 1 and summarized in Figure 1).

1) **Foundation** of STI policy framework and enabling conditions;
2) **Adaptation** to emerging technology and societal preparedness; and
3) **Integration** of STI to national sustainable development plan.

These 10 points and the three-tiered approach represent an ambitious agenda that emerged from the two STI Forums' discussions. Few Member States are likely to have developed STI Roadmaps that satisfy all of them. For example, advanced economies have mature foundations, with varying degree of adaptation/preparedness and nascent integration fully embracing SDGs. None of the IATT Member Agencies are in a position to support all 10 points. For example, several agencies are experienced with strengthening foundations based on STI policy reviews; some agencies have experience with sector-/Goal-based STI deep-dives; yet few have established technology foresights capabilities to analyse and advise on disruptive implications at country level. Critically, many of developing countries lack necessary STI policy capacities for foundations. Developed countries often face challenges in coordination for integration.

International facilitation and cooperation, including through mutual policy learning, have been emphasized as common themes to implement country level STI roadmaps both at developed and developing countries.

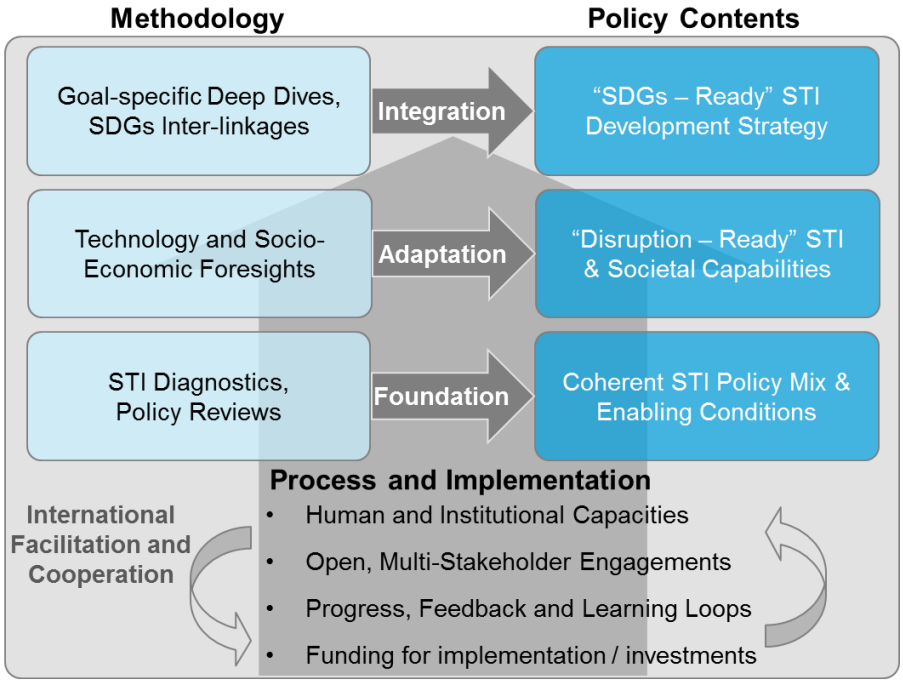
Table 1: Discussions on STI Roadmaps at STI Forums (excerpts from Co-Chair Summaries: year and paragraph number in bracket)[1]

	Methodology	Policy Content (and country examples)
Foundation	National science, technology and innovation plans and policies should be conceived and designed (…) building on **the diverse expertise and knowledge of stakeholders** (…) **identifying needs and gaps**. (2017: §69)	The **coherence of science, technology and innovation policy** needs to be advanced at all levels in order to accelerate technology transfer, technology diffusion and innovation. (2016: §20) Achieving all the Goals (…) will require **robust legal environments** that promote innovation. Those involve not only science, technology and innovation policy, but also **trade policy, intellectual property protection and other key areas**. (…) One example highlighted in that regard was the new intellectual property rights policy of the **Government of India**. (2016: §20)
Adaptation	Participatory technology assessment and prospective analysis (e.g., of the impact of technologies on employment) could be useful. There is a role for **foresight and horizon scanning** exercises going forward, including for examining technologies that are currently risky and unproven. (2016: §25)	The awareness of policymakers should be raised in terms of the **potential effects of accelerating technological change**, and **viable technology strategies** should be elaborated in each country. A group of friends could be convened (…) in order to discuss and formulate recommendations to address the **impacts of automation and other disruptive exponential technologies**. (2017: §46) Governments should acknowledge in their national plans the potential of science, technology, innovation and artificial intelligence in terms of bridging gaps in all aspects of the Goals, including mental health, well-being and resilience, following the examples of **Lebanon** and **Sierra Leone**. (2017: §62)
Integration	Achieving all the Goals will require **integrated assessment tools** to find desirable pathways that **resolve trade-offs and maximize synergies**. (2016: §20) The cross-cutting nature of the Sustainable Development Goals (their interdependencies, potential trade-offs and synergies) and of science, technology and innovation requires **holistic approaches and strategies**. In this context, multidisciplinary and integrated approaches are necessary to take into account **different sources of knowledge** (including traditional knowledge). (2017: §71) **"Deep dives" are needed for each Goal** for which road maps could help prioritize actions and promote cross-sectoral collaborations, as was illustrated by the forum's dedicated sessions on Goals 1, 2, 3, 5, 9 and 14. (2017: §73)	Coherence must also be achieved between science, technology and innovation policies **in general and those focused on supporting the 2030 Agenda**. (2016: §20) The challenge is to design science, technology and innovation policies and instruments for the Sustainable Development Goals that **translate the Goals' universality principle into action**, while respecting **national science, technology and innovation priorities and realities**. (2017: §36) **Mauritius** has made major strides in defining a strategy for a transition to an ocean-based economy, based on the precise identification of the required economic activities (…), underlying technology developments and social requirements. (2016: §24)

[1] STI Forum Co-Chairs Summaries for HLPF, 2016 and 2017. Authors acknowledge that roadmaps entail diverse definitions and meanings to different audience, but adhere to the STI Forum discussions so far as documented in Co-Chair Summaries to underpin the framework for discussions in this paper, for further refinements through IATT's work to continue.

	Country Challenges	International Facilitation and Cooperation
Capacity	Developing countries face a **severe lack of capacity in science, technology and innovation systems, infrastructure, trade and investment policy**. In addition, despite significant capacity-building efforts, many poor countries fail to make significant progress, as **maintaining and retaining newly established capacities** remain serious challenges. (2017: §39) Science, technology and innovation capacity-building in every country is essential. This includes building **human and institutional capacity** and strengthening **science advisory ecosystems** and science, technology and innovation policy. (2017: §81)	**Governments, the United Nations development system and development partners** should prioritize open and inclusive **capacity-building in science, technology and innovation policymaking**, including related policy research, especially on demand-side innovation policies that trigger knowledge use, as well as private sector training. (2017: §39)
Governance and Coordination	The design of science, technology and innovation action plans should be **inclusive and involve all stakeholders** from the outset. (2016: §24) Coherent policies should lead to coordinated approaches to enhance partnerships and proactively involve the **private sector**, which is already working on low-cost scalable technologies and the Goals. (2016: §22) Poverty must be overcome for high-tech capacity to be effectively created and used in poor countries. **Poor governance and lack of coordination** between science, technology and innovation policy and industrial policy are important challenges in Africa and elsewhere, as government entities often work in silos. (2017: §40)	Ownership can be fostered through co-design, co-development and co-production in order to **align international responses**, including from scientific and engineering communities, with national needs. (§36) Flexible science, technology and innovation action plans and technology road maps **at the national and global levels** are needed to support the achievement of the Goals. (2016: §24)
Policy Learning	Science, technology and innovation policies need to do a better job of **linking to and tackling development challenges**. (2016: §24) Science, technology and innovation road maps and action plans that have a particular focus on **accelerating progress** towards the Goals are essential. (2017: §72)	(STI roadmaps) are needed at the **subnational, national and global levels**, and should include **measures for tracking progress**. These road maps incorporate processes that require **feedback loops**, evaluate **what is working and not working**, and produce continual revisions that create a real learning environment. (2017: §72)
Resource	Coherent policies must lead to **adequate and diverse funding** of science, technology and innovation in order to plant the seeds for innovative research. (2016: §22) Science, technology and innovation policies (…) require leadership and need to be **adequately resourced**. (2016: §24)	The mapping of United Nations system activities on science, technology and innovation for the Goals conducted by the inter-agency task team and presented at the forum highlighted a number of significant activities, as well as **gaps in terms of resources, strategic focus, data and reporting**. The United Nations system and its Technology Facilitation Mechanism partners should work together to **systematically close these gaps and increase their joint impact**. (2017: §89)

Figure 1: Organizing Framework of STI Roadmap elements and approaches



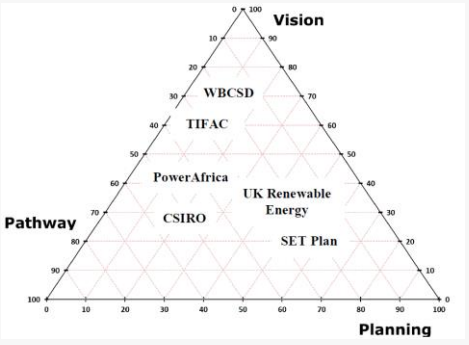
This framework, although derived from previous discussions and not theoretically or empirically grounded, is convenient in practically organizing multiple streams of work, as it can i) define a space for UN inter-agency joint work on "foundation"; ii) bridge with TFM's key parallel topic of rapid technological change through country level policy "adaptation"; iii) stimulate multi-stakeholder engagement on science-policy interface for "integration"; and iv) promote discussions on STI-related international facilitation and cooperation. The framework will be used throughout the paper.

Box 1: Policy roadmaps in comparison with visions, strategies or action plans

Roadmaps, in their traditional forms most typically through technology roadmapping as one of foresight techniques, have been used in industries as a tool for strategic planning. Deliberations on STI roadmaps as a policy instrument have emerged only recently[2], where STI Forums, following the adoption of Agenda 2030, have been instrumental[3].

A recent review of 15 STI policy roadmapping initiatives[4] analysed heterogeneity of their objectives, functions and approaches deployed, and found three future-oriented components typically combined in STI policy roadmaps, with varying emphasis:

- *Vision*: description of desired state, qualitative or quantitative.
- *Pathway*: assumptions on mechanisms of change, e.g. cost, performance, milestones or broader socioeconomic systems.
- *Action plan*: ranging from commitments with accountability and resource mechanisms or aspirational recommendations.



This combination distinguishes roadmaps as a coherent framework from policy documents or initiatives focusing on elements such as visions, strategy or action plans. The analysis also identified typical weaknesses of STI policy roadmaps useful to reflect on: implementation follow-up; experimentation; embeddedness in policy mix; theory of change in pathways; risks and uncertainties; governance; and adaptability and learning.

[2] e.g. Smart Roadmapping for STI Policy, Carayannis, Grebeniuk and Meissner (2016)
[3] The Sustainable Development Goals: Roadmaps to Progress, Colglazier (2018)
[4] Paving the pathways towards sustainable future? A critical review of STI policy roadmaps as policy instruments enabling sustainability transitions, Miedzinski, McDowall and Fahnestock (forthcoming, in the framework of Green.eu project funded from EU Horizon 2020 programme)

3. Landscape of methodologies to support country level STI Roadmaps

3.1 Overview of categories of relevant methodologies

IATT in preparation for the second STI Forum conducted a "mapping" of UN Agencies' efforts related to STI policy framework, action plans and roadmaps[5]. An updated horizon-scanning identifies dozens of relevant initiatives/programs/product lines across more than 10 UN Agencies, and other international agencies actively engaged in this space, such as OECD and EU. The STI policy support capabilities within and outside UN System broadly consist of the following, 7 categories:

"Foundation"

- STI policy and capacity diagnostics, assessments and reviews
- Functional STI-related diagnostics, e.g. entrepreneurship, ICT, intellectual property
- STI global indicators, statistics, analytical frameworks, benchmarking and trend analysis

"Adaptation"

- Foresight and scenario planning exercises
- STI-related norms and policy/regulatory standards

"Integration"

- Goal-/sector-/technology-specific "deep dive" STI assessment
- Systemic review of countries gaps, challenges, opportunities toward SDGs

The overall distribution of efforts across the UN System is concentrated in the "Foundation" largely addressing developing countries' capacity challenges, while UN agencies are increasingly moving toward assisting countries on "Integration" under the SDGs contexts. Countries have different levels of exposure to the UN System's offerings, from those receiving support from almost all agencies over the years, such as Rwanda, to those which have developed compelling national strategic STI roadmaps rather as a result of domestic efforts, such as Mauritius highlighted at the first STI Forum.

Developed countries, meanwhile, have both individually as well as collectively (including through non-governmental forums such as World Economic Forum) have developed approaches to "Adaptation," where UN Agencies are increasingly participating or commissioning for developing countries to benefit from. Methodologies for "Integration" is at a nascent stage over the last few years upon adoption of Agenda 2030, largely led by non-UN entities (except for "deep dive" in areas under agencies' core mandates).

The following sections summarize UN System's and others' established programs and recent initiatives, under each category and increasingly toward broader coverage of methodological approaches.

3.2 "Foundation"

STI policy and capacity diagnostics, assessments and reviews

Many agencies have conducted economy-wide STI policy reviews, through analysis of National Innovation System from scientific research to technology commercialization or absorption. Key examples covering a dozen or more countries include UNESCO's Mapping Research and Innovation series as part of the Go-SPIN platform; UNCTAD's Science, Technology and Innovation Policy (STIP) Reviews; and the World Bank's STI policy diagnostics. UNIDO, Regional Commissions such as UNECE, ESCAP and ECLAC, and outside UN System, European Commission and OECD, follow similar approaches to STI policy reviews with their respective member states.

[5] Landscape of Science, Technology and Innovation initiatives for the SDGs, IATT-STI (2017), Box 3

These reviews typically involve assessment of strengths and weaknesses of STI policy, institutional structures, governance frameworks and their performance, and identification of sector-specific opportunities and key gaps in institutional and policy capacities, through consultations with broad stakeholders. Reviews oftentimes generate recommendations for further strengthening STI policy capacity, and can lead to technical assistance or investment programs by the UN System and partners. Counterparts for these reviews are typically Ministry of Science and Technology or Ministry of Industry or Economy.

The existing approaches to economy-wide STI policy reviews, if compared against the breadth and complexities of the SDGs, are still at an early stage to embrace SDGs in their potentially strategic function to facilitate country level priority setting under the context of the SDGs and identify STI's critical contributions in line with the national priorities. Some agencies are responding by strengthening methodologies. For example, UNCTAD is developing a new methodology to align STIP Reviews in line with the SDGs by reconsidering priority-setting with a broader range of stakeholders - from international partners in private sectors to grass-root actors - and their expanding involvement and interlinkage within different sectors. The World Bank has piloted with several countries reviews focused on the quality of public spending related to STI policy mix, through STI Public Expenditure Review involving in-depth analysis of inputs and outputs in relation to outcomes as stated in policy objectives and with deep assessment of policy development and delivery capabilities. This can support Finance Ministry or Planning Commission as counterparts, to better align STI budgeting and investment decisions to broader development policy frameworks. UNIDO is adopting a quantitative assessment, be specifically statistical analysis of latent factors to barriers to innovation, based on the survey results with an aim to support evidence-based STI policy and strategy crafting.

Functional STI-related diagnostics

Alongside economy-wide diagnostics, agencies also have reviews on functional domains as described below, as cross-cutting foundational elements of national STI ecosystems towards different SDG(s).

The application of technology and success in innovation across sectors, such as agriculture, energy, health or industry, can be catalyzed by entrepreneurship. Entrepreneurship, the critical enabler to SDG 8, is increasingly recognized both as a source of locally developed innovation, but also as a key technology diffusion tool at both national and global level. UNCTAD's Entrepreneurship Policy Framework and Implementation Guidance conducts an assessment of the current state of the national ecosystem in which entrepreneurs acquire their skills, develop their business plans, start up, operate and grow their businesses, identifying country specific challenges and constraints in the process.

Industrial development and Information and Communication Technology (ICT) underpin the NIS establishment and directly enable SDG 9's achievement. ITU, jointly with UNIDO implemented ICT Centric Innovation Ecosystem Country Review to map the digital transformation with policy recommendations. The rapidly changing global economic environment further exacerbated the human resource problem which needs workers to be more innovative in all sectors. So the skills readiness and human capacity development (UNESCO, Science Report) is also a pertaining cross-cutting element, which has been highlighted within almost every deep dive analysis to achieve SDG 4.

To enable self-sufficient agriculture and growing industrial productivity, social and legal conditions like intellectual property protection (WIPO), trade-related issues (WTO) and public health (WHO) are crucial and interrelated to each other. For instance, in order to integrate Intellectual Property (IP) development objectives into a national strategy that is aligned with national development priorities and strategies, WIPO created a harmonized approach considering common problems in countries' IP strategies development process, with detailed guidance on questionnaire design and benchmark indicator generation. UNCTAD has also initiated Development Dimensions of Intellectual Property

advisory reports under which developing countries request a review of the extent to which their intellectual property policies are consistent with specific development objectives, such as access to medicines, access to textbooks and technology transfer. Furthermore, a trilateral cooperation between WHO, WTO and WIPO has been developed to diagnose the intersection areas between health, trade and IP, focusing on access to and innovation of medicines, to target on SDG 3. Additionally, a partnership between WHO and UNCTAD has recently examined the intersection between technology transfer and the local production of pharmaceuticals in developing countries.

Strategies and policy frameworks around Digital Economy (ITU, UNIDO, World Bank), notably, have received increasing attention given the cross-cutting implications of digital technologies including potentially disruptive impact and addressing concerns by substantial numbers of countries to be left behind the ongoing "fourth industrial revolution."

Even though the rapid technological changes bring challenges and concerns to both global and local market, innovation still opens up unique opportunities especially to the rural poor in developing countries regarding to productivity increase, raw material extraction, and human capital development. CELAC, with the support of FAO, conducted a regional analysis on innovation's positive impact on rural development and IFAD produced the *Rural Development Report* to analyse global, regional, and national pathways of rural transformation within different development stages.

STI global indicators, statistics, analytical frameworks, benchmarking and trend analysis

To promote evidence-based policy analysis and cross-country benchmarking and policy learning, the UN System has made considerable efforts to conceptualize and substantiate data and indicators related to countries' STI inputs and performance. Within UN System, UNESCO Institute for Statistics (UIS) launched Research and Experimental Development (R&D) Statistics Survey to collect data on the financial and human resource devoted to R&D, generated indicators and globally monitored the progress towards SDG 9.5. WIPO, jointly with Cornell University and INSEAD, published the Global Innovation Index annually ranking the innovation performance of some 130 economies based on 80+ indicators. World Bank Group's Enterprise Surveys generates indicators describing dimensions of product innovation and ICT technology usage at firm-level.

Outside UN System, OECD, EU and African Union (AU) have also contributed substantial amount of resources to help country develop data collection capacity and produce data in STI fields. OECD plays a leading role in the innovation data collection and interpretation and has developed the analytical frameworks *Oslo Manual* and *Frascati Manual* as the guidance in related data collection and use. OECD's Main Science and Technology Indicators (MSTI), generated by OECD surveys, reflect the level and structure of all efforts OECD member states undertaken in STI fields. EU Eurostat deploys Community Innovation Survey biennially to collect statistics about enterprise' product and process innovation in EU, and includes other science and technology related data in R&D, high-tech and human resources in its database. NEPAD, AU's New Partnership for Africa's Development, in partnership with OECD and UNESCO adopted the African STI Indicator Initiative (ASTII) aiming to build capacities for data collection and to develop international compatible STI indicators on the African continent. Similarly, RICYT cooperated with UNESCO to collect data in Ibero-American area.

Another category of data, statistics, and trend analysis, which is also commonly used in STI policy analysis, especially for functional diagnostics, does not directly measure countries' STI inputs and activities, but indirectly presents state's outputs and performance in adapting STI policy. Several noteworthy examples include: World Economic Forum's Global Competitiveness Index, UNIDO's Competitive Industrial Performance Index, ICT's World Telecommunication/ICT Indicators, and World Bank's World Development Indicators and Regulatory Indicators for Sustainable Energy.

