PROGRESS REPORT

of the Global Pilot Programme on STI for SDGs Roadmaps

EUR 30776 EN

TECHNOLOGY FACILITATION MECHANISM | SUSTAINABLE DEVELOPMENT GOALS

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PROGRESS REPORT

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June 2021

Foreword

Achieving the 17 Sustainable Development Goals (SDGs) is the most important global agenda for 2030. Recent analyses conducted by the United Nations and other international organisations point out that it is very difficult to achieve the SDGs if we continue to do business as usual. Efforts have been further hindered by the recent COVID-19 pandemic. Getting the SDGs agenda back on track is an urgent priority.

STI for SDGs roadmaps stimulate collective and coherent actions and strict progress evaluation so that STI contributes significantly to achieving the SDGs. Indeed, roadmaps are essential for the effective integration of STI into national and subnational development plans addressing the SDGs. In the early STI Forums convened by the United Nations Economic and Social Council, implementing STI for SDGs roadmaps was a point of intense discussion, and the Global Pilot Programme on STI for SDGs Roadmaps was launched at the High-Level Political Forum in 2019.

While taking account of local circumstances and priorities, each of the six countries (Ghana, Ethiopia, Kenya, India, Serbia and Ukraine) participating in the first phase of the programme has been working on implementing concrete roadmaps in line with the *Guidebook for the Preparation of Science, Technology and Innovation (STI) for SDGs Roadmaps* published by the UN Inter-Agency Task Team. The potential for STI for SDGs roadmaps to innovate national ecosystems in each country is well recognised following experiences in the initial stage.

What is needed today to harness STI for SDGs is dynamic roadmapping which encompasses a series of enhanced actions according to new circumstances. I hope that this report contributes to expanding the Global Pilot Programme and paves the way for the SDGs.

Michiharu Nakamura
UN 10-Member Group (2018-2020)

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Executive Summary

Background

The 2030 Agenda, adopted at the United Nations Sustainable Development Summit in September 2015, positioned Science, Technology and Innovation (STI) as key means to implement 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 TFM forum for discussing topics of common interest to Member States and STI stakeholders in the context of the 2030 Agenda.

As STI roadmaps and action plans to help realise the SDGs have been among the central topics throughout the first three STI Fora[1], IATT established a sub-working group on roadmaps[2] to further develop discussions and initiatives on STI roadmaps[3]. Consequently, the IATT sub-working group, together with the 10-Member Group[4], has launched the *Guidebook* for the preparation of STI for SDGs roadmaps.

As a means to engage countries in piloting the approach and methodology elaborated in the Guidebook, the IATT sub-working group has also launched a Global Pilot Programme on STI for SDGs roadmaps. **Since the last High-Level Political Forum (HLFP) in July 2019, five pilot countries –¬ Ethiopia, Ghana, India, Kenya and Serbia, together with two international partners, Japan and the European Union – have been participating in the first phase of the programme. Ukraine joined the programme in 2021.** As more countries become interested in joining the pilot programme[5], new efforts are also **underway to initiate a support mechanism for the second wave of countries joining**, through a new joint initiative called 'Partnership in Action'. The concept of this is described in a draft outreach note.

Meanwhile, **IATT has developed two background papers, one on international cooperation and another on methodologies. These, together with the *Guidebook*, inform of IATT's continuous dialogue with national authorities leading roadmap pilots and prepare the ground for solidifying respective pilot design as well as peer learning**.

1 *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 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.*

2 *IATT is coordinated by DESA and UNCTAD and the co-leads for its sub-working group on STI for SDGs roadmaps, which also include the World Bank and UNESCO; outside of the UN, EU JRC and OECD actively participate and contribute to the activities.*

3 *The objective of the sub-working group is to devise and implement, with the help of IATT partners and other stakeholders, an inter-sessional work programme that will enrich STI Forum discussions on STI roadmaps by delivering a tangible impact to be achieved over 2018-2019.*

4 *The 10-Member Group is a group of 10 high-level representatives from civil society, the private sector and the scientific community.*

5 *In total (including the countries in the first phase of the pilot programme), more than 20 countries, including a number of Asian and African countries – including Cambodia, China, Indonesia (Oman and Republic of Korea), Botswana, Chad, Rwanda, South Africa and Tunisia – have expressed interest in joining the programme to implement the roadmaps in line with the* Guidebook.