It has been well recognized, though, that indicators, statistics, analytical frameworks and trend analysis have been largely constrained, especially for many developing countries, to adequately inform baselines, targets and close learning loops to effectively facilitate planning and implementation of country level STI roadmaps for the SDGs. Thus, UNESCO UIS is proposing an augmented thematic set of indicators covering the business sector around the world to monitor the innovation process and to take the first step in remedying the innovation measurement gap between micro and macro level in world wide. By partnering with OECD, EU, RICYT and AU/NEPAD, UNESCO will offer capacity development support in data collection to developing countries and to adopt these thematic indicators to be internationally comparable so that they can be used to better target STI policies towards national and global SDGs.

3.3 "Adaptation"

Foresight and scenario planning exercises

International organizations have undertaken various efforts to conduct technology foresight and scenario exercises at global, regional and country levels, to inform R&D strategies as well as broader economic, social and environmental policies. UNCTAD's Commission on Science and Technology for Development (CSTD) has been a vocal advocate for the use of strategic foresight in policymaking.

At country level, UNDG's Innovation Facilities commissioned a report on applying foresight to the United Nations Development Assistance Framework (UNDAF), indicating possibilities of integrating foresight with the UN's strategic programming process to guide development assistance. In practice, most scalable UN assistance, for countries to apply foresight for development planning or SDGs implementation, has been through UNDP's Global Centre for Public Service Excellence, supporting 15 countries,[6] largely from Africa, by 2017.

UN agencies have also explored sectoral application of foresight exercises. For example, UNESCO's Futures Literacy Laboratories (FLL), a part of the Management of Social Transformations (MOST) Programme[7]. FLL is an innovative action-research/action-learning methodology that allows people to discover and share both the reasons for using the future and how to use it. Since 2013, UNESCO has been able to collaborate with local partners to run over 30 FLL.

Outside the UN System, European Commission and OECD have advanced foresight practices across different sectors and themes. The EU's Directorate-General for Research and Innovation has been ensuring effective cross-directorate collaboration on the foresight work, producing many collaborative studies, while the Joint Research Centre compliments its internal research capabilities by tapping into and enhancing a wider network of foresight professionals across all sectors and experimenting at EU Policy Lab. The OECD follows a similar route by engaging in community building around foresight activities. In 2014, the OECD launched Government Foresight Community with over 60 experienced foresight practitioners from 23 governments[8] to facilitate the knowledge exchange.

STI-related norms and policy/regulatory standards

Rapid technological advancements represent transformational opportunities as well as potential threats to sustainable development, raising global concerns around future of work, inequality across and within countries, security and human rights. An Expert Group Meeting in Mexico, April 2018 on *Accelerated Technological Change, Artificial Intelligence, Automation and Their Policy Implications for*

[6] Rwanda, Tonga, Maldives, the Pacific region, Papua New Guinea, Kazakhstan, Mauritius, Sri Lanka, Lesotho, Ghana, Namibia, South Africa, and Malawi.
[7] See program website.
[8] 3rd Annual Meeting of the Government Foresight Community: Opening Remarks (2014)

Sustainable Development Targets, reiterated policy challenges across economic, social, environmental as well as ethical and political dimensions (e.g. algorithmic biases, regulatory gaps on data/privacy, income distribution or adaptive social protection schemes), and produced a comprehensive matrix mapping likely impact of artificial intelligence across all SDGs and Targets[9].

World Economic Forum and private consultancies have been the leading voices in global debates on these topics, largely through large corporations' and developed economies' perspectives but with recent expansion to emerging economies and global development considerations. UN has taken an upstream, normative approach under Secretary General's Chief Executive Board (CEB), through identifying key challenges for the UN System such as to i) foster ethical standards before impacts are irreversible, without stifling innovation; ii) reduce disparities and promote the use of frontier technologies for the attainment of the SDGs; and iii) lead or support global multi-stakeholder consensus building.[10]

UN Agencies and international organizations, under respective mandates and work programs, are taking steps to raise awareness, promote inter-governmental and multi-stakeholder deliberations toward informing countries' policymaking in response to rapid technology changes. For example, ITU in partnership with more than 30 UN Agencies and other organizations has organized the second AI Global for Good Summit in May 2018 to collect good practices and surface concrete initiatives to harness artificial intelligence to benefit global goods. OECD, International Labour Organization (ILO) and International Monetary Fund (IMF), among others, have contributed to discussions on policies and policy coordination at Group of Twenty (G20), on skills[11], social protection[12], productivity, price levels and fiscal implications[13], respectively. UN Technology Facilitation Mechanism (TFM) will continue to facilitate multi-stakeholder dialogues on impact of rapid technological change on the achievement of the SDGs, as mandated by a GA resolution[14].

3.4 "Integration"

Goal-/sector-/technology-specific "deep dive" STI assessments

UN agencies have conducted deep-dive analysis and technical assistance for STI at the national, regional and global level, focusing on specific sustainable development goals or targets.

Agriculture is an obviously important sector in many developing countries where in many cases, the national innovation ecosystem is largely built on and used to embrace SDG 2. The World Bank, FAO, and OECD have conducted diagnostic approaches to agriculture innovation system (AIS) and theoretical frameworks that enable innovation to promote sector growth. STI diagnostics and policy analysis are available for related topics in food security (NCTAD), land degradation (UNCCD), and water resources management (UN Water) – which are linked to SDG 2, 15, and 6, respectively.

Economic development in the age of industrialization has been achieved at the cost of overexploitation of natural resource, so policymakers were looking for different antidotes before irreversible impact hits. Aligned with SDG 11 & 12, the concept of Inclusive Green Economy has been promoted and pioneered by UNEP, in partnership with IMF, WB, and OECD to support countries through assessment and advisory service. For example, UNEP's International Environmental Technology Center (IETC) provides policy advice to enhance the national or local use of

[9] Government of Mexico (forthcoming, 2018)
[10] UN CEB, Frontier Technologies and the Role of the UN System (2017)
[11] OECD, Future of work and skills (2017)
[12] ILO, Strengthening social protection for the future of work (2017)
[13] IMF, Technology and the future of work (2018)
[14] UN General Assembly, A/RES/72/242 (2017)

environmentally sound technologies to fight against toxic waste and pollutants emission applying its unique methodology – sustainability assessment of technology (SAT). Another UNEP's project, *Switch Africa Green*, supported six countries in Africa to achieve SDG 12 through policy support and capacity building facilitation to advance green business in agriculture, manufacturing, tourism and integrated waste management.

While a green economy was generally marked by sustainable use of natural resources, blue economy, as a concept interdependent with the green economy but more focusing on responsible and effective marine resources use, is becoming a more critical domain for people who are dependent on ocean economy and is seeking innovation integration to better achieve SDG 14. OECD Directorate for Science, Technology and Innovation's effort to provide global policymakers with evidence-based information to improve policy mix has been recognized to help sustainably manage ocean resources and develop ocean-related economy.

Climate Change (SDG 13) is a fundamental threat to sustainable development, affecting people, putting food at risk, endangering biodiversity, and threatening coast states. Technology and innovation can be a robust solution for addressing climate change problem. Under UNFCCC framework, UNEP conducted Technology Needs Assessments (TNA) to assist developing countries in determining their technology priorities for the adaption to climate change and for the mitigation of greenhouse gas emissions. At the global level, UNDP's guidance[15] helps countries prioritize their technology needs and implement appropriate policy.

Energy, as the foundation of sustainable development, interacts with all the goals mentioned in the above Goal/Target specific STI assessments and is at the center of efforts to tackle problems like climate change and public health. Renewable energy, as a critical target of SDG 7, is making significant stride in increasing efficiency and growing consumption shares. International Renewable Energy Agency (IREA) developed Renewables Readiness Assessments for decision makers to identify the actions needed to overcome barriers to renewable energy deployment and shape the policy consistent with national priorities.

Systemic reviews of countries' gaps, challenges, opportunities toward SDGs

To guide STI roadmaps as integral elements of national sustainable development plans, countries need clarity and priorities in Goals and Targets that require accelerated progress. Given the voluntary and country-led principles of follow-up and review of SDGs implementation, and early stages of countries' development of "ambitious national responses to the overall implementation" of Agenda 2030[16], comparable evidence base is still limited in assessing countries' gaps and policy priorities in achieving the SDGs (let alone where, among respective country priorities, STI can contribute).

Outside the UN System, attempts have been made to fill this gap. For example, the Sustainable Development Solutions Network (SDSN) developed SDGs Dashboard and Index across developing and developed countries. OECD conducted "Measuring Distance to the SDG Targets," assessing about a dozen countries. Brookings Institution recently published what it sees as "the first study to present a detailed national and subnational assessment of SDG status within a G-7 economy" for Canada[17] (Box 2).

[15] UNDP, Handbook for Conducting Technology Needs Assessment for Climate Change
[16] Agenda 2030, para 74, 78, 79
[17] McArthur and Rasmussen, *Who and What Gets Left Behind? Assessing Canada's Domestic Status on the Sustainable Development Goals* (2017)

Box 2: Canada case

In assessing Canada's domestic status toward achieving the SDGs, Brookings Institution emphasized the high ambition of "leaving no one behind." The approach taken therefore flags, for example on targets aiming to reach universal coverage but with trends not indicating all people reached by 2030 as "breakthrough needed," irrespective of current proximity to universality (e.g. from 97% to 98% over the last 10 years doesn't indicate universality over the next 15 years).

In Canada's context, of the 169 SDGs Targets, 61 Targets with 73 indicators were analysed, as they are outcome-focused, quantified, measurable (including with proxies) with available data. The study found that for more than half of the 73 indicators, Canada is either "moving backwards" or "breakthrough needed," concluding that Canada is not yet fully on track of any of the SDGs, drawing attention to the people and issues that are currently being left behind amid Canada's pursuit of economic, social and environmental progress.

Table: Summary of Canada's status on domestic SDG indicators

Sustainable Development Goal	Moving backwards	Breakthrough needed	Acceleration needed	On track
1 Poverty		•	•	• • •
2 Hunger & food systems	• • •			
3 Good health & well-being	•	• •	• • • • • •	• • •
4 Quality Education	• •	•		• • •
5 Gender equality	•	• • • • •		
6 Clean water & sanitation	• •	• •	•	
7 Affordable & clean energy	•	•	•	•
8 Decent work & economic growth		• •	•	•
9 Industry, innovation & infrastructure	•	• •		
10 Reduced inequalities	•	•		
11 Sustainable cities & communities	• • •			•
12 Responsible consumption & production		• • •		
13 Climate action		•		
14 Life below water	•		•	• •
15 Life on land		• • •		•
16 Peace, justice & strong institutions	• •	• •	•	• •
	18	26	12	17

The findings illustrate possible guiding questions for developing STI roadmaps addressing national challenges. How can Canada reverse the negative trends or achieve breakthrough for the SDGs Targets where the country performs poorly, for example, on safe drinking water, child obesity, food insecurity, protecting land and marine resource, meeting 2030 emissions targets, and leave no one behind including indigenous peoples? And what can STI contributions in doing so?

While the report did not focus on STI, it highlights a pertinent question on adaptation. "The SDG targets help illuminate Canada's educational challenge as the world economy enters a period of accelerated automation. The country scores well on measures of access, but a large share of the population is being left behind in terms of basic skills for literacy and numeracy. Well over 3 million adult Canadians might lack crucial literacy skills while more than 5 million might lack core numeracy skills. These numbers raise pivotal questions of how Canadians can best be supported to develop relevant skill sets at all stages of life."

Source: Brookings Institution

Upon countries' determination on gaps and priorities in achieving the SDGs, a possible approach to help governments formulate efficient and effective policy responses to SDGs as indivisible and interlinked agenda is interaction mapping to address the inter-linkages, synergies and trade-offs across SDGs and Targets. ICSU has conducted a mapping of 4 Goals[18], and is expanding the analysis to all SDGs. Based on the global analysis, ICSU and INGSA are applying the similar analysis to country level, with Jamaica as the first pilot, to identify areas where cross-cutting policy interventions could address multiple development outcomes, as opposed to tackling individual SDGs Goals/Targets in

[18] ICSU, A Guide to SDG Interactions: from Science to Implementation (2017)

isolation from the areas closely interrelated. Through the three-phase approach, International Council for Science (ICSU) and International Network for Government Science Advice (INGSA)'s Interactions Mapping Project aims to define a common methodology for mapping interactions between all 17 SDGs (Phase I), then to identify national priority implementation clusters, policy and knowledge gaps through an extensive consultation and consensus building process involving relevant scientific, policy and stakeholder communities at national level on the key interactions relating to the country's priorities (Phase II), and STI policy formulation recommendations based on the interaction map (Phase III). This interaction network analysis, and the science-policy-practice dialogue that underpins it, is at nascent state but could potentially provide a dynamic tool kit allowing each country to analyze key areas inter-related to the full set of SDGs for STI policy interventions and facilitate a deliberative process across ministries, and sectors.

Another complementary tool to understand interconnections of goals and targets and help establish policy coherence is the integrative model for Development Goals strategies (iSDG)[19] developed by the Millennium Institute, which enables policy makers at all level of governance simulate the consequences of a variety of policies addressing SDGs, both individually and concurrently and test their likely impacts to social, economic and environmental development. The iSDG model analyzes specific nation's trends for 17 SDGs covering 78 indicators until 2030 under a business-as-usual scenario and supports the simulation of budget implications for policy interventions. Using the Synergy Assessment feature, the iSDG model quantitatively measures the contribution of each policy within a comprehensive strategy to the final achievements and projects synergies emerging from the interaction among policies. Based on the simulation result, policy makers and sector exports can assess the financial resource allocation across sectors and effectively develop a national coherent SDG strategy, as well as evaluate the alignment of existing national strategies and budgets with the SDGs.

Within the UN system, UNDG Acceleration Toolkit provides a set of diagnostic, models, methodologies, and guidance to expert working groups and policymakers for analzying interconnections among SDGs. Two unique assessment tools target on identifying policy gaps against the full set of SDGs and formulating policies to address the development priorities. The Rapid Integrated Assessment (RIA) tool[20], which has been applied in over 25 countries, aids countries to assess the readiness to implement the SDGs and facilitate mainstreaming of SDGs into national and local plans. By reviewing current national development plans and the level of alignment between plans and SDG target in social, economic and environmental dimensions, RIA develops a SDG profile that identifies development challenges, corresponding indicators and interlinkages for policymakers. The SDG Accelerator and Bottle Neck Assessment (ABA)[21] tool supports countries to identify catalytic policy areas (accelerators) that can trigger positive effects across SDGs, prioritize interventions that drive progress on the accelerators, analyze factors that might obstruct an intervention (bottlenecks), and prepare solutions. With the guidance of the assessment, policymakers or UN country team could develop an action plan towards national development objectives in line with SDGs.

Whether produced by scientists or development practitioners, these diagnostic approaches are well positioned to assist countries to integrate national development strategies fully addressing challenges in context of the SDGs and provide robust grounds for the STI roadmaps to be a fully integrated element of the development strategies.

[19] Millennium Institute, iSDG Model Documentation (2017)
[20] UNDP, Rapid Integrated Assessment (2016)
[21] UNDP, SDG Accelerator and Bottleneck Assessment (2017)

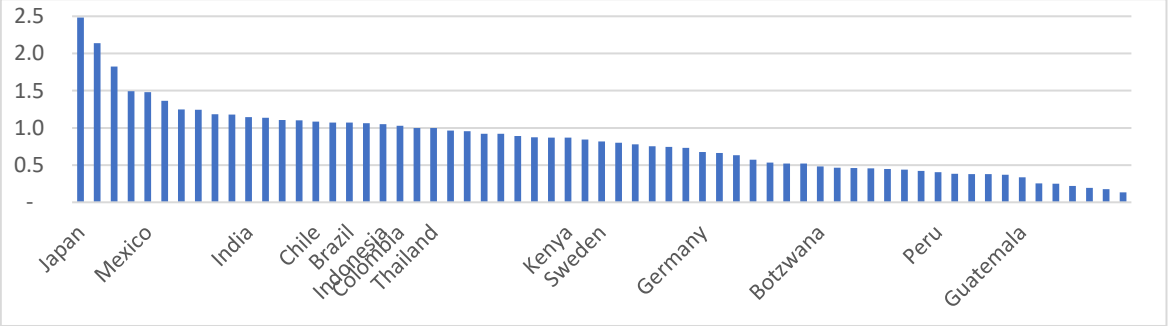
4. Landscape of country experiences of STI Roadmaps

4.1 Countries' efforts on STI for SDGs in Voluntary National Reviews

In the Addis Ababa Action Agenda, Member States committed to "adopt science, technology and innovation strategies as integral elements of our national sustainable development strategies" (para 119). While there is no official mechanism to track progress of this commitment, one possible measure is to interpret Voluntary National Reviews (VNRs).

64 countries submitted VNRs in 2016 and 2017. A meta-review of VNRs indicates that countries were still at very early stages to position STI strategies as integral elements of the national sustainable development strategies. Overall emphasis on STI in these VNRs can be proxied by counting the frequency of appearances of terms science, technology or innovation[22] (Figure 1). Most "STI-intensive" VNRs included: Japan (2.5 appearances of STI per page), Italy (2.1), Korea (1.8), Portugal (1.5), Mexico (1.5). Countries seem to have increased attention to STI in VNRs over time, as the average references to STI per page was around 0.6 in 2016, and increased to 0.9 in 2017.

Figure 2: Frequency of mention to STI in VNRs (per page)



Through references to STI, most VNRs discuss STI in context of a small sub-set of Goals, such as Goal 9 (alongside Goal 2, 7, and to lesser extent, 11, 13), and not as much on means of implementation for the SDGs as a whole, or to address national development challenges the countries prioritize. VNRs also often report on existing, ongoing STI initiatives, but not necessarily present STI plans or strategies, or initiatives as a coherent program under an overarching strategic framework or roadmaps to guide effective STI efforts, with coordinated implementation arrangements including M&E framework.

A few VNRs, though, indicate that the countries conducted analysis of the current state of national STI systems and discuss ways to strengthen it. For example, Brazil refers to the mapping of 2,000 laboratories in universities and research centers, most of which recently receiving public investment, and identifies diversification of STI system as a challenge not only through new policies and instruments but also through new institutional models. A few VNRs also describe national coordination mechanisms to assure STI policy coherence and cross-sectoral implementation. For example, Kenya describes roles of three agencies to strengthen effectiveness and efficiency of national innovation systems, and measurement of progress (AUC/NEPAD-led R&D and innovation indicators); India refers to Innovation Index Framework.

Broadly, VNRs from developed countries tend to elaborate more on STI's contributions to achieve broader set of the Goals, than those from developing countries. Some developed countries, such as

[22] To capture relevant terms (e.g. science, scientist community, scientific evidence), word count was applied with "scien" "technolog" and "innovat" in English documents; "cienc" "cientí" "tecnolog" "innova" in Spanish documents; "scien" "technolog" "innova" in French documents, and "наука" "научный" "ученый" "технолог" "инновац" in Russian documents.

Japan and Sweden, also specify current programs, plans and recommendations on international STI contributions, through development assistance and international research partnerships. Brazil and Thailand are two examples of middle-income countries that elaborate in their VNRs STI plans to contribute to broad set of SDGs beyond Goal 9 (health, gender and ocean for Brazil; and food, energy, sustainable consumption and production, cities and disaster risk for Thailand) while also specifying international STI contributions to SDGs (2016-2019 Multi-Year Plan incorporating scientific and technological exchange by Brazil; and 200 scholarships in fields of STI and environmentally friendly technologies for developing countries by Thailand).

Notably, virtually no VNRs present strategic coherence from STI efforts to progress toward achievement of the SDGs. LDCs, facing daunting development challenges across most of the Goals while national innovation systems and STI capacities are still weak or nascent, appear to have difficulties in positioning effective and efficient use of STI against most pressing challenges in respective countries (therefore highlighting needs for more technology transfers in general). Developed and upper middle-income countries, under Global Indicators Framework with remaining gaps and also facing stagnant productivity growth, largely did not position STI policies and programs as strategic elements of national or multi-stakeholder efforts toward SDGs with budgetary or any other administrative arrangements[23].