This progress report for the Global Pilot Programme is designed to take stock of the state of pilot countries, to draw lessons and implications from the current implementation and to suggest ideas for the way forward. The longer, full version of the progress report will also be available on the TFM website.

Current state of pilot countries

This progress report uses the *SDG Index* to provide comparative information on where pilot countries have started with respect to STI and SDGs[6] (***Figures 1 and 2***). The two indexes show a positive correlation but with significant variance. One key observation is that **more effort needs to be dedicated to improving STI capability, particularly in developing countries**, as Goal 9 (which has been primarily structured around STI) appears to be one of the weakest. Another important point to note is that **there is significant room for improvement in harnessing STI for SDGs**, as some of the pilot countries perform poorly on the *SDG Index*.

Lessons learned in pilots (following steps specified in the *Guidebook*)

All six pilot countries have taken the initial step in the STI for SDGs roadmapping exercise, the *objective setting of pilot projects*. They have done so within the context of their national development plans and their economic and social conditions. All of them have **chosen a narrow set of SDGs** because of the difficulty in tackling all of the SDGs simultaneously. As most countries are low income or lower middle-income countries with high poverty rates and the largest shares of employment in agriculture, it is not surprising that **SDGs 1, 2 and 4 are the most commonly chosen goals**.

As the second step – *assessment of the current situation* of both SDG gaps and STI supply/capability – requires a lot of data and expertise, the depth of the assessment has varied across the pilot countries. In the third step of *developing a vision, goals and targets*, what seems to matter are the institutional set-ups through which they have engaged in the pilot exercise, especially in **involving the highest levels of government in the process**.

The fourth step, *assessing alternative pathways*, is perhaps the most complex and expensive one, requiring the engagement of representatives from different groups in the innovation chain, not only including technology but the agents involved in the value chain to diffusion and use as well as the provision of complementary inputs, including finance and infrastructure. None of the pilot countries have yet fully *developed detailed roadmaps* or have reached the *execution or implementation phase*. However, during these steps, **monitoring and evaluation is a critical element as it will enable countries to learn from the implementation experience and adjust as well as take into account the impact of changes in the context, i.e. the current COVID-19 crisis**. The *use of data and expertise* has varied widely across pilot countries, predominantly dependant on what information is readily available as well as how much effort they have put into developing and collecting relevant data. There has also been considerable variation in the extent to which domestic and international expertise has been used to help develop the roadmap, as well as the nature and depth of stakeholder consultations.

The most common challenge, experienced by all countries, **has been achieving stakeholder involvement and active participation**. Pilot countries doing relatively well have succeeded in involving several ministries and agencies, creating platforms for gaining effective coordination and collaboration within government and between government and other stakeholders. **One related challenge has been getting a focus on SDGs into the development of national plans and the STI for SDGs roadmap.** The second major challenge has been the availability of updated data and relevant expertise to do the assessment to develop priorities. Besides COVID-19, another common

6 *Note: We are fully aware that data for indicators is missing and indicators for some important dimensions are lacking, particularly in developing countries. Our intention is to contextualise where the countries started their pilot projects to help monitoring and evaluation processes to follow.*

problem which has slowed the preparation of the roadmaps is **the lack of a specific budget to develop and, more importantly, implement the STI for the SDG roadmap**.

Table 1 presents a review of progress on the development of the STI for SDG roadmaps by each of the pilot countries.