4.2 STI Roadmap pioneering examples in practice

Beyond what's documented in VNRs, "most countries have development plans that mention the role of science, technology and innovation, and some knowledge infrastructure is in place through institutions and ministries[24]" before the SDGs came in place. OECD tracks STI policy frameworks and strategies of around 50 countries[25] beyond OECD membership.

Some countries are actively elevating the STI policy discussions under broader scope of the SDGs. For example, Kenya presented Action Plans and Roadmaps at the STI Forum 2016.

Figure 3: STI in Kenya Vision 2030

<table>
<tr><td>Vision for 2030</td><td colspan="3">A nation that harnesses STI to foster global competitiveness for wealth creation, national prosperity and a high quality of life for its people</td></tr>
<tr><td rowspan="2">Strategy</td><td colspan="3">Enhance the application of STI in the national priority sectors for optimal benefits for Kenya's socio-economic and political development</td></tr>
<tr><td>Economic Pillar</td><td>Social Pillar</td><td>Political Pillar</td></tr>
<tr><td>Master Plan</td><td>To maintain a sustained economic growth of 10% p.a. starting from 2012</td><td>A just and cohesive society enjoying social equity and development in a clean and secure environment</td><td>An issue-based people-centered, results-oriented and accountable democratic political system</td></tr>
<tr><td>Implementation</td><td colspan="3">Science, Technology and Innovation</td></tr>
</table>

Under the vision, the presented STI Roadmap of Kenya included:

[23] For example, Belgium, the Czech Republic, Denmark, Slovenia and Sweden, utilized OECD's "Measuring Distance to the SDGs Targets" study in assessing the areas where countries fall behind OECD average in preparation of the VNRs; but none of these countries documented alignment of STI efforts to long-distance areas requiring accelerated progress.

[24] Co-Chairs Summary 2017

[25] OECD Science, Technology and Industry Outlook Policy Database

- 7 policies (regulatory framework; transforming economy; resource allocation, 2% of GDP for R&D; facilitation/acquisition of IPR; knowledge sharing; human capital; and STI infrastructure)
- 17 Goals with STI contributions (e.g. ICT to address poverty, agricultural research, digital learning and STEM, renewable energy, smart transportation systems, data for climate analytics)
- Stakeholders engagement plan (e.g. research institutes, businesses, consumer, youth, women)
- Major initiatives (Presidential Digital Talent Program, Digital Literacy Program, Enterprise Kenya)
- Leveraging international support (e.g. Smart Africa Initiative)

Following the vision and strategies, Kenya has made strong strides in STI-enabled development. For example, through digital payments, financial inclusion in Kenya increased from 4% to 90% in the past 10 years. In maximizing STI's potential, though, Kenya similarly to many countries faces coordination and implementation challenges to move from plans to impact[26].

Many countries' STI roadmaps interact with supra-national and/or sub-national roadmaps. For example, most regional bodies have programs to enhance coherence and synergize across national STI efforts (notably European Union, but also African Union, ASEAN, Organization of American States), with varying level of implementation arrangements and resource mechanisms. Visible efforts are ongoing also at subnational level (e.g. Rwanda's Kigali Smart City, Vietnam's Ho-Chi-Min city).

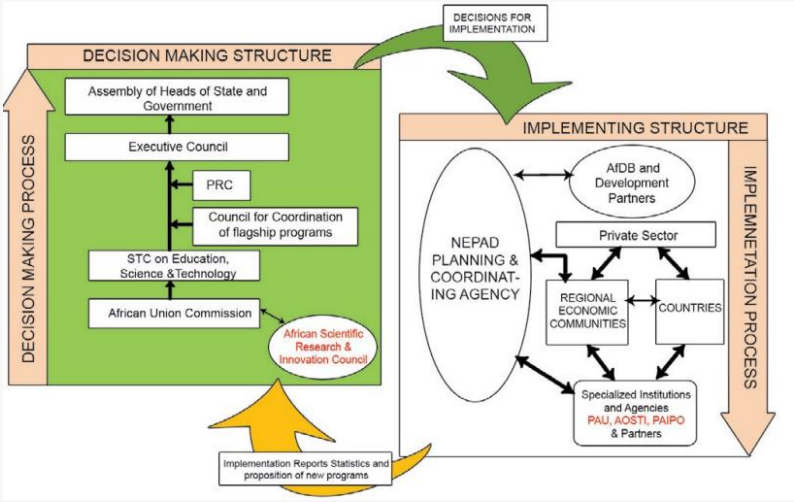
Box 3: Africa STI Strategy 2024

African Union, under its long-term development vision of AU Agenda 2063, adopted Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024). The strategy built on the review of Consolidated Action Plan (CPA, since 2003) under the oversight of a High Level Panel of eminent scientists with support of a Working Group comprising African Academy of Science, African Union Commission, NEPAD Agency, African Development Bank, ICSU, UNECA and UNESCO. The Strategy specified 6 areas of priorities including:

- Eradicate hunger and ensure food and nutrition security (e.g. cultivation techniques, seeds, soil, climate);
- Prevent and control diseases and ensure well-being (e.g. maternal and child health, traditional medicine);
- Communication – physical & intellectual mobility (land, air, river and maritime routes, energy, ICT);
- Protect our space (environmental protection, biodiversity, atmospheric physics, space technologies, water cycle);
- Live together – build the society (citizenship, history and shared value, regional integration, urban hydrology); and
- Create wealth (education, human resource, mineral resources, forests, aquatics, water resources).

The strategy constituted then with development of flagship programs, and five phases of implementation – kick-off and institutional setting (2014); first series of flagship programs (2015-17); second series (2018-20); third series (2021-23); and final evaluation and definition of next 10-year strategy (2024).

Figure: Institutional Architecture for Implementation of STISA-2024



[26] Such as through multi-stakeholder engagement including academia; balancing short-term and long-term goals; and penetration to the local level, according to the discussions at EGM on STI Roadmaps for the SDGs, May 8-9, 2018, Tokyo.

Implementation of STISA-2024 was envisaged to be supported by coordination across AU, Regional Economic Communities (RECs) and national levels, through heads of states, ministerial conference, harmonization of flagship programs, additional resource mobilization from donors and development banks, and regional implementation institutions such as African Scientific Research and Innovation Council (ASRIC), African Observatory of Science Technology and Innovation (AOSTI), Pan-African University (PAU), Pan-African Intellectual Property Organization (PAIPO) and engaging private sector.

4.3 State of countries' STI Roadmaps in context of the SDGs

To deepen the discussions on STI for SDGs Roadmaps, UN IATT in partnership with Japan organized an Expert Group Meeting in May 2018 in Tokyo, participated by around 70 experts and practitioners, including representatives from 12 countries (Kenya, Ghana, Rwanda, Brazil, Colombia, Jamaica, Guatemala, Serbia, Thailand, UK, Australia, Japan)[27]. Discussions at the meeting, as well as responses to the questionnaire to the meeting participants (summarized in Table 2), shed light on similarities and differences, and common challenges, in formulating and implementing STI Roadmaps.

Foundation: most countries have some forms of national multi-year STI policies or strategies, with a responsible government agency (typically under ministry of science and technology and/or ministry of industry or economy), with supporting legal and administrative frameworks (e.g. academic research management, intellectual property, technology commercialization, technology extension, entrepreneurial ecosystem) at varying levels of sophistication and enforcement. Most countries also have some forms of coordination bodies for inter-ministerial and multi-stakeholder engagement (either under president office, cabinet office, national development commission, or supported by ministry responsible for national STI strategy), with varying breadth and depth of participation.

Countries vary, though, in their emphasis on objectives and priorities in national STI policies. Some have greater emphasis on research excellence, economic growth and industrial competitiveness, while others elaborate sectoral priorities such as on agriculture, health, education, energy or ICT infrastructure (e.g. Ghana). Sophistication or mere presence of M&E frameworks also largely vary, from some countries limited to inputs (such as for R&D, either public spending as % of budget, or total spending as % of GDP) to others with outputs (e.g. publications, researchers trained) and outcomes specifically linked to development objectives including with rigorous impact evaluations (e.g. Colombia on beneficiary firm productivity growth). These variances appear not necessarily correlated with countries' income levels.

Common challenges include: lack of capacity to implement STI policies; political leadership and balanced engagement / participation to align resources to aspirations and address fragmentation; evidence base for effectiveness and efficiency of STI programs including on social and environmental, beyond economic outcomes; and gender disparity in the field of STI (Guatemala is an exception).

Adaptation: countries' emphasis varies in pre-empting, accommodating and adapting to rapid technological changes, ranging from safeguarding against potential concerns (e.g. automation and unemployment, cybersecurity, bioethics) to unlocking opportunities (e.g. Rwanda's forward-looking regulatory frameworks on drones; Serbia's 4th industrial revolution; Oman on firm capabilities; Japan's human-centric "society 5.0" vision). Policy deliberation and responses are, though, at early stages.

Common challenges include: trust in STI systems; inequity within and across countries including through brain drain; investing in human capital for continuous re-skilling; risk of stranded asset and legacy capital stock; and links to longer-term and global roadmaps especially on environmental goals.

[27] STI for SDGs Roadmaps EGM Meeting Report IATT and JST (2018)

Table 2: State of STI Roadmaps, summary country examples (see Annex 4 for underlying submissions)

Country	Reference stat & ranking[28]			"Foundation"	"Adaptation"	"Integration"
	GDP p.c.	GII (1-122)	GCI (1-140)	*STI policy frameworks, institutional arrangements, and international support*	*Emerging policy responses, and international support if applicable*	*State of national plan for the SDGs and STI's roles in it*
Japan	38,283	14	6	• S&T basic plan guiding thematic and budgetary priorities and M&E • Council for STI at cabinet office	• Human-centric "society 5.0" vision and thematic strategies e.g. on AI, robotics	• PM-chaired SDGs promotion headquarter overseeing STI taskforce
Serbia	13,721	62	94	• S&T strategy, smart specialization, legal, institutional frameworks and M&E • Min of Edu, S&T, with inter-ministerial coordination bodies • Support: EU/EC JRC, OECD, WB	• Move faster with 4th industrial revolution, entrepreneurship, IT sector development • Support: Germany (Fraunhofer)	• EU accession process (ERPs) facilitates SDGs-related cross-sectoral reforms, while STI's role yet to be defined
Colombia	13,124	65	61	• STI in NDP consolidating productive and academic sector policies • Planning Dept. and a national council comprising of ministries & industry • Support: WB, OECD	• Big data guideline, smart cities, CoE for IoT, human capital investments • Discussions on effects of tech on unemployment in infancy	• OECD accession process facilitate alignment of NDPs to SDG Targets • Green Growth Mission with STI as a key
Brazil	14,024	69	75	• STI strategy and legal framework • Min. of STI with research institutes and industry • Support: EU, OECD, WB	• Cyber security; frontier scientific research and commercialization	• Commission for 2030 agenda implementation to analyse targets and verify sufficiency / gaps
Guatemala	7,367	98	78	• S&T policy with constitutional and legal frameworks • National STI council • Support: Chile (CONISYT), UNESCO	• Open data portal, biomass research • Support: CELAC	• STI roadmap yet to be an integral element of SDGs plans; early efforts by S&T secretariat
Ghana	3,980	n.a.	119	• National STI Policy • Min of Env & STI, with scientific institutions • Support: UNCTAD, WB, Denmark (DANIDA)	• Biosafety Act on GMOs • Awareness emerging on AI and robotics	• Political championship for SDGs; STI roadmap yet to be elaborated

[28] GDP p.c.: 2016 GPD per capita, PPP in 2011 USD (WB WDI), GII: Global Innovation Index 2017 (WIPO, Cornel Univ. and INSEAD), GCI: Global Competitiveness Index 2016-17 (WEF).

Integration: overall, most countries are yet to fully integrate STI to respective national sustainable development strategies. This integration appears to involve at least the below three aspects:

- First, extent to which countries have mainstreamed SDGs into national development strategies obviously varies and depends on multiple factors, such as cultural context (e.g. Thailand's SEP: Sufficiency Economy Philosophy), political and administrative leadership (e.g. PM championship in Japan), and accession planning to regional or other cooperation bodies requiring adherence to shared policy standards (e.g. Serbia to EU, Colombia to OECD).
- Second, extent to which STI is integrated into national plans toward the SDGs also varies, and depends on awareness, readiness and capabilities to harness STI to achieve the national priorities both vertically (per sectors or Goals) and horizontally (STI system-wide). Even in countries at relatively lower level of maturity in STI foundation and adaptation, though, additional factors can drive this aspect of integration, such as early STI successes (Rwanda, Kenya) and international learning and spillover (e.g. Jamaica and CARICOM).
- Third, functioning of science-policy interface, including understanding of inter-linkages, trade-offs and synergies across or within economic, social and environmental objectives (and through both natural and social sciences), varies and affects effectiveness and efficiency of policy mix to achieve the SDGs ("science for policy" rather than "policy for science"). This is underpinned by the breadth and depth of engagements between policy-/decision-makers and STI stakeholders, and can be spearheaded by domestic leading research institutes (e.g. Fiocruz in Brazil) and/or international multi-stakeholder cooperation (e.g. ICSU/INGSA with pilot countries).

Given that the UN Member States are still at an initial stage of the collective journey to fully harness STI for SDGs, the common challenges are around generating awareness, momentum and political will, with demonstrated utility of integrated approaches to STI for SDGs roadmaps.

5. International facilitation and cooperation

Against the richness of "supply-side" of international support to country level STI Roadmaps along the three aspects (foundation, adaptation and integration) as summarized in Chapter 3, "demand-side" discussions at the EGM in Tokyo complemented by analyses of countries' and agencies' examples highlighted several takeaways and questions for further discussions.

Roles of international and supranational policy guidance and assistance. Regional and other cooperation bodies are influencing country-level strategies and roadmaps, by incentivizing governments to adhere to policy standards, providing technical assistance for capacity building, funding investments, and facilitating spillover and peer learning. Based on country reviews, it should be noted that catalytic influence and technical, financial capacities of the coordination bodies vary (e.g. across EU, OECD, ASEAN, CARICOM, AU). What next steps can members of these organizations take to learn from each other and strengthen the necessary capabilities to harness STI for the SDGs, generating regional or collective goods and addressing collective challenges?

STI strategies by donor countries / agencies. Developed countries and donor organizations (e.g. EC JRC, Japan, UK, Australia) and emerging donors (e.g. China, Korea, Brazil, Thailand) have capably demonstrated that STI can support the acceleration of achievement of the SDGs across national borders, assisting developing countries through STI cooperation based on respective countries' development experiences and comparative advantages. Meanwhile, in most donor countries, public spending for STI has increased faster than, or at least decreased slower than, for official development assistance. In a fiscally constrained and interconnected world, what international STI cooperation strategies by and among developed countries can best harness STI as a 'bridging force' to serve both national and global interests?

UN agencies' 'business models' in support of STI roadmaps. Many developing countries have benefitted from UN agencies' support and expertise, notably UNCTAD, UNESCO, WB and Regional Commissions, to diagnose and strengthen foundations of STI systems and capabilities. Countries also have utilized function-/sector-/goal-specific STI assistance from agencies such as WIPO, UNIDO, UNEP, ITU, among others. Yet, the number of countries these agencies can assist per year, under current financial, administrative and operational models and instruments falls short of closing the gaps among countries and could be inadequate to deliver on the commitment of "leaving no one behind" by 2030. How best can UN agencies join forces to synergize, and harmonize where appropriate, methodologies and approaches to fit countries' demands and fill the gaps, at scale, while acknowledging and accommodating diversity of realities and circumstances countries face?

Upon progress of deliberations on country level roadmaps, the IATT sub-working group on STI roadmaps will explore over the next year some of these questions with a view to also promote international and global STI roadmaps, as part of TFM's work program toward the fourth STI Forum.

6. Conclusion

The EGM discussions reconfirmed that "STI for SDGs Roadmaps" are a powerful multi-stakeholder engagement tool to envision, plan, communicate and facilitate actions, track progress, and foster a learning environment to harness STI to achieve the SDGs. STI for SDGs Roadmaps as integral elements of national sustainable development strategies can be TFM's major output over the next two years by elevating the STI agenda to the highest political level of respective countries' decision makers.

In response to strong interest expressed by countries participating in the deliberations so far, IATT is committed to implement an inter-sessional work program in 2018/19 to pilot and scale adoption of country level roadmaps, develop common principles of STI for SDGs Roadmaps based on lessons learnt, and strengthen international cooperation accordingly. Upon further consultations and analysis, the inter-sessional work program can include the following components:

- **Peer learning**: nurturing a community of policy practitioners on STI for SDGs Roadmaps, to share common challenges and identify good practices, engaging developed and developing countries and refining conceptual frameworks presented in this paper for further discussions.
- **Joint support for pilots**: identifying pilot countries for joint assessment, building on existing work programs of IATT agencies and other organizations, with a view to better synergize, harmonize and scale-up existing approaches, methodologies and instruments related to development and implementation of STI Roadmaps through economy-wide and sector/Goal-specific policy reviews, technology needs assessments, foresight exercises, and other technical and financial assistance.
- **Donor coordination**: promote dialogues among donor countries and agencies to take stock of existing international assistance programs on STI, with a view to strengthen complementarities, increase multi-stakeholder participation (possibly including research funders, philanthropies and private investors) and better address recipients' needs and gaps.
- **Knowledge and advocacy**: commissioning a group of experts to mainstream STI for SDGs roadmaps at the broader development policy discourse, gather and synthesize evidence base and country case studies, define future research agendas, and propose concrete actions by TFM to inform possible development of global STI roadmaps to facilitate subnational, national and international efforts toward achievement of the SDGs by all Member States.

This background paper provides an overview of the current efforts toward STI for SDGs roadmaps as a common understanding for incoming participants to the collective efforts. The IATT will stand ready to engage in further deliberations with Member States and stakeholders to advance the contribution of STI to achievement of the SDGs.

Acknowledgements and Disclaimers

[To be added in the final paper]

Annex 1: STI diagnostics and assistance for country level STI roadmaps

Case of Rwanda

Historical UN System Inputs to Rwanda

Agency	WB	UNEP	UNIDO	WIPO	UNDP	UNESCO	UNCTAD	ITU
Instru-ment	Building Science, Technology, and Innovation Capacity in Rwanda; New Drivers of Growth Study	Rwanda Technical Needs Assessment	Review of the SEZ Policy and Development of Industrial Parks in Rwanda	Integrating Intellectual Property into Innovation Policy Formulation in Rwanda	Foresight Xchange	GO→ SPIN: Country Profile: Rwanda	Rwanda STIP Reviews	Rwanda ICT centric innovation ecosystem country review
Scope	National	Sector	Sector	Function	Foresight	National	National	Function
Time Started	2006, 2018	2009	2013	2014	2014	2015	2016	2017
Length of Study		4 years	2 years	7 months		1 year	7 months	In process

Rwanda has experienced a recovery from an unprecedented tragedy until 1994 through impressive development strides during last twenty years, benefiting from a strong and visionary leadership. The government aims to develop a service-oriented and knowledge-based economy and to use STI to drive economic and social opportunity under a strategic document entitled Envision 2020.

Against this dynamic backdrop, almost all UN agencies with STI-related programs and instruments have provided support into key issues related to STI in Rwanda in past fifteen years. UN System's combined footprint in Rwanda's economy and STI's roles in it therefore provides a rich space for reflections and analysis of comparative advantages among agencies and lessons on potential improvements.

World Bank, at an early phase of Rwanda's recovery and growth, analysed policy needs and addresses specific recommendations on institutions and programs. With the support of the World Bank and UNESCO, Rwanda's national STI policy was approved and published in 2005, taking the first step of transforming Rwanda into a knowledge-based society. World Bank then played a crucial role in the second and third step converting STI policy into detailed and specific programs and implementing these recommendations. From conducting a baseline study of existing capacity and constraints to making particular recommendations like "…train 50 environmental impact assessment experts in various industrial subsectors, including food processing", World Bank prepared a series of detailed Needs Assessment and Action Plans (NAAPs) for Rwanda's national STI capacity building.

UNESCO recently conducted a comprehensive review of STI policies building on a standardized data collection process and providing comparative insights. UNESCO STI policy review *Mapping Innovation and Research in Rwanda* is based on Rwanda government's replies to a standardized survey (GO->SPIN Survey) on STI policies and operational policy instruments. This standard survey is distributed worldwide and can be implemented by other agencies. For example, the African Observatory on STI (AOSTI) took the responsibility for following up GO->SPIN surveys with a group of West African Countries after 2013. Also, Rwanda's country profile contains inventories of stakeholders, legal framework, and contents of STI policies, which offer a complete set of essential information to policymakers and researchers. Regarding functional diagnostic after 2015, the

inventory of Rwanda STI institutions provides UN agencies or other research institutions a detailed list of 56 actors including government ministries, public agencies, and private sector institutions.

UNCTAD also conducted STIP review and recommended sector-specific actions in line with a few of the SDGs, by looking into interrelationships among the goals and identifying trade-offs and strengthening policy synergies across Rwanda's sectoral development. This STIP review examined a group of actors' involvements in Rwanda's STI policy towards SDGs, including business, municipalities, civil society, and academia. By further assessing STI policies in energy, ICT, agriculture, and industry, UNCTAD proposed an action plan in terms of immediate needs, long-term strategies, and sector policies. For instance, when reviewing the technological research services (SDG 9) in Rwanda, the report called for policy attention across domains in medicine and health (SDG 3), agriculture (SDG 2 & 8), and industry (SDG 9) regarding to government R&D expenditure and aim to facilitate the emergence of a well-balanced sectoral innovation subsystems.

Besides economy-wide STI policy review and assessment, UN agencies have also conducted deep-dive analysis and technical assistance for Rwanda' STI strategy and capacity, focusing on specific goals or domains. WIPO implemented a project to review Rwanda's NIS and helped Rwanda integrate intellectual property into innovation policy formulation in May 2014. ITU's country review for ICT Centric Innovation Ecosystem in Rwanda is still in progress. UNEP's TNA project highlights the most appropriate technologies with implementation action plans in agriculture and energy sector, which has highest vulnerability characteristics in Rwanda, to mitigate or adapt to the effects of climate change.

UN agencies adopted foresight exercises for Rwanda to help further explore governance growth opportunities and promote innovation in public service delivery. In 2014, UNDP Global Centre for Public Service Excellence (GCPSE) worked closely with Rwanda government to bring decision markers together for a knowledge sharing event name foresightXchange for the foresight methodologies learning and policy development on urbanization and rural development[29]. Through the workshop, Rwanda developed a shared understanding and vision of the use of strategic foresight in enhancing the policy development capacity, and commissioned a further foresight study in 2016 in line with the Economic Development and Poverty Reduction Strategy (EDPRS II) targeting on improving service delivery in secondary cities to promote the quality of life for all Rwandans toward SDGs.

Rwanda STI policy reviews and assessments conducted by each UN agency may have rooms for further synergies. UNESCO and UNCTAD for example implemented policy review projects covering a very similar time frame for Rwanda, so the policy review outputs were partially overlapped. While the data collection methods carried by authors were different, there might have been a certain amount of duplicated work like the fact-finding mission, desk review, and stakeholder interviews.

The lack of appropriate human capital within different sectors in Rwanda was a common challenge identified by almost every STI policy review or functional diagnostic. Recommendations by agencies vary – from UNCTAD on labor market survey[30], UNEP and WIPO on strengthening training to individuals[31] to ITU on advocacy and outreach to youth[32], lacking system-wide coherence or strategic roadmap to address capacity demands at individual, institutional and societal levels.

[29]UNDP, Introduction to UNDP Global Centre for Public Service Excellence (2015)

[30] "conducting a national job market or labor force demand research to identify the gap between market demand and labor force supply within all industries"(UNCTAD)

[31]" *Setting up … regular training in energy sector especially for design and management of power plants (UNEP TNA); Incorporate intellectual property into the curriculum of primary, secondary and higher educational establishments and promote intellectual property education at all levels … "*(WIPO)

[32] "*There is a need to guide more young people into ICT careers, through community outreach, mentorship, and strengthened curricula"(*ITU)

Case of Brazil

Coverage of Brazil in STI assessments and assistance by international organizations

Agency	EU	UNIDO	UNESCO	OECD	WB
Instruments	RIO (Previously named Erawatch) Country Report 2015	UNIDO National report on e-commerce development	Science Report	STI Outlook 2016	Lending and technical assistance
Category	National Review	Functional Diagnostic	National Review	National Review	Subnational, sectoral
Time Started	2010	2017	2015	2017	Ongoing
Length of Study	Annual Report			Biennial Report	

After a rapid economic growth and social progress up to 2013, Brazil's economy first stumbled and then fell into recession, triggered by weaker international commodities markets on which Brazil is highly dependent, with a rising domestic political uncertainty. To boost the country's economic performance and increase productivity through innovation, the government launched the new National Strategy in Science, Technology and Innovation (ENCTI 2016-2019) in May 2016, aimed to raise national STI investment to 2% of GDP until the end of 2019.

Even though the social inclusion progress is slowing down and the labour productivity is stagnating, Brazil is still at the scientific and technological forefront in many areas such as agricultural production and tropical diseases control and treatment and has universal cooperation in STI with countries, regions and international organizations. EU and OECD, UNESCO, and UNIDO's studies shed light on Brazil's national innovation system from different angles and represent rooms for rich discussions on potential synergies, coherence and complementarities among UN system support toward Brazil's STI roadmaps at national and subnational levels for the SDGs.

OECD's national innovation profile provides a biennial analysis of new policies and instruments being used in Brazil and monitors Brazil STI performance. Brazil's *National Innovation Profile*, as a part of *OECD Science, Technology, and Innovation Outlook*, briefly covers Brazil NIS's dynamics and state based on most recent data from OECD, taking account of the framework conditions for innovation and economic environment. As these STI outlooks are biennial reports, the innovation assessments are focusing on recent policy changes rather than reiterating existing challenges and policies. Furthermore, reports benchmark Brazil STI system's performance with OECD member states' using OECD STI performance index, which helps Brazil to monitor the policy implementation and assess the performance. For example, by comparing the benchmark exercise in 2014 and 2016, decision makers and researchers can easily find Brazil made a great stride in improving entrepreneurship environment and increasing international co-invention.

EU's *Research and Innovation Observatory (RIO) National Report* conducted national STIP assessments for Brazil with a focus on internationalization in line with SDG 17. Comparing to OECD's national innovation profile, EU conducted very similar but more comprehensive assessments of Brazilian research and innovation (R&I) system annually by analysing R&I expenditure and framework conditions. Nevertheless, *RIO National Reports* aligned the assessment in line with SDG 17, specifically focusing on Brazilian foreign policies for R&I cooperation and scientific interactions at national, regional and global level. For instance, the 2016 review called EU member and other partners' attention to several Brazilian scientific and research activities by generating a list of programmes with collaboration potential. EU's national STIP assessments for Brazil present a unique

way for countries, especially countries with comparative advantage in STI field, to develop the NIS with a strong commitment to global partnership and cooperation.

Despite the unfavourable economic landscape in Brazil, E-commerce industry is not likely suffered as much as others, in which became the target sector UNIDO conducted a functional diagnosis. E-commerce development in Brazil outweighed the effect of economic instability like inflation, bureaucracy and protected economy and maintained growth because of the large and young middle class and growing internet connectivity. UNIDO's *National Report on E-Commerce Development in Brazil* examined the industry landscape and identified the challenges for SME and E-commerce business, to design solutions in meeting country's demand of boosting the whole economy and improving STI performance. This report could be a functional diagnosis model in E-commerce for countries with a sizable population and similar unstable political or economic environment like Colombia to develop a subsystem within NIS towards SDGs.

UNESCO's *Science Report* is unique in providing a comprehensive scientific landscape at global, regional and national level, reflecting the insights of socio-economic, geopolitical and environmental trends. In the case of Brazil, trends in STI governance, R&D and education have been revealed and a regional unbalanced STI development problem has been raised because of the country's large territory. The combined picture drew by UNESCO improved Brazil decision makers' understanding of regional and global support to STI related issues like funding sources and human resource mobility.

World Bank has focused largely on strengthening public administration capacities on STI at State and sectoral levels. At State level, for example, $480m Rio Grande do Sul program focuses on strengthening the capacity of the State planning agency and sector secretariats for infrastructure, education, economic development and science and technology. At sector level, $50m Energy and Mineral Sector Strengthening program aims to strengthen the capacity of key public sector institutions to improve the contribution of energy and mineral resources to accelerated national economic growth and increased social and environmental sustainability in a context of globalization and technological change, including through enhancement of applied sectoral R&D laboratories.

National STI assessment reports and assistance programs for Brazil conducted by different agencies represent wide-ranging partnerships, while posing a challenge to further synergies and coherence facing unstable policy environment. From 2012 to 2016, four Science, Technology and Innovation Ministers were nominated and the Ministry of Science, Technology and Innovation and the Ministry of Communications were merged. Assessments largely agree on bottlenecks that hindering STI development in Brazil, such as internal market protection, complicated tax structure, insufficient talent availability, and underdeveloped infrastructure, while emphasis varied. For example, OECD measured Brazil's globalization level through the low share of international co-authored scientific articles and international co-patenting but EU more valued Brazil's universal foreign policy for STI cooperation. As UNESCO points out regional development is unbalanced, across Brazil's highly diverse 27 states, while subnational assessment and assistance have been limited by UN System besides World Bank.

Annex 2: Foresight tools at UN and international organizations

UNCTAD

UNCTAD, through The Commission on Science and Technology for Development (CSTD), has been advocating the relevance and the use of strategic foresight in policy making. In 2014, CSTD addressed Strategic foresight for the post-2015 development agenda as one of its priority themes, outlining experiences around the world through a mapping analysis of the top ten foresight methods per region:

> Foresight exercises in **Europe** emphasize both anticipating and collaboratively shaping the future through coordinated governance and decision-making. Foresight is increasingly practised in an institutionalized form and there is growing interest in sharing foresight experiences, for example through the European Foresight Platform and the International Foresight Academy. Some countries, such as France, have a rich history of futures work that stretches back several decades and still influences current practice. Others, for example Ireland and the United Kingdom of Great Britain and Northern Ireland, have a shorter history influenced by technology foresight and sustainable futures traditions. In Eastern Europe, little legacy remains of the communist era tradition of futures thinking in the context of State central planning. Recent work has been heavily influenced by technology foresight practices in Northern and Western Europe. The European Commission and the United Nations Industrial Development Organization have played important roles in this policy tool transfer. Activities in Southern Europe began relatively recently, with over half represented by technology foresight exercises in Spain.
>
> Foresight in **Latin America** has evolved slowly but progressively. Many countries have launched national programmes and projects incorporating concepts and techniques from a wide range of international foresight exercises, mainly from Europe. However, the region has also achieved its own foresight style due to the creative use of limited resources, which has at times resulted in effective innovations in practices and tools, from new management systems and online support tools to new ways of achieving stakeholder commitment. International organizations, such as the Organization of the Andrés Bello Agreement on Educational, Scientific and Cultural Integration, United Nations Economic Commission for Latin America and the Caribbean, United Nations Industrial Development Organization and, more recently, the European Commission, have also played a key role in supporting foresight programmes and capacity-building activities in the region.
>
> In **North America**, many of the most popular foresight methods were developed in the United States of America in the 1950s and 1960s and used extensively in both the public and private sectors. Much foresight activity is conducted at State and federal levels in Canada and the United States. The National Intelligence Council of the United States produces a global trends report to shape strategic conversations within and beyond Government. Sectoral technology road map exercises are particularly popular among United States firms.
>
> In **Asia**, Japan pioneered the development of national technology foresight and, since 1970, has used the Delphi method to forecast and shape future technological trajectories. Besides having an influence in Europe, experiences in Japan inspired similar exercises in China and the Republic of Korea and in South-East Asia. In the context of the Asia-Pacific Economic Cooperation forum, the Centre for Technology Foresight was set up in 1998 to conduct region-wide studies and develop capabilities in member countries, work largely influenced by practices in Australia, Japan, North America and Northern and Western Europe.
>
> Most foresight exercises in **Africa** are sponsored or conducted by international organizations, such as the African Development Bank, European Union, Food and Agriculture Organization of the

United Nations, International Food Policy Research Institute, Joint United Nations Programme on HIV/AIDS and United Nations Development Programme. The majority of exercises consider Africa as whole and only a few focus on individual countries.

UNCTAD published Foresight for Digital Development report analyzing new digital trends such as 3D printing, Big Data, Internet of Things, Massive Open Online Courses and automation from a policy perspective, and positioned integration of strategic foresight thinking into the national planning and policy process as an important policy innovation for implementation of the 2030 agenda. In 2017, UNCTAD released a technical research paper "Digital Tools for Foresight" that explores how Big Data and computer simulations could enrich existing foresight methods; the paper presents use cases from developing countries that address some of the SDGs.

UNDP

In 2012 UNDP, in collaboration with the Government of Singapore, established the Global Centre for Public Service Excellence (GCPSE). GCPSE champions public service excellence by applying research findings towards the improvement of government policies and UNDP's programming. GCPSE is leading UNDP's strategic foresight agenda, through a series of publications[33].

By 2017, GCPSE has worked closely with over 15 governments (Rwanda, Tonga, Maldives, the Pacific region, Papua New Guinea, Kazakhstan, Mauritius, Sri Lanka, Lesotho, Ghana, Namibia, South Africa, and Malawi) in exploring, tailoring and mainstreaming Foresight for development, development planning or SDGs implementation. In 2018 GCPSE released a comprehensive and user-friendly Foresight manual.

UNESCO

UNESCO has had a strong dedication to building internal foresight capabilities for more than a decade – its Anticipation and Foresight Programme was established in 1999 and had been informing the insights for UNESCO World Reports as well as organizing lecture series. The program was evaluated in 2006[34]. Currently, the majority of UNESCO's foresight activities were conducted under the Bureau of Strategic Planning.

UNESCO has the Intersectoral Platform on Anticipation and Foresight under its Social and Human Sciences agenda. The platform, launched in 2009 with the last updates in 2014, includes:

- The UNESCO Future Forum series aims at fostering the reflection on key future-oriented issues in the domains of the Organization.
- The UNESCO Future Lecture Series is an opportunity for an audience composed of representatives of UNESCO's Member States, its Secretariat, the scientific and intellectual community, civil society and the media to exchange views with internationally renowned personalities on issues of concern.

In 2014, UNESCO initiated a two-day knowledge lab to explore the role of foresight and anticipation in the Organization's work. The KnowLab presented 2 cases of UNESCO using foresight – All Africa Futures Forum (2014) and the UNESCO Internal Oversight Service (IOS). IOS provides independent oversight including internal audit, evaluation, and investigation to support the Organization's functioning.[35]

[33] Foresight as a Strategic Long-Term Planning Tool for Developing Countries (2014); Stewardship of the Future (2015); Africa and Foresight: Better Futures in Development (2017)
[34] UNESCO, Evaluation of UNESCO Anticipation and Foresight Programme (2016)
[35] UNESCO, How Do We Identify Great Opportunities? – A Reflective Report (2015)

Currently, UNESCO is preparing to release its major work on Futures Literacy [36] - publication Transforming the Future: Anticipation in the 21st Century (to be released on April 25, 2018). One of the case studies in the forthcoming publication[37] includes Futures Literacy Laboratories (FLL) - an innovative action-research/action-learning methodology that allows people to discover and share both the reasons for using the future and how to use it. Since 2013, UNESCO has been able to collaborate with local partners to run over 30 FLL.

UNDG

In 2016, UNDG's Innovation Facilities commissioned a report on Applying Foresight and Alternative Future to the United Nations Development Assistance Framework. This publication got the closest to technical analysis of possibilities of integrating foresight with UN tools (such as technical assistance).

European Union

European Commission's Directorate-General for Research and Innovation (DG RTD) produce research around foresight and use foresight activities in their work. On the producer side, DG RTD supervises high-priority interdisciplinary foresight projects that are carried out either by high-level expert groups or in collaboration with academic institutions. Foresight projects are funded under different DG RTD research themes, some examples of the latest research projects include:

- Collaborative project "Forward-looking analysis of grand societal challenges and innovative policies" (2013-2015) that aims at developing a set of scenarios of long-term socioeconomic evolution in the EU.
- Collaborative project Foodsecure (2012-2017), a research consortium that aims at providing tools and strategies to assess the future of global food and nutrition security.
- "Future prospects on transport evolution and innovation challenges for the competitiveness of Europe" project (2012-2014) that explores scenarios of transport innovations and their implementation to address the issue of competitiveness for EU transport industries and service providers.
- Future Scenarios for Research & Innovation Policies in Europe is one of the latest foresight reports produced by the DG RTD.

On the user side, DG RTD recently established a unit (DG RTD UNIT A6) with the mission of leading foresight for research and innovation policymaking; the unit played a significant role in establishing the Horizon 2020 agenda.[38]

EU's Joint Research Centre (JRC) provides foresight intelligence, develops methodological guides, training courses and networks on foresight. The JRC manages the sharing platforms Forlearn and Forsociety and organizes an annual international conference on future-oriented technology analysis (FTA).

In 2016, the Foresight and Behavioral Insights unit was established at the JRC to focus on innovation in public policy through foresight, horizon scanning, policy labs and behavioral sciences. Later it was transformed into the EU Policy Lab is a collaborative and experimental space for innovative policymaking. It is both a physical space and a way of working that combines foresight, behavioral

[36] UNESCO, UNESCO Pioneers Futures Literacy (2017)
[37] UNESCO, Transforming the Future: Anticipation in the 21st Century (Forthcoming, 2018)
[38] EU, Concurrent Design Foresight (2015)

insights and design thinking. Currently the EU Policy Lab is conducting a foresight study on SDGs, basing the process on scenarios and building on previous experience.

The JRC co-developed a future simulation tool called the 'Scenario Exploration System' (SES) that engages participants in future-oriented systems thinking. The simulation uses foresight studies produced by JRC, such as "2035: Paths towards a Sustainable EU Economy" and "Delivering on EU food safety and nutrition in 2050 – Future challenges and policy".

OECD

The OECD has a long history of using foresight activities: the OECD's strategic foresight group – International Futures Programme (IFP) – was created in 1990 and existed for almost 25 years. The Programme was tasked with monitoring major developments and trends; highlighting growth sectors of the future; and testing new ideas to help governments map strategy. The work included cross-sectoral foresight research, as well as themed reports.[39] The latest IFP reports were published in 2014 and focus on the space economy[40]. Results of more recent foresight research activities be found in reports such as Science, Technology, and Innovation Outlook (2016) that has a chapter on Future Technology Trends.

The OECD actively engages in community building around foresight activities. In 2005 the OECD Committee for Digital Economy Policy started organizing Technology Foresight Forums to help identify opportunities and challenges for the Internet economy posed by technical developments. In 2014, the OECD launched Government Foresight Community with over 60 experienced foresight practitioners from 23 governments to facilitate the knowledge exchange.

[39] OECD, Foresight at OECD: Supporting Long-term Policy Making (2011)
[40] OECD, The Space Economy at Glance 2014 (2014)

Annex 3: Goal-specific STI trend analysis, toolkits and benchmarking

SDG 2 Zero Hunger

World Bank Group: Agricultural Innovation Systems: An Investment Sourcebook draws on the emerging principles of Agricultural Innovation System (AIS) analysis and action to help to identify, design, and implement the investments, approaches, and complementary interventions that appear most likely to strengthen innovation systems and promote agricultural innovation and equitable growth.

UNCTAD: The role of science, technology and innovation in ensuring food security by 2030 introduces the challenge of ensuring food security and one section of the report explores how countries can reimagine their food systems as innovation systems with attentions to the building of local innovative capabilities, enabling infrastructure for agricultural innovation, developing coherent policies and strengthening knowledge flows to facilitate technology dissemination.