Moving forward

Building on the progress made and success achieved thus far, collective actions are needed to expand and strengthen the Global Pilot Programme on STI for SDGs roadmaps. Setting up a community of practice of countries developing and implementing roadmaps would be an enormous help, for example. The UN IATT and its Member countries with relevant stakeholders need to further **draw upon existing national and international information, technical as well as financial resources and take full advantage of the opportunities offered by new and existing technologies**[7] **through the aforementioned 'Partnership in Action'**.

7 *There is a great opportunity to harness new digital technologies and take advantage of the convergence between digital, physical and biological technologies, while addressing the potentially negative effects of these disruptive technologies, such as the tendency for increasing inequality, the risk of serious issues for privacy, security and autonomy as more personal data becomes digitised.*

Table 1

Six countries participating in the Global Pilot Programme on STI for SDGs roadmaps

	KENYA	GHANA
Lead and other institutions involved	■ National Treasury, Department for Planning ■ NACOSTI, ACTS ■ Line ministries (Education, Science & Technology, Foreign Affairs, ICT, Agriculture, Industry)	■ Ministry of Environment, Science, Technology & Innovation ■ CSIR-STEPRI
Underlying policy frameworks	■ Kenya Vision 2030 ■ MTP III 2018-22, 'Big Four' ■ STI Policy, Research Priorities ■ Digital Economy Blueprint ■ Agricultural Sector Transformation and Growth Strategy (2019-2029)	■ Agenda for Jobs 2017-2021 ■ CPESDP 2017-24 ■ National STI Policy 2017
Roadmap scope and objectives	■ The 'Big Four' (agriculture, health, manufacturing, housing) ■ Agro-processing and ICT as an initial focus ■ SDG 2 and those closed linked to it (SDG 1, SDG 8 and SDG 9)	■ Focusing on SDGs 1, 2, 3, 4, 6, 8 and 9. The roadmap discussed these SDGs and the strategies, programmes and activities to ensure STI accelerate the achievement of these prioritised SDGs

	ETHIOPIA	INDIA	SERBIA	UKRAINE
	■ Ministry of Innovation & Technology ■ Ministry of Science and Higher Education	■ PSA office ■ Niti Aayog, Minister of External Affairs, RIS ■ National Coordination Committee	■ Lead is the Ministry of Education, Science & Technology, coordinating Inter-Ministerial Working Group and cooperation with the national Agenda 2030 group. Other actors are working groups for Smart Specialisation (4S) priority domains led by businesses and academia, the Statistical Office, National Patent Office; National Analytics Team (academia-led)	■ Lead is the Deputy Prime Minister's Office ■ Ministry of Education and Science, ■ Ministry of Economy ■ National Smart ■ Specialisation Team
	■ GTP III 2015-20 ■ STI Policy 2012	■ Strategy for New India @ 75 ■ STI Policy 2013	■ EU Accession Process and 4S ■ New STI and industrial policy under Prime Minister ■ Agenda 2030	■ EU Agenda 2030 integration process and Smart Specialisation ■ Agenda 2030
	■ SDG 8 (job creation)	■ Agriculture, energy, water, health; align with key initiatives (e.g. *Doubling Farmers Income*, JAM Trinity) ■ Strong international focus – Africa and Far East	■ Develop the implementation plan to guide work on the four defined Smart Specialisation priority domains and horizontal actions ■ Priorities include creative industries; food for the future; machines and production processes of the future; ICT	■ Identify national SDG priorities ■ Coordinate national and regional (subnational) priorities ■ Identify STI potential and key actions ■ Develop a detailed action plan

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	KENYA	GHANA
Approach to pilot	■ Sectoral deep-dive, target-driven (100% food and nutrition security by 2022) ■ R&D & adoption/ diffusion ■ Aiming for an East Africa regional model	■ Build on technology incubation centres ■ Aim for investment proposals and institutional strengthening
Timeframe and key milestones	■ To be updated	■ Dec 2019. Deliberation of the objective of the roadmap and development of tentative workplan ■ June 2020. Inauguration of Technical Task Team ■ July 2020. Technical task meeting validating the situational analysis report and discussing the roadmap outline (composition for drafting working teams) ■ Sep. 2020. Finalisation of the situational analysis report ■ Feb. 2021. Presentation by Ghana's focal person for the STI for SDGs pilot at the African STI Forum ■ March 2021. Submission and review of the 1st draft of the roadmap ■ March 2021. Task Team meeting to discuss 1st draft of the roadmap and provide comments and feedback ■ April 2021. Expected finalisation of the roadmap