CELAC and FAO: Innovation for Sustainable Rural Development aims to recognize that the experience and knowledge of family farming can also be a source of innovation, and to propose a theoretical policy framework that enables innovation to be part of a sustainable rural strategy based on the strengthening of family farming and an inclusive food system.

OECD: Agricultural Innovation Systems reviews recent trends in agricultural innovation systems (AIS) and discusses the impact of a wide range of policies on the creation and diffusion of innovation in the agricultural and agrifood sector. It suggests a framework for analyzing the role of governments in fostering increased innovation, with a view to helping to identify practical actions that governments could take to improve productivity growth, sustainable use of resources, and resilience to future market developments in national and global agriculture and agrifood systems.

IFAD: Rural Development Report 2016 focuses on inclusive rural transformation as a central element of the global efforts to eliminate poverty and hunger, and build inclusive and sustainable societies for all by analyzing global, regional, and national pathways of rural transformation within four stages.

SDG 3 Good Health and Well-being

WTO, WHO, WIPO (Trilateral Cooperation): Promoting Access to Medical Technologies and Innovation – Intersection between Public Health, Intellectual Property and Trade has emerged from an ongoing programme of trilateral cooperation between WHO, WTO and WIPO. It responds to an increasing demand, particularly in developing countries, for strengthened capacity for informed policy-making in areas of intersection between health, trade and IP, focusing on access to and innovation of medicines and other medical technologies.

FAO, OIE, WHO (Tripartite Collaboration): One Health WHO works closely with the FAO and the World Organisation for Animal Health (OIE) to promote multi-sectoral responses to food safety hazards, risks from zoonoses, and other public health threats at the human-animal-ecosystem interface and provide guidance on how to reduce these risks. Product: Antimicrobial resistance – A manual for developing national action plan.

UNCTAD and WHO: UNCTAD and WHO have been collaborating under the Global Strategy and Plan of Action on Public Health, Innovation and Intellectual Property on issues related to technology transfer and the local production of pharmaceuticals in developing countries.

SDG 4 Quality Education

UNESCO: Science Report (National and Regional Level) analyses the trends and developments in science, technology and innovation policy and governance between 2010 and mid-2015 described in Science Report provide essential baseline information on the concerns and priorities of countries with the aim of orienting the implementation of the Agenda 2030 and driving the assessment of the SDGs. (The reports take a glance of global trends in innovation, as well as regional/national major policy reforms or transitions in STI field.)

SDG 5 Gender Equality

UNESCO: Measuring Gender Equality in Science and Engineering: The SAGA Science, Technology and Innovation Gender Objectives List For the advancement of gender equality in STEM, UNESCO has developed, within the framework of SAGA project, a toolkit aimed at defining a conceptual and methodological framework to integrate, monitor and evaluate gender equality in STEM and improve the design of gender-sensitive and evidence-based policies.

UNDG: Gender Equality and Big Data outlines the value of big data (organic, unstructured data) for monitoring the Sustainable Development Goals (SDGs) in relation to women. Research methods included a landscape review, interviews with UN Women and UN Global Pulse experts, and others in international development. The report presents the benefits of big data (for example, real time data), risks (for example, elite capture and privacy), and policy implications (for example, how it can be incorporated in project cycles from planning to evaluation). It ends with a compendium of gender-related big data projects and their relevance to the SDGs.

SDG 6 Clean Water and Sanitation

UN Water: The UN World Water Development Report (Annual) is a comprehensive review that gives an overall picture of the state, use and management of the world's freshwater resources and aims to provide decision-makers with tools to formulate and implement sustainable water policies. The Knowledge, Innovation, Research, and Capacity Development chapter offers a review of trends in knowledge, research, innovation, capacity building and wastewater management, with a focus on current gaps and barriers. Responses to these challenges are presented in terms of capacity development, public awareness and improved collaboration, highlighting the potential for improving cost recovery and applying technological responses at appropriate scales.

SDG 7 Affordable and Clean Energy

World Bank: Regulatory Indicators for Sustainable Energy: A Global Scorecard for Policy Makers (RISE) is a tool for policymakers to compare national policy frameworks for sustainable energy and identify opportunities to attract investment. RISE assesses countries' policy support for each of the three pillars of sustainable energy – access to modern energy, energy efficiency, and renewable energy. With 27 indicators covering 111 countries and representing 96% of the world population, RISE provides a reference point to help policymakers benchmark their sector policy framework against those of regional and global peers, and a powerful tool to help develop policies that advance sustainable energy goals.

International Renewable Energy Agency (IREA): Renewable Energy Innovation Outlook analyses the emerging developments, identifies technology-, industry- and policy-related challenges to be overcome, and assesses the potential breakthroughs and research needed to scale-up the deployment of renewable-based solutions.

IREA: Renewable Energy Readiness Assessment (National level) provides valuable policy guidance and technical assistance to determine the best available renewable-based power options. The resulting guidance helps to devise effective implementing mechanism for renewables and simultaneously improve the country's energy security.

SDG 8 Decent Work and Economic Growth

WIPO: Integrating Intellectual Property into Innovation Policy Formulation (National Level) reviews IP in national innovation systems. Determining gaps and challenges through in-depth discussions with stakeholders; Country-specific recommendations for more effectively using the IP to strengthen NIS; Assist interested countries in formulating IP strategies which are aligned with national development priorities.

UNCTAD: Entrepreneurship Policy Framework and Implementation Guidance (Technical Cooperation at National Level) conducts a comprehensive assessment of the current state of the national "eco-system" in which entrepreneurs acquire their skills, develop their business plans, start up, operate and grow their businesses, identifying country specific challenges and constraints in the process. With the knowledge acquired, UNCTAD works with policymakers, institutions and entrepreneurs to set objectives and targets for an overall national entrepreneurship strategy, defining priorities both in terms of groups of entrepreneurs to be assisted and in terms of policy gaps and bottlenecks to be remedied.

IFC: Landscape of Inclusive Business Models of Healthcare in India: Business Model Innovations International Finance Corporation (IFC) defines inclusive business models (IBM) as enterprises that help expand access to goods, services, and livelihood opportunities to those at the base of the pyramid in commercially viable, scalable ways. The context of India - poor health indicators, a globalized economy, the government's willingness to work with the private sector, and recognition of the poor as clients rather than beneficiaries - has led to the emergence of inclusive business models in the Indian economy.

SDG 9 Industry, Innovation and Infrastructure

UNIDO: National Report on E-commerce development (National Level) analyses MSME in the country and cross-border e-commerce challenge.

UNIDO: Industrial development report 2016: The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development Through evidence-based research and analysis, IDR 2016 highly appreciates the role of technology and technological innovation in the process of industrialization and affirms the necessity of industrialization for the development process. Key findings of the report indicate that technology can help promote all three dimensions of developments, i.e. economy, society, and environment.

ITU: ICT centric Innovation Ecosystem Country Review (National Level) A Country Review provides a comprehensive assessment of the innovation ecosystem and a full digital transformation roadmap with specific policies and project recommendations, at the national level. Country reviews are a multi-stakeholder, cross-sectoral approach to develop ICT centric innovation policies and programs at the national level.

SDG 11 Sustainable Cities and Communities

UNCTAD: Science, technology and innovation for sustainable cities and peri-urban communities provides an overview of how science, technology and innovation can address key challenges of rapid

urbanization, particularly in developing countries. It proposes technology and policy options for consideration by national governments and the international community, with a view to promoting sustainable urban development.

UNEP: International Environmental Technology Center (IETC) (National Level) Policy Advice - IETC provides technical and advisory support to governments, helping to enhance national and local use of environmentally sound technologies and approaches. IETC has developed a methodology – sustainability assessment of technologies (SAT) – to assist policy makers in the assessment and selection of the appropriate technology under specific local conditions.

UNEP (PAGE): Green Industrial Policy: Concept, Policies, Country Experiences gives a detailed overview of different policies and instruments for green industrial policy, analyses the key policies that support structural change and enhance productivity, while taking social and environmental concerns into account; and examines case studies from four countries at different levels of income and technological capacity.

SDG 12 Responsible Consumption and Production

UNEP: Switch Africa Green - Policy Support Component (National Level) supports the formulation of policies, regulations and standards, and the establishment, or strengthening, of relevant institutions necessary for resource efficient and green businesses to emerge and grow. The policy support component also supports the collection, analysis and dissemination of data on the combination of economic, social and environmental gains from the shift to SCP (Sustainable Consumption and Production) practices, to promote engagement of other ministries responsible for economic and development policies. The extent to which the public sector can support demand for more sustainable goods and services through procurement activities will also be explored.

IETC: Guidelines for Framework Legislation for Integrated Waste Management provide relevant information to those who are involved in developing waste management legislation, and through that, assist them in considering appropriate legal and administrative measures which might be suitable to their national circumstances.

SDG 13 Climate Action

UNEP: Technology Needs Assessment (National Level) assists developing country Parties to the UNFCCC determine their technology priorities for the mitigation of greenhouse gas emissions and adaptation to climate change.

UNDP: Handbook for Conducting Technology Needs Assessment for Climate Change helps countries articulate their own priority technology needs and formulate appropriate actions.

SDG 14 Life below Water

OECD: The Ocean Economy in 2030 explores the growth prospects for the ocean economy, its capacity for future employment creation and innovation, and its role in addressing global challenges. Special attention is devoted to the emerging ocean-based industries in light of their high growth and innovation potential, and contribution to addressing challenges such as energy security, environment, climate change, and food security.

OECD: The Ocean Economy and Innovation by Directorate for Science, Technology and Innovation is a programme of work on the ocean economy and innovation with the objective to provide decision-makers with an improved toolbox to foster innovation for harnessing the ocean economy's potential

in a responsible and sustainable way. This will include new evidence-based information to decision-makers to improve their innovation policy mix for sustainable ocean management.

UNECA: Africa's Blue Economy: A policy handbook offers a step by step guide to help African member States to better mainstream the Blue Economy into their national development plans, strategies, policies and laws. The Blue Economy approach is premised in the sustainable use, management and conservation of aquatic and marine ecosystems and associated resources.

UNESCO: Intergovernmental Oceanographic Commission (IOC) coordinates programmes in marine research, services, observation systems, hazard mitigation, and capacity development in order to understand and effectively manage the resources of the ocean and coastal areas. By applying this knowledge, the Commission aims to improve the governance, management, institutional capacity, and decision-making processes of its Member States with respect to marine resources and climate variability and to foster sustainable development of the marine environment, in particular in developing countries.

SDG 15 Life on Land

UNCCD: Science – Policy Interface (SPI) promotes dialogue between scientists and policy makers on desertification, land degradation and drought (DLDD). The mandate of the SPI is to provide the Committee on Science and Technology (CST) thematic guidance on knowledge requirements for implementing the UNCCD. Product: Sustainable Land Management Contribution to successful Land-Based Climate Change Adaption and Mitigation.

Annex 4: Responses to the Questionnaire on STI Roadmaps [41]

Brazil

Foundation

Policy Framework. The Brazilian government has introduced new legal framework aiming to simplify agreements for public research promotion, to facilitate the internationalization of scientific and technological institutions and to increase the interaction between them and companies.as well as the National Strategy for Science, Technology and Innovation (ENCTI) 2016-22, which sets out the main challenges for STI policy, mainly on the building of an articulated and robust national system of STI oriented to the innovation promotion, guiding the STI efforts to support national development as the critical challenge to be faced. ENCTI shows the essential processes of expansion, consolidation and integration. These processes are treated from the fundamental pillars that make up the National System: research promotion; laboratory infrastructure; financing of actions; human resources and business innovation (access the complete ENCTI form). The ENCTI seeks to decrease the existing technological gap in Brazil by means of investments in science and innovation. The strategy aims for gross expenditure on research and development (GERD) to reach 2.0% of GDP in 2019.

Analytical and evidence base. In June 2015, Brazil and the OECD signed a cooperation agreement that will deepen and systematize the bilateral relationship. The agreement institutionalizes Brazilian participation in various OECD forums and establishes mechanisms for the definition of future lines of work. The Brazilian Government has participated in about 36 instances of the organization, such as "associate", "participant" or "guest", and has already joined the 26 Recommendations and other instruments of the Organization.

The Country Partnership Framework – CPF 2018-23 is based on the Systematic Country Diagnosis (SCD), a comprehensive analysis of the World Bank Group on opportunities and challenges for Brazil to achieve poverty reduction and shared prosperity in a socially and environmentally sustainable manner and is the result of extensive consultations with federal and state governments, the private sector, civil society, and academic experts. The CPF guides the works of International Bank for Reconstruction and Development (IBRD), the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA) in the country.

The EU – Brazil cooperation relies on the need to continuously improve framework conditions for cooperation working on mechanisms to support cooperation and to involve all relevant Brazilian actors, at federal and State level. Main areas for cooperation are involved like marine research, health, information and communication technologies and nanotechnology, among others as the agreement to enhance the research policy dialogue in transport, in particular aviation, as well as to policy dialogues in environmental research and space research.

Stakeholder engagement. For the establishment of national regulation and the national STI policy the Ministry of Science technology and innovation has adopted the forum realization which the STI organized society, like ABC–Brazilian Science Academy; ANM-Medicine National Academy; ABIPTI-Brazilian Research, Technology and innovation Institutions Association; ANPEI-National R&D Innovators Companies Association; CONFAP-National Research Support Foundations Council; EMBRAPII-Brazilian Research and Industrial Innovation Company; SBPC-Brazilian Society for Science Progress; Fiocruz and universities; economic and entrepreneur society, like industry (National Industry Council), mainly for building the recent STI regulation (Lei nº 13.243/2016, decreto 9283/2018)

Adaptation

Emerging technological change and trend. Although the country has revised its legislation, as well the ENCTI strategy, the de-financing of science and technology is the largest ever witnessed in the history of this country. The government has conscience about the importance of STI for the country progress. However, the speech is not translated into public policy and financing of actions.

Policy response. Most of them are concerned about relevant issues on STI policies as shown:

[41] These responses were submitted by the participants of the Expert Group Meeting (EGM) on STI Roadmaps for the SDGs in Tokyo, May 8-9 2018 to inform the EGM discussions and this Background Paper. While many of the responses reflect policymakers' perspectives within or across respective countries' relevant ministries and/or agencies, The IATT and EGM Secretariat did not request the EGM participants to obtain formal clearances from responsible authorities in submitting these responses. The responses therefore should be considered solely informational materials, not necessarily representing official country positions on relevant policy deliberations at the UN fora or indicating official endorsement of external or non-governmental contributions to respective countries' policy formulation.

Cyber Security: Strengthening of the National Center for Cyber Defense, with promotion of cyber defense research and development, and the cyber security industry for productive competitiveness as shown in Cyber Security Green Book, organized by Main Office of Presidency of Brazil.

Scientific Research: Strengthening of basic and technological research produced by research centers; Consolidation and expansion of the activities of the INCT Program, which enables mobilization and articulation of the best research groups in frontier areas of science and in strategic areas for the country's sustainable development; Stimulus to the interaction between research centers and companies; Incentive to commercialization of public research; Encouraging international cooperation with leading countries and institutions in strategic areas.

Workforce re-skilling: Strengthening of the Human Resources Training Program in Strategic Areas (RHAE) and the National Program for Access to Technical Education and Employment (Pronatec); Strengthening of inter-institutional cooperation programs for the training of high-level human resources, such as the Inter-institutional Masters Project (Minter) and the Inter-Institutional PhD (Dinter); Encouraging international mobility programs, such as the Science without Borders Program, at master's and doctoral level, mainly through cooperative projects in strategic areas; Encouraging the training of engineers to work in PD & I; Attracting talent from abroad and to the North, Northeast and Midwest Regions of Brazil; Fixation of human resources contracted from university expansion.

Industrial development: Encouragement of intellectual property protection and technology transfer; Modernization of processes related to the granting of patents and intellectual property; Extension of articulation between universities, research centers and companies in the development of innovative technologies; Attraction of global R & D centers; Incentive to entrepreneurial capital investment funds; Stimulus to technology-based entrepreneurship with a focus on entrepreneurs and startups; Promotion of the constitution and consolidation of innovation-oriented environments, such as incubators, parks and technology centers; Encouraging the formation and development of entrepreneurial environments, such as business accelerators, cooperative workspaces (coworking) and open laboratories for prototyping products and processes; Strengthening the supply of technological services for companies; Stimulus to extension initiatives.

Integration

Sectoral STI strategies. All the strategies necessaries to supply the country growing has been pointed in the ENCTI how mentioned in question. What is observed is a certain inoperancy by the government side.

The Ministry of Science, Technology, Innovation and Communications is the government area responsible for implementing S & T policy in the country. In the ministerial structure, the other folders contain secretariats or under-secretaries that are responsible for the sectoral implementation of the national policy.

Strategic areas concerned on ENCTI: Aerospace and defense; Water; Foods; Biomes and Bioeconomics; Social Sciences and Knowledge; Climate; Digital Economy and Society; Energy; Strategic Minerals; Nuclear; Health; Convergent and Enabling Technologies.

Sponsoring for R & D is mainly through public sector funds, administered by development agencies such as the National Council for Scientific and Technological Development (CNPq), Funding of Studies and Projects (FINEP), state foundations for research support.

STI roadmap as an integral element of national sustainable development plans.

Executive, Legislative and Judiciary sector, the productive sector, academia and civil society organizations should give priority to building solutions, including multisectoral partnerships, on such issues as the promotion of human rights and the improvement of social and economic conditions of populations. People remain central to the new development agenda.

Strategic plan defined by Brazilian Commission for 2030 Agenda implementation: (i) the launch of the Action Plan of the National Commission for ODS; (ii) the mapping of the relationship between the public policies in force in the Ministries and the 2016-2019 PPA with the ODS targets to verify sufficiency and possible gaps; (iii) the adaptation of global goals to the national reality; (iv) the definition of national ODS indicators; (v) the development of tools / platform for the dissemination of ODS; and (vi) processes and initiatives for the internalization / localization of Agenda 2030 throughout the national territory.

International consensus and partnerships on STI roadmaps for the SDGs

Colombia

Foundation

Policy Framework

- Every four years Colombia prepares and issues a National Development Plan. One of the main goals of the 2010-2014 and the 2014-2018 development plans is for STI to be one of the principal sources of growth in Colombia.
- Additionally, the Productive Development Policy (issue in 2016) is the main policy framework. It focuses on solving market and government failures to raise productivity, especially through technology adoption and innovation among firms. This includes specific policy instruments such as technological extension programs for medium-sized firms, innovation vouchers and soft-skills training.
- The Law of Agricultural Innovation was approved in December 2017 which generates a new institutional framework to integrate R&D, training and technological extension for agricultural innovation at the local level.
- The government is finishing a National Policy for Laboratories to improve the measurement capabilities of both public and private laboratories in the country through: improved technical and metrological capabilities of laboratories; incentives to consolidate the market for laboratory services and encourage networking; and coordination of regulatory entities to implement best technical regulation practices applicable to laboratories.
- The Spin-Offs Law was enacted in 2017 that allows public university professors and researchers to commercialize their innovations by creating their own companies. In 2017 the national Government reached the goal of granting 8 new technological licenses.
- Colombia has important tax incentives for firms that carry out innovation projects. A total of

Institutional arrangements for implementation

- The National System for Competitiveness and the National System for Science, Technology and Innovation were recently consolidated in a single system called the SNCCTI to increase synergies between the productive sector and academia for grater and more pertinent knowledge generation.
- In 2012 it was created iNNpulsa Colombia to strengthen entrepreneurial and innovation capacities for business development and higher competitiveness. At 2017, iNNpulsa has mobilized a total of COP 117,000 million (USD 39 million) and has impacted 28,800 beneficiaries throughout the country. iNNpulsa created the innovative entrepreneurship ecosystem called Aldea in 2016.
- The implementation of the National Intellectual Property Administrative System and the Inter-sectoral Commission on Intellectual Property have strengthened the institutional framework for intellectual property and have become the highest decision body.

Financing

- The goal of the current government is to achieve an investment in STI equivalent to 1% of GDP in 2018 (up from 0,51% in 2010 and 0,68% in 2017).
- To promote STI investment in all regions of the country, the SGR Fund allocates 10% of the total resources of the SGR. Since 2012, resources of COP 2.5 trillion (USD 833 million) from this fund have financed 312 STI projects.
- Private investment increased its participation from 53.5% in 2010 to 70% in 2017 of all STI Activities. The Tax Benefits program, which grants tax discounts to companies that make qualified investments in STI Activities, was key to achieve this goal. Since 2015, the program helped finance 789 private innovation and development initiatives.
- Also, a Law on Secured Transactions (Garantías Mobiliarias) was approved to increase companies' access to credit by using some types of intellectual property as collateral.

Analytical and evidence base

- The National Planning Department (DNP) and the World Bank Group (WB) have implemented a methodology of Public Expenditure Analysis of STI. The first phase of the analysis ended in 2015 and studied the functionality and governance of all the policy instruments offered by national entities. Results show: Duplication of efforts, excessive use of subsidies, low specialization, and scattered supply. A Recommendations Plan with specific actions in terms of budget, rational use of the instruments and centralization of the technical assistance supply for STI as a monitoring tool is being implemented. There is an ongoing pilot for a 2nd phase focused on efficiency- 5 policy instruments were evaluated in 2017.
- DNP and WB carried out a technological extension program with an impact evaluation. Preliminary results from the pilot show the program increases management quality by 16%. Similarly, the Productive Transformation Program (PTP) has a technical assistance instrument *Colombia Productiva* to adopt existing technologies towards increased productivity and improved export capabilities. It is expected to assist 400 companies and its impact evaluation is being carried out by the World Bank.

- DNP and the Colombian Observatory of Science and Technology (OCyT) an independent NGO, developed the Regional Innovation Index for Colombia (IDIC), based on the Global Innovation Index methodology. This annual index measures skills and innovation in 26 of the 32 *departamentos* (provinces) in the country. The IDIC has become an important tool to identify skill gaps, local conditions harming innovation, inefficiencies, and lack of coordination between the investment of the SGR Fund for STI and the regional needs. These helps *departamentos* identify key bottlenecks and prioritize policy actions to improve innovation inputs and outputs.
- In 2014, Colombia was subject to the OECD's Innovation Policy Review, which recommends improving the incentive scheme for innovation and entrepreneurship in public universities.
- Since November 2017, the OECD Development Centre is conducting a Productive Transformation Peer Review evaluating the Productive Development Policy. It will issue its recommendations in November 2018.

Stakeholder engagement

The SNCCTI is headed by an executive council composed of public and private entities. It includes the President's Office, Ministry of Trade, Industry and Tourism, the DNP, the National Department of STI (Colciencias), Chambers of Commerce and Private Council on Competitiveness (which represents a large group of the most important companies in Colombia). All these entities participated in the formulation of the current STI policy framework. There are also 7 technical committees for specific topics, such as STI and Productive Development, also composed both of public and private sector representatives. At the local level, there are 32 Regional Committees on Competitiveness, Science, Technology and Innovation, which are responsible for articulating, within each *departamento*, the implementation of policies for competitiveness and STI.

Adaptation

Emerging technological changes and trends

The current relevant policy deliberations have been around the readiness of information to inform evidence-based discussions. The country recently (April 2018) approved policy guidelines for Big Data to enhance the country's capabilities to generate, process and harness information, especially the public sector, and to enhance both available and security of data from public entities.

Colombia is also working on a policy for the development of Smart-cities, which will promote strategies to use the technological advancements, from a sustainable point of view, to increase the welfare of their citizens. This is still at an early stage.

Also, in 2016 Colombia started its first Center of excellence and appropriation on the internet of things (IoT), with the joint efforts of 5 universities, 3 multinationals in the Information and communication technology - ICT sector (HP, Intel, Microsoft) and 6 national companies from different sectors, the Center implementing applied research, product development, creation of technology based businesses, and strategies for the public to appropriate this technology and play a role in the smart cities initiative.

Nevertheless, policy discussions around most emerging technologies and their effects on, for instance, unemployment, are still in their infancy.

Policy response

The National Development Plan (PND) and the Productive Development Policy have different strategies to thrive in the face of rapid technological changes:

1) Increase the supply of innovation services for business: DNP and iNNpulsa devised the Innovation Vouchers Project, a co-financing mechanism to link companies with innovation service providers.

2) An array of technological extension programs focused on improving management soft skills, production processes, machinery, quality standards certification and export logistics to accelerate technology adoption and productivity within firms.

3) Increase companies' growth through innovation: The government has developed different programs, i) Seed capital program of iNNpulsa to foster innovation and entrepreneurship in SMEs; ii) the Aldea ecosystem connects companies in a community of innovative entrepreneurs to obtain assistance to develop, commercialize and distribute a good or service, including innovations. During 2016-17, Aldea benefited 178 projects worth close to COP 6,300 million (USD 2.1 million).

4) Development of productive linkages in chosen sector

5) Involvement of the private sector in all the initiatives of sustainable growth: The SENA Entrepreneurship Fund (Fondo Emprender) supports ventures under sustainable business models that solve social problems. In 2017 the fund allocated COP 115,452 million (USD 38 million) to support 964 companies. Evidence show that the success rate for assisted companies is 46 percentage points higher than the rate of those who did not receive the assistance.

6) Improve the size, quality and impact of highly skilled human capital and their research in the country: In 2017 Colciencias and other entities awarded 2,078 scholarships, scholarships-credits and credits for masters/PhDs. To increase the scientific production carried out by Colombian researchers, Colciencias offered workshops to promote good practices (peer evaluation process, assessment of the originality of submitted work, ethics, etc.), in 2017, 9,555 scientific articles were published by Colombian researchers in specialized scientific journals.

Integration

Sectoral STI strategies

Colombia Científica is a program led by Colciencias to strengthen research quality through strategic alliances between Higher Education Institutions (IES), national and international R & D Centers, and the productive sector. Such alliances are focused on 5 strategic components (health, food, society, bio-economy, and sustainable energies) with a regional focus.

The STI Parks are infrastructure projects for specialized research and development services, they promote the consolidation of technology-based companies to transform the productive system at the local level.

Colombia BIO described in question 4 incorporates sectorial strategies for the application of biodiversity in the development of goods and services related to bio-economy and biotechnology.

The Green Growth Mission led by DNP and described in question 4 is a cross-cutting strategy for different sectors.

As mentioned before, the country recently approved policy guidelines for Big Data.

The Ministry of Agricultural is carrying out different projects of technical assistance and technological extension for sustainable development to increase the efficiency in the use of land, water and energy.

STI roadmap as an integral element of national sustainable development plans

Colombia is a leader in the implementation of the SDG in public policy. In 2018 it was approved a policy document (CONPES 3918) to define targets and goal indicators for each SDG, in terms of CTI the document recommends creating a network that integrates the public, private, academia and civil society sectors, to share and disseminate all the knowledge generated for sustainable development. This task would be led by Colciencias, based on the creation of participatory, interdisciplinary and regional agendas that help plan national investment efforts in CTI.

Additionally, the DNP analyzed the correspondence of the 169 SDG targets with the National Development Plan (PND), the requirements to become an OECD country, the strategy of Green Growth and the Peace Agreements. This analysis evidenced an alignment of the SDGs around all of these agendas: 92 SDG targets have specific actions defined in the PND, the efforts made by the country to be admitted to the OECD have allowed important advances in 87 SDG targets; the Green Growth strategy is directly related to 86 goals of the SDG agenda; and the implementation of the Peace Agreements signed by the national government will have a direct impact on at least 68 of the SDG targets.

The country has conducted and benefitted from different analysis throughout different sectors. Colciencias is carrying out consultations, interviews, workshops and a scientometrics analysis to define a policy agenda that will define the guideline for the coordination between STI and sustainable development for 2030,

In parallel, the Green Growth Mission led by DNP seeks to define the public policies to guide the country's economic development towards green growth in 2030. The Mission has 8 strategic components (Water Productivity, Soil Productivity, Labor Productivity, Responsible Consumption of inputs, Bio-economy, Forestry Economics, Business Formalization, and Energy Efficiency and Renewable Energies) and 2 transversal components: Harmonization of instruments and policies and Science, Technology and Innovation. All these components carry consultancy documents, experts' meetings, workshops, advising from civil society organizations and private sector.

Created in 2016, Colombia BIO is a program that aims to know, value, conserve and take advantage of the country's biodiversity, contributing to a sustainable and socially inclusive development. By 2017, the program was able to record 285.000 new species in the Global Biodiversity Information Facility (GBIF).

International consensus and partnerships on STI roadmaps for the SDGs

One recommendation would be to construct an inter-sectoral and cross-cutting agenda, where both national and local governments are involved. The success of this policy depends on the coordination of different sectors to increase efficiency and to multiply the individual efforts. One first step in this direction is to analyze the correspondence between the SDG targets, the government plan, and the individual efforts of each sector or government entity to identify cross-roads and collaboration opportunities.

There is still progress to be made in topics of intellectual property, where the Technology Facilitation Mechanism is key, so another recommendation is to continue on this effort to build robust and clear guidelines for technology transfer from one country to another, in order to align national laws to those guidelines.

There are many initiatives that still need financing, in Colombia there are efforts made my specific *departamentos*, especially those affected the most by the internal conflict, and offer important opportunities in a Peace agreement scenario to attract FDI, and to attract the private sector to invest in these regions, generate employment, train human capital and generate jobs.

European Commission

Foundation

STI policy framework. The implementation arrangements related to science, technology, and innovation are enshrined in Articles 179 to 190 of the Treaty on the Functioning of the European Union. Article 179 explicitly states that "The Union shall have the objective of strengthening its scientific and technological bases by achieving a European research area in which researchers, scientific knowledge and technology circulate freely, and encouraging it to become more competitive, including in its industry, while promoting all the research activities deemed necessary by virtue of other Chapters of the Treaties."

The above articles of the Treaty are implemented by means of multiannual Framework Programmes for research and innovation that span seven years. The current Framework Programme, Horizon 2020, has a budget of 80 billion euros covering the period for 2014-2020. The European Commission will present (expectedly) on 7th June the proposal for the next Framework Programme to be adopted by the European Parliament and Council – in co-decision. This new Programme should enter into force in 2021 when the current Horizon 2020 will have reached its planned end. The orientation is to propose a Programme able to deliver more in terms of impact along a systemic rather than a sectoral approach. The Sustainable Development Goals will be a compass to inspire our thinking about the transitions to activate.

Analytical and evidence base. The current Framework Programme, Horizon 2020, as any major initiative of the Commission was based on an impact assessment aimed at gathering evidence and selecting the best option, as well as on the mid-term and ex-post evaluation of the previous Framework Programme. A novelty was the introduction of a target for Sustainable Development oriented research and innovation at a level of 60% of total budget.

In 2015, the European Commission established the independent expert group on the "Follow-up to Rio +20, notably the Sustainable Development Goals" with the purpose of providing advice on the role of science, technology and innovation (STI) for implementing the new sustainable development agenda ("2030 Agenda"). One of the recommendation of the report, for example, is to improve the orientation of STI policies towards the SDGs. In particular, to integrate in the future Horizon 2020 work programmes the SDGs framework and language, increase the share of Horizon 2020 funds allocated to SDGs oriented projects and align the Horizon 2020 monitoring of the expenditure contributing to SD with the key underpinnings of the 2030 Agenda.

In 2017 an independent high level group on maximizing the impact of EU Research & Innovation Programmes, chaired by Pascal Lamy, carried out an ex-post evaluation of Horizon 2020 and delivered a set of recommendations to the European Commission and the Commissioner for research, science, and innovation, Carlos Moedas. Several of the recommendations, included: prioritizing research & innovation in the EU and national budgets; building a true EU innovation policy that creates future markets; adopting a mission-oriented, impact-focused approach to address global challenges; mobilise and involve citizens; make international R&I cooperation a trade-mark of EU research and innovation; capture and better communicate impact. These have been taken into account in formulating the proposal for the future framework programme.

Stakeholder engagement. The Horizon 2020 Specific Programme is implemented through multi-year work programmes setting out funding opportunities, mainly through calls for proposals, under the different work programme parts. The work programme cycle takes place over a period of about 18 months. In large terms the cycle consists of strategic programming that establishes the specific priorities for a Work Programme and of WP preparation during which the details of the calls for proposals are established. Work Programmes are adopted with the Commission decision. Strategic programming is about identifying specific priorities for the WP, within the framework of the Horizon 2020 Regulation and Specific Programme. Strategic programme provides a coherent, evidence-based process, using extensive consultation.

The first step is to gather evidence, such as science and technology trends, market data, the results from Foresight exercises and other forms of intelligence. Consultations with the Horizon 2020 Advisory Groups are an important part of this work. Advisory group experts provide high quality and timely advice to the Commission services during the preparation of the Horizon 2020 work programme. In addition there have been consultations of other stakeholder groups and EU citizens at large, through both targeted and open consultation exercises. The final work programme for Horizon 2020, covering the period 2018-2020, was adopted in October 2017. The EU Member States are involved and have to support the adoption and review of work programmes through dedicated Programme Committees, comprising representatives from respective ministries for research, science and technology in each country.

Adaptation

Emerging technological changes and trends. The communication "Key steps for a sustainable European future", adopted by the European Commission in November 2016, sets a mandate to carry out regular monitoring and reporting on the SDGs. All services of the European Commission, as well as public stakeholders (i.e. Member States), are consulted by DG ESTAT on the list of selected SDGs indicators for the European Union. The list is revised regularly on annual basis and each year DG ESTAT issues a report. The first report was issued in November 2017 and the next one will precede the United Nations High Level Political Forum (HLPF) in 2019. Historically, DG ESTAT has developed a thorough database of indicators for sustainable development, particularly, covering the climate change and environment dimensions.

The European Commission is regularly conducting trend analysis, foresights, scenario exercise, consultations, including on policy implications of emerging technologies. For instance, the EU Policy Lab at the Joint Research Centre is a collaborative and experimental space for innovative policy-making. It is both a physical space and a way of working that combines foresight, behavioural insights and design thinking. The studies it conducts can be accessed here. Currently the EU Policy Lab is conducting a foresight study on SDGs, basing the process on scenarios and building on previous experience. A qualitative approach is essential to make sense of all the available evidence, including quantitative data wherever it is available, but also covering the less tangible aspects of societies.

Policy response. EU's Future and Emerging Technologies (FET) Flagships are ambitious game-changing and large scale research initiatives that have the potential of delivering a profound transformational impact on economy and society. FET Flagships are long term and large scale research initiatives driven by an ambitious vision. They tackle major science and technology challenges expected to result in 'game changing' impacts that benefit economy and society. FET Flagships are realised through a long-term and sustained effort at European level by: building on large scale research cooperation across academia, industry and national research programmes and mobilising Europe's best researchers around an ambitious research and development roadmap.

The Smart Specialisation approach combines industrial, educational and innovation policies to support countries or regions in developing strategies focused on priority areas for knowledge-based investments, building on their strengths and comparative advantages. Following its wide use in Europe, Smart Specialisation is increasingly becoming a driver of decentralised innovation policies in several countries and regions around the world. Collaborating countries and regions are able to combine complementary strengths, exploit their competences in research and innovation, get necessary research capacity, overcome a lack of critical mass and fragmentation and have access to global value chains. The Smart Specialisation Platform, coordinated by the European Commission's Joint Research Centre provides information, methodologies, expertise and advice to national and regional policy makers, as well as promotes mutual learning, trans-national co-operation and contributes to academic debates around the concept of smart specialisation.

Integration

Sectoral STI strategies. The communication "Key steps for a sustainable European future", adopted by the European Commission in November 2016, and accompanying staff working document establishes a commitment to mainstream the SDGs in all EU policies, including research and innovation. In particular, the communication demonstrates how the SDGs targets are complementary to the ten priorities identified in the mandate of the current European Commission and how they are being addressed through key initiatives at European level (section 8 provides an overview of these

initiatives). Research and innovation policies are positioned high on the agenda as a driver and enabler of sustainable development.

The communication may be considered a milestone in advancing the SDGs within the European Commission. Regarding research and innovation, in the current drafting processes and adoption of the next Framework Programme different services of the European Commission have been involved, for example, health, environment, and climate. This is to show the cross-cutting nature of research and innovation and possibility to establish more coherent programming in other sectors in the future.

STI roadmap as an integral element of national sustainable development plans. Sustainable development is enshrined in the European Union's (EU) founding Treaty (Article 3)[42] and is also at the heart of its policies and actions. The EU has been leading progress towards sustainability on global scale, becoming the world's blueprint for global sustainable development, and is a test bed for the development of new environmental technologies and approaches (as presented in the EPSC note by Karl Falkenberg, "Sustainability Now"). As regards research and innovation, the European framework programme, Horizon 2020, is expected to invest at least 60% of its funds into sustainable development related issues.

The European Union, historically, has developed its sustainable development strategy encompassing economic, social, and environmental priorities. Already in 1997 sustainable development became a fundamental objective of the EU when it was included in the Treaty of Amsterdam as an overarching objective of EU policies. At the Gothenburg Summit in June 2001, EU leaders launched the first EU sustainable development strategy based on a proposal from the European Commission. This 2001 strategy was composed of two main parts. The first proposed objectives and policy measures to tackle a number of key unsustainable trends while the second part, arguably more ambitious, called for a new approach to policy-making that ensures the EU's economic, social and environmental policies mutually reinforce each other. One major instrument developed for this purpose was the obligation for the Commission to submit each new major policy proposal to an Impact Assessment.

A proposal for the review of the EU sustainable development strategy was presented by the European Commission in December 2005, taking stock of changing global trends such as climate change, increased instability, terrorist threats and violence. The renewed EU SDS (adopted in 2009) set out a single, coherent strategy on how the EU will more effectively live up to its long-standing commitment to meet the challenges of sustainable development. It recognised the need to gradually change our current unsustainable consumption and production patterns and move towards a better integrated approach to policy-making. It reaffirmed the need for global solidarity and recognised the importance of strengthening our work with partners outside the EU, including those rapidly developing countries which will have a significant impact on global sustainable development.

International consensus and partnerships on STI roadmaps for the SDGs

Underlying the research programme Horizon 2020 is the principle that international cooperation in STI is indispensable for achieving the SDGs. This priority that the Commissioner for research, science, and innovation labels "Open to the World", works hand-in-hand with two other priorities we are implementing, "Open Science" and "Open innovation". There are a number of key initiatives which exemplify our commitment on international cooperation and which can be used as a means for developing global partnerships (SDG 17, target 17.6) and STI roadmaps for the future. These include:

1) The European and Developing Countries Clinical Trials Partnership (EDCTP), which allows us to foster collaboration and alignment of the research agenda on addressing infectious diseases between countries in sub-Saharan Africa and Europe. The EDCTP addresses mainly SDG 3 on health but has linkages also to SDG 1 on ending poverty worldwide.

2) FOOD 2030, a R&I policy framework for Food and Nutrition Security that aims to structure, connect, scale-up EU Research and Innovation by mobilizing resources, convening stakeholders, and aligning R&I agenda in response to the Sustainable Development Goals and the COP21 Climate commitments. FOOD 2030 is fostering international collaboration on Food and Nutrition Security through dialogue platforms, such as the EU-Africa High Level Policy Dialogue on science, technology and innovation. The first R&I Partnership under the EU-Africa High Level Policy Dialogue, established in 2016 focusses on food and nutrition security and sustainable agriculture, with a joint budget of over EUR 70 Million. It aims at jointly developing solutions for agriculture and food systems that improve nutrition, are low in waste, have a reduced environmental impact and address food safety issues. At the same time, they aim at capacity building and sharing of research infrastructures. The roadmap for a second partnership on climate change and sustainable energy, was adopted

[42] "In its relations with the wider world, the Union shall uphold and promote its values and interests and contribute to the protection of its citizens. It shall contribute to peace, security, the sustainable development of the Earth, solidarity and mutual respect among peoples, free and fair trade, eradication of poverty and the protection of human rights, in particular the rights of the child, as well as to the strict observance and the development of international law, including respect for the principles of the United Nations Charter": (http://eur-lex.europa.eu/resource.html?uri=cellar:2bf140bf-a3f8-4ab2-b506-fd71826e6da6.0023.02/DOC_1&format=PDF)

in October 2017 at the senior officials meeting with members of the African Union and the European Commission. The focus of the partnership is to increase joint research efforts, for example, in the domain of earth observations (satellite and in situ monitoring) for understanding on migration patterns triggered by climate change between Europe and Africa. There is scope for extending focus to SDGs targets and ensuring capacity-building of basic infrastructure for climate services in Africa, in particular, through alignment with funding from the EU's international cooperation and development funding.

3) The 2013 Galway Statement on Atlantic Ocean Cooperation between the European Union, the United States of America and Canada which has established a formal Atlantic Ocean Research Alliance (AORA) building on existing initiatives and programmes to increase coherence and coordination. This is further evolving into the All Atlantic Ocean Research Alliance, involving the Southern Hemisphere. The European Commission has a leading role in AORA. Commitments have been translated into investments with over EUR 140 million supporting 14 projects so far in the Horizon 2020 Blue Growth calls, including for Arctic cooperation.

4) The use of Earth Observations and geo-spatial information are indispensable for tracking our progress towards achieving the SDGs. The European Commission, as co-chair of the Group on Earth Observations (GEO), is helping to create full and open access and synergistic cooperation between its member governments and participating organizations for the sharing of Earth Observations in implementing the SDGs. The GEO Engagement Strategy, endorsed during the GEO-XIII Plenary meeting in November 2016, enshrines the SDGs as a GEO priority area for coordinated and proactive engagement by the GEO international community. The primary purpose of this initiative is to organize and realize the potential of Earth observations and geospatial information to advance the 2030 Agenda and enable societal benefits through achievement of the SDGs. This Initiative supports efforts to integrate Earth observations and geospatial information into national development and monitoring frameworks for the SDGs. GEO also benefits from data stemming from the EU initiative COPERNICUS, that could feed national statistical offices with geo-spatial data from Europe and beyond. Collaboration with UN Environment has been initiated in this direction, to link it up with the work of the Inter-Agency Task Force.

5) A number of thematic scientific network, coordinated by the European Commission in areas related to disaster risk management, environment, etc (e.g. Global Flood Partnership) harness the potential of STI in addressing global challenges, allow for knowledge sharing, capacity building and mutual learning.

Ghana

Foundation

STI policy framework.

The National STI Policy (revised in 2017) projects a vision of Ghana transformed to a developed country with STI as the key driver. The policy is to build a strong STI capacity to drive the social and economic development for the sustainable transformation of the economy. This is spelt out explicitly in the document which is currently before the Cabinet for adoption.

The STI policy is intended to be contextualized and fully integrated into a national development framework which fully harnesses the nation's total science and technology capacity to achieve national objectives for wealth creation, poverty reduction, enterprise competitiveness, sustainable environmental management and industrial growth. The stated objectives of the policy are:

- ✓ provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy to provide the basic needs of the society;
- ✓ facilitate mastering of scientific and technological capabilities by a critical mass of the products of all educational institutions;
- ✓ create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation;
- ✓ ensure that STI supports Ghana's trade and export drive for greater competitiveness; and
- ✓ promote a science and technology culture in the society.

The last National STI policy was published in 2010 as a national document on the adoption of the then Cabinet. The responsible ministry spearheading the current revision and adoption is the Ministry of Environment, Science, Technology and Innovation (MESTI). Under MESTI, there are scientific institutions established to address the mandate of harnessing the country's scientific

and technological capacity for national development. These include the Council for Scientific and Industrial Research (CSIR), the Ghana Atomic Energy Commission (GAEC) and the Environmental Protection Agency (EPA).

Nevertheless, the National Innovation System (NIS) of Ghana goes beyond the scientific institutions operating under MESTI. There are the 11 public universities and over 100 private universities contributing to scientific human resource development through their science-based faculties. For example, each year, the Kwame Nkrumah University of Science and Technology (KNUST), which is the leading science-based university in the country graduated at the first degree B.Sc. level over 12, 500 graduates over the three-year period from 2013 to 2015. Over the same period, KNUST produced a total of 1361 graduates at the master's degree level and 77 at the doctorate level. These graduates come from diverse disciplines including civil engineering, agricultural engineering, aerospace engineering, natural resource management, biological science, biochemistry, pharmacy and medicine. Graduates of science-related disciplines are mainly produced from the public universities. With the growing unemployment in the country, some are still employed in various economic sectors of the economy.

The sector ministry prepared an implementation plan to facilitate the implementation of the policy. The outcomes of implementation include the execution of some projects such as the Computer for Schools Project and a market-oriented project under the Component 2 of the Ghana Skills and Technology Development Programme funded by the World Bank, DANIDA and the Government of Ghana. About $2.5 million was invested in the market-oriented project for developing structured mechanisms that facilitates effective transfer of technologies to the private sector in five scientific institutions including the CSIR and GAEC. The structured system also ensures the generation of ideas from the private sector for the development of appropriate innovations and technologies that provides business solutions.

Analytical and evidence base.

Yes. In 2009, the UNCTAD collaborated with the Science and Technology Policy Research Institute (STEPRI) of the CSIR and the World Bank to carry out a Science, Technology and Innovation Policy (STIP) review for Ghana. It was on the basis of the review that the 2010 National STI Policy was prepared and published. The formulation of the policy was participatory with the constitution of a drafting committee with representation of key stakeholders such as academia in the universities and research institutes, relevant ministries and public institutions, civil society organization and private sector (e.g. Association of Ghana Industries and Ghana Chamber of Industry and Commerce). The drafts were taken through stakeholder consultation processes until the final adoption by Cabinet. The 2017 revised policy has also gone through the same process. The Government of Ghana fully sponsored all the various stages of the policy revision and stakeholder consultation.

Stakeholder engagement.

Participants of the various fora came from the following:

Academia – lecturers in the universities and researchers in scientific research institutions

Private sector – members of the Association of Ghana Industries and the Ghana Chamber of Industry and Commerce

Farmer-bases organisations – the Ghana Farmers and Fishermen Association

NGOs

Public sector institutions – the relevant ministries e.g. Ministry of Trade and Industry, Ministry of Education and Ministry of Food and Agriculture; National Development Planning Commission; regulatory organisations e.g. Food and Drugs Authority and Ghana Standards Authority.

Adaptation

Emerging technological changes and trends.

Biotechnology – A number of consultation/ sensitization workshops, symposia and fora have been held on the subject of Genetically Modified Organisms (GMOs)/ GM crops. The Biosafety Act of 2011 (Act 831) emerged from background studies and series of consultations with stakeholders including parliamentarians. The level of awareness was improved even though some public concern exists in the application of biotechnology generally. The National Biosafety Authority (NBA) mandated to regulate field trials and importation of genetically modified organisms was established under the Biosafety Act.

ICT policy formulation has seen a less controversial public reaction. Ghana went through participatory consultative processes to produce the ICT for Development Policy. Consequently, there were the formulation of the relevant projects such as the establishment of the ICT centres in schools, the inclusion of the ICT study as a part of the curriculum in basic and second cycle schools and government laptop distribution to schools.

The level of awareness about the importance of ICT is very high and it translates to the application of ICT in almost all the sectors of the economy. In industry, commerce, healthcare, banking and finance. Even in agriculture, there are companies providing agricultural market information to farmers.

Other emerging technologies are yet to see such high level of awareness. For example, nanotechnology has not experienced much awareness. Awareness of Artificial Intelligence, robotics and others are emerging in the school system. There is for instance robotics competition among high schools where teams are assessed on the level of their robotics applications. However, there is a big gap which needs to be filled in organizing more structured awareness creation programmes.

Policy response.

Generally I believe Ghana has a vision which relates or underpins the greater vision of emerging as a country beyond aid as our President stated recently. We broadly aim at advancing higher than our present lower middle income status. So the broad strategy is the promotion of ICT, biotechnology and other new technologies (though on a lower key than ICT and biotechnology).

Integration

Sectoral STI strategies.

Ghana has a number of sectoral policies including for agriculture, energy, environment, education and health. There is also the cross-sector policy such as the STI policy. What one finds is that, in each of these sector-specific policies, the issues of technology and innovation are raised if not explicitly, then implicitly. For example in the Food and Agriculture Sector Development Policy (FASDEP II) of 2007, there are stated policy strategies for Science and Technology applied in food and agriculture development. FASDEP's vision is for a modernized food and agriculture in which productivity and production improvements are based on Science and Technology. The policy document underscores the point that prioritization of research on the basis of commodities targeted in FASDEP and public funding of basic research will guide the promotion of Science and Technology in agriculture development. Apart from this, it advocates for demand-driven research, which is motivated from the desires of final users or beneficiaries. Sector-specific policies therefore illustrate the areas in which Ghana aims at harnessing Science and Technology and Innovation for achieving specific development goals.

The connection with the SDGs is also evident in the ways the strategies are elaborated for the achievement of the goals and objectives. Again using FASDEP as an example, the policy adopts the seven-part vision for agriculture in Africa of the Comprehensive Africa Agricultural Development Programme (CAADP). The vision includes food security, improved productivity of agriculture to attain annual growth rate of 6%, with particular attention to small-scale farmers and women, as well as, dynamic agricultural markets, and sustainable use of the natural resource base. In essence, these are the people-oriented SDGs, which touch the very base of the pyramid of human societies.

The strategies can still be enhanced in various ways. An important approach to enhancement is the elaboration of harnessing the expertise of Ghanaian professional in the diaspora. There are scientists, engineers, doctors, entrepreneurs and academicians abroad whose expertise can contribute a great deal to achieving the national development goals in various sectors e.g. industry, energy, environment, healthcare and banking. There is the need to enact a holistic strategic policy for attracting the diasporean experts to engage with their motherland/ fatherland for accelerated development.

STI roadmap as an integral element of national sustainable development plans.

Ghana is yet to clearly elaborate an STI roadmap for SDGs. But it has taken certain initiatives which can contribute to the implementation of STI roadmap when it is elaborated. For example, President Nana Akufo-Addo inaugurated a 15-member Inter-Ministerial Committee for the implementation of the SDGs in September 2017. The President was appointed as co-Chair of the Advocacy Group of Eminent Persons by the UN Secretary General, António Guterres, and he wants Ghana to become a shining example for the implementation of the SDGs.

The Minister for Planning chairs the inter-ministerial committee on SDGs. It has the Ministers for Trade and Industry; Foreign Affairs and Regional Integration; Finance; Food and Agriculture; Attorney General; Environment, Science, Technology and Innovation; Monitoring and Evaluation; Education; Health; Sanitation and Water Resources; Local Government and Rural Development; Gender, Children and Social Protection; Employment and Labour Relations; and Fisheries and Aquaculture as members.

Additionally, Ghana also established an SDG Implementation Coordination Committee to provide technical support to the implementation and monitoring of the SDG agenda. The National Development Planning Commission (NDPC) chairs this multi-stakeholder committee with cross-government representation as well as members from Civil Society Organisations (CSOs), the private sector, and academia. The Ghana Statistical Service (GSS) is a member of the Committee and acts as the data

champion for the SDGs at the national level. The report annexed to this Questionnaire gives details about the work of this committee.

Despite these initiatives, it will be necessary to elaborate an STI Roadmap which details the strategies for harnessing and applying STI for the achievement of each of the SDGs.

International consensus and partnerships on STI roadmaps for the SDGs

Taking note of the fact that all countries have their contextual peculiarities, I recommend that all countries draw their National STI Roadmap for the SDGs. Such a roadmap will be informed by the development aspirations of the country, the resource base, the socio-economic challenges and the national priorities, among others.

Specific structures should be put in place in the respective countries to ensure the implementation of the roadmap. An inter-ministerial committee such as what we have in Ghana is exemplary.

Institutionalizing Monitoring and Evaluation of the implementation of the roadmap is very important. There should be an organ responsible for this.

The roadmap should be formulated through a participatory process involving all the stakeholders including civil society, farmers, academia, entrepreneurs (large, medium, small and micro) and public servants.

Ghana is very much a developing country in spite of its lower middle income status. The question of relevance is: what priorities should donors and international community consider, given the progress so far, opportunities STI enable, and challenges or constraints that may persist, in your country?

The harnessing of STI for the achievement of the SDGs is best done in a formalized Research and Innovation system. Advanced countries including the NICs and their derivatives e.g. BRICS, invested seriously in R&D and are still investing at least over 2% of GDP for most of the advanced countries. It should be a priority to assist developing countries to strengthen and enhance their Research and Innovation systems. Donor support should be invested in improving their research systems.

In addition to improving research systems, there should be investment in building systems bridging the gap between the research system and the private sector or more specifically, the productive systems in the various sectors of the economy. Technologies when produced in the research system must be transferred to the productive ends of in the economy. This is a major challenge in Ghana. More importantly, the technology transfer system must have its inherent mechanism for dialogue between the researchers and entrepreneurs such that demand-driven research should be the norm in the research system. In principle, research should prop up the productive activities in all the sectors of the economy – agriculture, industry, energy, healthcare, etc.

Guatemala

Foundation

STI policy framework. There are legal and political frameworks that guide the actioning of science, technology and innovation. From the Political Constitution to the normatives that create institutionalism for the guidance, coordination, support and funding of the scientific and technological activities (Art. 80 of the Political Constitution of the Republic of Guatemala establishes that science and technology are fundamental for society including the Law of Promotion of the Scientific and Technological Development * Decree 63-91) which creates the National System of Science and Technology as well as the Decree 73-92 that creates the financial instrument for the National System of Science and Technology: National Science and Technology Fund (FONACYT) which presents the following objectives: the finance of activities described in the National Plan for Scientific and Technological Development; increase the quality and quantity of research; achieve the adequate transfer of knowledge, the funding of research for the solutions of problems for the productive sector and the support in the training of human resources.

In terms of the political frames, the “National Policy of Scientific and Technological Development 2015-2032” and its plan on “Strategic National Plan of Scientific and Technological Development 2018- 2025” are worth mentioning. Both documents are essential for the National System of Science and Technology; and they focus on the following axes: High Level of Human Capital Training, Research Based on the Social and Productive Needs, Transfer and Innovation of the technology and the popularization of science and technology.

The results of these axes are the following: In 2025 the country will count with high academic level professionals that will contribute to the development of Guatemala. This result will be measured by the number of PhD students and graduates in scientific and social disciplines and the number of high level professionals that will be part of the labor market of Guatemala.

In 2025 a research study will be carried out, highlighting the regional level for the quality and results of the latter. This result will be measured, among others, by the number of research centers, which are the base for graduate studies of excellence, by the quantity of publications and by the quantity of research studies that provide an answer to the social and productivity needs.

In 2015 innovations were developed and technology was transferred between the academia and the productive sector. This will be measured by the number of inventions and registered patents, the number of bureaus of technology transfer, the number of research centers that obtain royalties for the technological developments executed.

In 2025 the Guatemalan society demands knowledge on scientific and technological aspects that have contributed to its development and within the institutional level will consolidate scientific events taking them from national to an international level. This result will be measured by the number of promotion and dissemination activities; and by the number of departments in which popularization events take place.

Analytical and evidence base.

Yes. For the proposal, design and development of the new funding lines of the National Science and Technology Fund we count with the support of CONICYT from Chile and their experience in the execution of funds in the areas of human capital training, research and popularization of science and technology. Also we count with the support of the UNESCO for the report Go Spin ***Survey on Research and Innovation in the Republic of Guatemala***, whose diagnosis was used as an input for the design of the new funding guidelines and it was also used for the formulation of the Strategic National Plan of Scientific and Technological Development. The formulation of the National Plan of Development Kat'un: Guatemala 2032, which was coordinated and organized by the National Council of Urban and Rural Development, with the support of the Secretariat of Planning and Programing of the Presidency, it was used as a frame for the formulation of the policy and for the Strategic National Plan of Scientific and Technological Development.

Stakeholder engagement.

For the elaboration of the National Policy of Scientific and Technological Development and the Strategic National Plan of Scientific and Technological Development we counted with the active participation of the different bodies of the National System of Science and Technology: National Council of Science and Technology (CONCYT); the Advisory Committee of the (CONCYT); Technical Commissions of the National System of Science and Technology. These three agencies/bodies are comprised of the public, private and academic sectors.

For the implementation of the Policy and the Plan, we count with the participation of researchers, university authorities, ministries, secretariats, representatives of the National Congress, and members of the technical commissions.

Adaptation

Emerging technological changes and trends.

With the support of the European Community and regional organizations such as CELAC and CTCAP we count with the "Counseling in research and innovation policies to support the CELAC countries in achieving the Sustainable Development Goals". To this end, we have participated in a series of regional workshops and visits by experts where it was defined and prioritized a topic that would identify mission- based research on the subject of Biomass. With this shared theme by the agencies of science and technology in the Central American context, the mobilization of resources, the support for the private and public sector for the promotion of the action plan of the Biomass mission is expected.

Policy response.

Within the National Policy of Scientific and Technological Development framework, support will be given to the Implementation of the Open Data Portal

Integration

Sectoral STI strategies.

Several public policies have been analyzed within the national context and about 30 policies have been identified, these policies include aspects related to the use and application of science, technology and innovation for the development of the sector and for benefit of the population. Such is the case of technology in the classroom, the development of research to solve problems of health, the adjustment and transfer of technology for the development of the agricultural sector and protection of the environment.

STI roadmap as an integral element of national sustainable development plans.

The STI roadmap has not been carried out as an integral element for the plans of sustainable development. Nevertheless, the National Secretariat for Science and Technology has undertaken efforts by applying the road map methodology for the benefit of the decision makers of the National System of Science and Technology. Within Converciencia's frame 2017, a road map workshop was carried out in which several offers of projects were defined: educational technologies, patents promotion, food safety and nutrition. These initiatives were shared to members of the academia as well as the private sector.

International consensus and partnerships on STI roadmaps for the SDGs

We consider and hope that in this forum of the United Nations we can strengthen ties of cooperation, not only with this system but with other international actors such as the European Union and other regional agencies within the Latin-American and Ibero-American levels. Another important aspect is to follow up with the countries to advise them in policies and plans with the SDGs and support in the definition of projects oriented towards the fulfillment of the above mentioned objectives. It would be interesting to see the development of regional projects and, in our case, projects within the Central American context.

Japan

Foundation

STI policy framework.

The Council for Science, Technology and Innovation (CSTI), set up in Cabinet Office as the headquarters for the promotion of STI policy in the cross-ministerial and sectoral manners, overlooks all of the nation's STI and formulates the STI policy framework. Roles of CSTI include formulation of STI policy framework, evaluation of nation's R&D activities, and coordination of cross-ministerial and sectoral R&D programs, as detailed below.

- Formulation of frameworks of basic policies
  - 5th Science and Technology Basic Plan, with a new concept of 'Society 5.0' (Jun. 2018)
    - Formulated every 5 years
  - National Integrated Innovation Strategy (Jun. 2018)
    - Formulated annually
- Allocation of STI budget and human resources
  - Policies for the Allocation of Resources including the Science and Technology Budget
    - Formulated annually
  - Action Plan for the Implementation of Important Science and Technology Policy Measures
    - Formulated annually
- Evaluation of Nationally Important R&D
  - General Guidelines for Evaluating Government Funded R&D
  - Evaluation and follow-up of Large-scale R&D
- Other Activities surrounding the Promotion of STI
  - Decision making and coordination regarding R&D programs (listed below)
    - Cross-ministerial Strategic Innovation Promotion Program (SIP)
    - Public/Private R&D Investment Strategic Expansion Program (PRISM)
    - Impulsing Paradigm Change through Disruptive Technologies Program (ImPACT)

Analytical and evidence base.

- CSTI, comprised of Prime Minister and relevant Ministers as well as external experts from private sector, academia, and national R&D institute, conducts the benchmarking exercises and policy reviews in the multidirectional manner.
- The analytical data, generated by the CSTI Secretariat in Cabinet Office with its data analysis system, and external data sources such as the OECD reports and UN reports are also utilized for reviewing the current STI policy frameworks.

Stakeholder engagement.

- External experts from private sector, academia, and national R&D institute play an influential role for formulating and implementing the current STI policy framework, together with Prime Minister and relevant Ministers, within CSTI.
- In the context of 'STI for SDGs' implementation, CSTI also formulated the 'STI for SDGs Task Force', consisting of experts from relevant ministries and agencies, academia, private sector, international organization, national R&D institutes, and other affiliated organizations, besides the existing CSTI members.

Adaptation

Emerging technological changes and trends.

CSTI analyzes, foresights, and discusses on the latest STI trends as well as emerging technological changes.

CSTI formulated the 5th Science and Technology Basic Plan in 2016, which included a concept of 'Society 5.0', aiming at realizing the advanced fusion of cyberspace and physical space, balancing economic advancement with the resolution of social problems, and consolidating the 'human-centered society.'

As realizing the necessity for corresponding to the latest Artificial Intelligence technology, CSTI recently built a new framework for AI/IT human resource development and included it into the National Integrated Innovation Strategy.

Policy response.

National Integrated Innovation Strategy, or corresponded national strategy, is formulated annually by CSTI for the purpose of corresponding to the rapid technological changes. Government of Japan draws the new STI strategies as needed basis. 'Artificial Intelligence Technology Strategy' and 'Robot Strategy' are recent examples of nation's policy response.

Integration

Sectoral STI strategies.

The 5th Science and Technology Basic Plan specifies domain-specific strategies and plans while some other strategies, such as 'Basic Plan on Space Policy' and 'Basic Plan on Ocean Policy,' describe sector-specific national strategies and plans.

STI roadmap as an integral element of national sustainable development plans.
With the awareness of the high relevancy between the existing national policies, plans, strategies, and sectoral projects, and the contribution to the achievement of SDGs, CSTI Secretariat preliminary drew up the 'STI for SDGs Roadmap' by linking those existing approaches and SDGs' 17 goals.

CSTI/CSTI Secretariat is planning to provide instruction to the relevant ministries, institutes, and local government to further integrate the elements of SDGs into the existing approaches for strengthening the relevancy and ensuring the compatibility between the achievement of SDGs and national and regional development.

International consensus and partnerships on STI roadmaps for the SDGs

CSTI Secretariat / 'STI for SDGs Task Force' will share its roadmap with the international community at the future international occasions. CSTI Secretariat will also explore the peer leaning among various countries to develop international consensus and partnership as well as advance own SDGs agenda.

'STI for SDGs Task Force' will discuss the framework of 'SDGs Platform,' where the matching between Japan's technological and knowledge seeds and social/regional needs is made.

Serbia

Foundation

STI policy framework.

The central role in the institutional governance belongs to the Ministry of Education, Science and Technological Development (MESTD), a body of the state administration in charge of performing the activities related to development, improvement and financing of the scientific research and innovation activities in the function of scientific, technological and economic development of the Republic of Serbia. Scientific research and innovation activity is regulated by the **Law on Scientific and Research Activity** and the **Law on Innovation Activity** with the relevant set of bylaws and the laws regulating the field of intellectual property. There is an established legal framework for knowledge transfer and utilization of results from publicly funded research. IPR laws are major instruments for protection of the results of publicly and private funded research and innovation and institution in charge for IPR of research and innovations on national level is **Intellectual Property Office**.

The basic strategic document is the National Strategy for **Scientific and Technological Development of the Republic of Serbia for the period 2016-2020** **"RESEARCH FOR INNOVATION"**. Strategy defines six specific objectives and measures that create conditions for their realization. In addition, the Strategy articulates a number of measurable Key Performance Indicators (KPIs) that measure the progress of the strategy implementation and establish a narrative that puts science, technology, and innovation at the centre of Serbia's economic development. Presented KPIs are directly linked to the relevant monitoring and evaluation framework which will in turn delineate the impact of this strategy along the coming years.

Research, technological and innovative activities of public and private entities are financed by the budget of the Republic of Serbia. Actually the Ministry of Education, Science and Technological development allocates the budget for those activities in line with the Law on the Budget for each year. At the moment STI activities are financed through the following programs: Basic research programme, Research program in the field of technological development, Programme for co-founding of integrated and interdisciplinary research and Innovation activity programme. In addition to this, STI activities are partly financed by other funding sources and notably from credit/loan funds, international funds and private sector investment. Innovation activities are additionally financed from the funds secured for this purpose by the Pre-accession Fund (IPA) allocated to Republic of Serbia toped up with the budget of the RS and co-financed by the private sector, through the programme lines of the Innovation Fund.

Currently, model of financing of research in Serbia (through MESTD programs) is an entirely project-based model with extremely high success rates and limited influence on the economic development. A new model of financing has been proposed by "Research for Innovation" Strategy and ministry is entering in complex reforms this and next year: MESTD currently working on a new legal framework that will create a mix of merit-based institutional funding in parallel with highly-competitive project-based funding to improve both the excellence and relevance of our R&D. At the same time the new entity, **Science Foundation**, will be established. Foundation will implement and finance the competitive programmes in the future.

In addition to this, there is (in final phase of development) **Infrastructure Road map**, prepared according to the ESFRI rules.

Based on Law on Innovation Activity the **Innovation Fund** (IF) has been established as a particular legal entity for the implementation and monitoring different innovation programmes. *Operational since 2011, the Innovation Fund has been a pioneering effort to operationalize and institutionalize innovation imperative – first by increasing the capacity of startups and resources available for their growth but also by the promotion of linkages between research and technology development and economy, and encourage and support the development of innovative technologies. The intention of the Innovation Fund is to contribute to the overall development of innovations through various financial aid instruments, particularly by fostering the establishment of new and strengthening the existing companies, by positioning them to access venture capital markets, and by attracting foreign direct investment in the high-tech research and development.*

Centralized **Technology Transfer Facility** is established within IF in order to coordinate individual technology transfer offices created at four State Universities. IF Programms are: Mini grants program, Matching grants program, Collaborative grant scheme program, Technology transfer facility and Innovation vouchers. These programs are intended to support activities within micro or small sized companies incorporated for no longer than three years, other InnSMEs and academic R&D. Financing decisions are made entirely by an Independent International Investment Committee based on the previous international expert's peer-reviewers. **Monitoring and evaluation** are built into the IF's instruments.

In the period from 2011 to 2016, the total investment in science, technological development and innovations was in the range between 0.7% and 0.9% of GDP (GERD/GDP).

The Republic of Serbia has started preparation process of **Smart Specialization Strategy** - RIS3 on national level. The MESTD is coordinating this process together with other relevant ministries and institutions. One of the major achievement of the national RIS3 development up to now is the document titled "Mapping of economic, innovative and scientific potential in Serbia". The next steps will be focused on implementation of Entrepreneurial discovery process – EDP which is conducted through a public private dialogue in order to define priorities on national level.

Analytical and evidence base.

Policy mix peer review report on Serbia, April 2017, EU FP7 Danube-INCO.NET project (FP7-609497) This report summarized the main findings of the review team to conduct a research and innovation (R&I) policy mix peer review in Serbia. The review team visited the country in September 2016, and had interviews from all major stakeholder groups (government, academia, business and intermediary organisations providing special innovation services). The findings of the report are based on the analyzes of the national innovation system in Serbia that facing with the major challenges. After a successful recovery from the recession and in parallel with taking steps to reduce unemployment, new sources of economic growth and social development should be mobilized. Innovation represents one of the best opportunities to do this. It requires a new generation of entrepreneurs, who are able to adapt to new technologies in a creative way and consider innovation as their daily experience to improve the competitive position of their firms. The changes should focus on: Encourage businesses to increase demand for innovation and research; Improve human capacity, with a special focus on young scientists and inventors / innovators; Adjust the public research and knowledge & technology transfer system to the requirement of the economy and society, and; Increase private and public funding for RTDI.

Science, technology and innovation in South East Europe**, Chapter 9 external review**, August 2017, OECD This report was focuses on five sub-dimensions, which correspond to areas of policy action: First, the chapter assesses the governance of STI policies, based on a holistic strategy and horizontally coordinated implementation through adequately professionalized institutions. Next, the chapter examines the capacity of governments to improve the public research system, to support excellent and relevant research. Thirdly, the chapter investigates the support mechanisms needed to promote business investment in innovation and innovative start-ups, as well as technology diffusion. A fourth sub-dimension on public-private knowledge transfers and linkages examines policies to facilitate science-industry collaboration and technology transfer to overcome barriers existing between academia and business. Finally, human resources for innovation focus on specific policies to unleash the human capital in STI through appropriate incentives and mobility schemes. Addressing those challenges would enable the country to build an innovation ecosystem which would facilitate the transition towards a knowledge-based economy.

TAIEX Expert Mission on Assessment of Institutional Framework for the Implementation HORIZON 2020 projects, April 2016, TAIEX EC instrument (ETT IND/EXP 60479) The objective of the mission was to analyse current support structures for the participation of Serbia in HORIZON 2020 Programme and to assist the Government of the Republic of Serbia in defining the steps towards possibly more efficient system.

European Commission - Serbia Report 2018
Related to report on:
Chapter 7: Intellectual property law Serbia has a good level of preparation on intellectual property rights. Serbia should therefore, in particular: further align the law on copyright and related rights, the law on topographies of semiconductor products, and the laws on patents and trademarks with the EU acquis and further strengthen enforcement capacity and coordination of different stakeholders.
Chapter 20: Enterprise and industrial policy Serbia is moderately prepared on enterprise and industrial policy. Some progress was made on promoting entrepreneurship and facilitating access to finance for SMEs. Serbia should in particular: develop a comprehensive industrial policy based on EU principles and using the findings of the smart specialisation exercise and make efforts to improve the predictability of the business environment, with the emphasis on addressing the issue of unpredictable parafiscal charges.
Chapter 25: Science and research Serbia is at a good level of preparation in the area of science and research. Some progress was made with regard to innovation policy and participation to the EU programmes for research. In the coming year, Serbia should in particular implement the national research strategy, and in particular stimulate cooperation between industry and academia.

Supporting an Innovation Agenda for the Western Balkans, April 2018, Joint Research Centre EC (JRC111430) This report presents the ongoing work of the European Commission's Joint Research Centre (JRC) in supporting an Innovation Agenda for the WB in cooperation with the Directorate-General for Neighbourhood and Enlargement Negotiations (DG NEAR). It provides a preliminary overview of the present situation in the context of economic, innovative and scientific potential of the Western Balkan economies, presenting tools and methodologies that can help address the existing and emerging challenges. As the integration and enlargement processes move on pace, it is a good time to take stock and set new directions for future cooperation.

Stakeholder engagement.

The Republic of Serbia have strengthened horizontal coordination. Beside the MESTD the institutional framework consists of the following institutions: National Council for Scientific and Technological Development, Specialised Scientific Committees and other bodies, committees and institutions jointly participating in the implementation of the scientific research and innovation policy. In addition to the aforementioned, it is important to underline the institutions of national importance cooperating with the MESTD on the implementation of the activities in the field of science and scientific research activity. Those are primarily the following: Serbian Academy of Sciences and Arts (SASA), the highest scientific and artistic institution in Serbia and Matica Srpska, the oldest literary, cultural and scientific society of Serbian people achieving outstanding results in the field of encyclopaedias, publishing and scientific research. Also, the National Council for Higher Education, relevant institutes, institutions of higher education (universities and faculties), centres of excellence, the Innovation Fund, Project Implementation Unit in the Public Sector, Centre for the Promotion of Science, Association of Institutes of Serbia, Conference of Universities of Serbia (KONUS), Science Centre Petnica, national and regional talent centres, scientific and professional associations, research and development centres, innovation centres, business and technology incubators, science technology parks, business and technology incubators, public enterprises, small and medium-sized enterprises, Chamber of Commerce of Serbia and regional chambers of commerce, financial institutions and other business and NGO organisations, institutions and bodies that are included in specific policy making and implementing processes.

Interministerial coordination goes through the formation of Working groups during the preparation process of legal and strategic documents, including several relevant institutions from different public and private sectors, and has a formal and informal mechanisms to ensure synergies and avoid overlapping across the Ministries and sectoral policies.

In addition to that, in order to ensure successful supporting mechanism for innovations Prime-minister cabinet established the government Council for Innovative Entrepreneurship and Information Technologies.

Adaptation

Emerging technological changes and trends.

The mapping report on research, innovation and economic potential of RS done last year by Fraunhofer institute and further analyses done in the scope of RIS3.

Policy response.

Government of the Republic of Serbia established the **Council for Innovative Entrepreneurship and Information Technologies** with the aim to make Serbia move faster with the fourth industrial revolution. Members of the Council are Prime Minister of the Republic of Serbia as chairman, representatives from the government and various ministries responsible for education, innovation and economy, as well as members from universities. Council through daily consultations with IT industry from Serbia, start-ups and innovative companies, developed the Action Plan and started its fast implementation. During the first year of implementation, concrete parallel efforts were carried out by the Government in several areas. At the beginning, Government adopted the Strategy for the Development of the IT Sector 2017-2020 with focus on key areas and initiatives: Development of human capital through education system, Building of innovation infrastructure through modernisation and equipping, Competitive market through initiatives that will significantly facilitate business and Financial incentives through implementation of the Innovation Fund programs.

Good example:
Digital Serbia Initiative is a private, non-profit organisation leading the transformation of Serbia into a digital society with aim to create an environment where Serbian technology companies are regional
leaders in their fields, providing ample local employment opportunities and an excellent quality of life for Serbian citizens. In a digital Serbia each individual will be able to realise their full potential and present their talent and innovative skills on the global market.
Digital Serbia Initiative aims at building and strengthening all aspects of a successful digital and high-tech innovation ecosystem through participation in improving of government policy and modernizing the regulatory framework in order to create a stimulating business environment, providing assistance to the entrepreneurial start-ups and scale-ups in the creation and the scaling-up of new businesses, enhancing education through strengthening the formal education system, deepening the Serbian talent pool and creating new offerings in adult education, fostering the exchange of ideas and facilitating co-operation on local and international level, etc.

Integration

Sectoral STI strategies.

The Republic of Serbia, as EU candidate country, has started preparation process of **Smart Specialization Strategy** - RIS3 on national level. The MESTD is coordinating this process, together with Public Policy Secretariat of the Government of Serbia and other relevant ministries and institutions, and is responsible for its preparation. RIS3 Interministerial Working Group consists of representatives of the following institutions: Ministry of Education, Science and Technological Development; Ministry of Economy; Public Policy Secretariat of the Government of Serbia; Ministry of Agriculture, Forestry and Water Management; Ministry of Labor and Employment; Ministry of Trade and Telecommunication; Ministry of Finance; Chamber of Commerce and Industry of Serbia; Serbian Academy of Science and Arts; and Provincial Secretariat for Economy and Tourism of AP Vojvodina. The RIS3 Inter-ministerial Working Group has established the operational and analytical teams to perform the process on an effective way, and it is in charge of collecting statistical data, data processing as well as preparation and coordination of activities related to the Entrepreneurial discovery process (EDP). The Joint Research Centre of European Commission (JRC) is supporting this process in Serbia right from the beginning, putting in place its own expertise as well as the expertise of the external experts. In that respect Serbia is JRC targeted country in the 2-year period, 2017-2018. The documents Roadmap for Developing Research and Innovation Strategy for Smart Specialization and Mapping of Economic, Innovative and Scientific Potential in Serbia have been prepared as a base for future definition of priorities at national level.
The next stage in the development of RIS3 is a qualitative analysis for the identification of priority domains and the co-creation of a policy mix developed on the real needs of stakeholders in the innovation ecosystem that would grantee the ownership of relevant stakeholders in later stages.

STI roadmap as an integral element of national sustainable development plans.
Republic of Serbia has several strategic important documents of public policies that correspond to STI, such as Strategy and Policy Development of the Industry of Republic of Serbia for the period 2011-2020, Strategy for supporting the development of small and medium enterprises, entrepreneurship and competitiveness for the period from 2015 to 2020, Program for improvement of the position of the Republic of Serbia on the World Bank ranking - Doing business, Strategy of the

development of education in the Republic of Serbia until 2020 and of course Strategy for Scientific and Technological Development of the Republic of Serbia for the period 2016-2020 "RESEARCH FOR INNOVATION". The common points are creation of environment for increasing competitiveness, utilization of innovation potential, increase number of employees, improvement of human capital, investing in knowledge and technology and easier integration into the EU common market.

Strategy and Policy of Development of Industry of the Republic of Serbia from 2011 to 2020 (Industrial Policy) is document pro-actively focused on the export competitiveness of high value-added industrial and high value-added services, based on knowledge, innovation, research and development. This strategy is complementary with sectoral strategy which regulates STI area.

Strategy for supporting the development of small and medium enterprises, entrepreneurship and competitiveness for the period from 2015 to 2020 also targeted STI within its priorities in order to achieve a strategic vision - the development of entrepreneurship and competitiveness, based on private entrepreneurial initiative, knowledge and innovation, in order to empower domestic micro, small, medium-sized companies and entrepreneurs to adequately respond to the pressure of competition in the common EU market and contribute to improving living standards in the Republic of Serbia.

Also, there is the **Strategy of regulatory reform and improvement of the public policy management system for period 2016-2020** on national level. Regulatory reform and reform of public policy management system are essential for public administration reform focused on establishing a legal and institutional framework that will enable citizens and the economy an adequate environment for effective and efficient functioning.

In addition to this, there is a document **Economic Reform Programme** for the Period 2018-2020, which was prepared along the fourth cycle of reporting. The Economic Reform Program (ERP) is the most important strategic document in the economic dialogue with the European Commission and the Member States of the European Union (EU). The aim of this document is the preparation of the Republic of Serbia, as a candidate country for EU membership, for participation in the process of economic and fiscal analyses as any of EU member states is doing. The Republic of Serbia is developing the program of economic reforms annually to ensure sustainable and inclusive economic growth, in line with the strategic goal of reducing the development gap between the domestic economy and the EU.

Priority areas within this document are: PUBLIC FINANCE MANAGEMENT, ENERGY AND TRANSPORT MARKET REFORM, SECTORAL DEVELOPMENT, BUSINESS ENVIRONMENT AND REDUCTION OF THE INFORMAL ECONOMY, RESEARCH, DEVELOPMENT AND INNOVATION, AND DIGITAL ECONOMY (with its structural reform Programme supporting innovations and technological development in the public and private sectors), TRADE-RELATED REFORMS, EDUCATION AND SKILLS, EMPLOYMENT AND LABOUR MARKET and SOCIAL INCLUSION, POVERTY REDUCTION AND EQUAL OPPORTUNITIES.

Also, there is a document and additional supportive initiative on national level **The Action Plan for Implementation of the Government Program** APSPV (Management by results). The Government Program is a planning document with priorities that the Government plans to achieve during the period of its mandate. The Action Plan for the Implementation of the Government Program is an operational document of the Government, which aims to fulfil the priorities from the Government Program through achievement of priority goals, concrete results and inter-results, based on results-based management principles. There is a Coordination Body for the preparation and monitoring of the implementation of the AP. STI within this AP is target within the priority goal CREATING ECONOMIC OPPORTUNITIES FOR ALL.

International consensus and partnerships on STI roadmaps for the SDGs

A big challenge for implementation of STI policies in Western Balkans is the lack of human resources for innovation scale-up and technology transfer. It is mostly a consequence of intensive brain-drain. Any potentially successful roadmap should incorporate effective cross-border mentorship for innovators and entrepreneurs.

An area that is not covered well with STI policy papers is social innovations and non-commercial applications of technology with the goal of societal development. Unemployment and inadequate environment for entrepreneurial careers are challenges for all kinds of innovations, which do not have to exhibit financial outcome but small increase in quality of life.

Investments in Serbia depends a lot on foreign direct investments (FDI). Achieving most of SDGs depend on our ability to attract investors in high-tech products and R&D.

Practice of routine application of innovative solutions in areas like healthy food productions, clean energy and responsible production is a challenge for implementation of STI policies. It is not only about innovations but more about habit to learn about and implement innovative solution. Serbia needs robust cross-sectorial legal framework for the support of innovation-based sustainable economy.

Bibliography

(To be added in the final paper)