ETHIOPIA	INDIA	SERBIA	UKRAINE
■ Sectoral. Build on 24 technology roadmaps	■ International national and subnational levels (Lighthouse India, cooperative federalism) ■ Data/dashboard to be substantiated through STI PER inputs	■ Leverage on ongoing work underpinning the production of 4S, taking into consideration the national, subnational and international dimensions ■ Mix of deep dives and horizontal activities building on existing stakeholder mechanisms and working groups contributing to 4S methodology	■ Leverage on ongoing work underpinning the production of a Smart Specialisation strategy, taking into consideration the national, subnational and international dimensions ■ Mix of deep dives and horizontal activities building on existing stakeholder mechanisms and working groups
	■ First 6 months (in India) ■ End 1st year (AfDB AMs?) ■ End 2nd year (in NY)	■ Adoption of Smart Specialisation Strategy (February 2020) and a detailed roadmap (October 2020) ■ Adoption of the action plan (STI for SDGs roadmap) in March 2021	■ Adoption of first regional Smart Specialisation strategies (December 2021) ■ National-level roadmap to be decided

V

	KENYA		GHANA	
Partners (DESA: The Secretariat)	IATT focal	■ WB (STI PER) ■ UNESCO (Saga, GO-SPIN)	■ UNESCO ■ WB	
	UN, Others	■ Private partnership (Toyota)	■ OECD	
		Possible EU/ACP, AUC, RECs, Japan-India-Africa cooperation		

*****Key abbreviations: [Kenya] National Commission on Science, Technology and Innovation; African Centre for Technology Studies; Mid-Term Plan III. [Ghana] Council for Scientific and Industrial Research – Science and Technology Policy Research Institute; Coordinated Programme of Economic and Social Development Policies. [Ethiopia] Growth and Transformation Plan III. [India] National Institution for Transforming India; Research and Information System for Developing Countries; electronic National Agricultural Market; Mission Indradhanush; Swachh Bharat Mission Gramin; National Innovation Foundation. [Serbia] Research and Innovation Strategies for Smart Specialisation.*

	ETHIOPIA	INDIA	SERBIA	UKRAINE
	■ UNCTAD (STIP Review) ■ WB, UNESCO	■ WB (STI PER) ■ ESCAP	■ EU JRC ■ UNIDO	■ EU/JRC ■ UNIDO
	■ UNDP, UNIDO	■ OECD ■ UNDP		

CHAPTER 1.

Introduction

Background

The 2030 Agenda, adopted at the United Nations Sustainable Development Summit in September 2015, positioned science, technology and innovation (STI) as key means to implement 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 TFM forum for discussing topics of common interest to Member States and STI stakeholders in the context of the 2030 Agenda.

STI roadmaps and action plans to help realise the SDGs have been among the central topics throughout the first three 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 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 translating these objectives into concrete outcomes, the IATT established a sub-working group for taking the discussions and initiatives on ST I roadmaps forward. The objective of the sub-working group on STI for SDGs roadmaps is to devise and implement – with the help of IATT partners and other stakeholders – an inter-sessional work programme that will enrich STI Forum discussions on STI roadmaps by delivering a tangible impact to be achieved over 2018-2019.

Consequently, the IATT sub-working group, together with 10-Member Group, has launched the *Guidebook* for the preparation of STI for SDGs roadmaps. The *Guidebook* is currently being translated into eight languages, including the six UN official languages. As a means to engage countries in piloting the approach and methodology elaborated in the *Guidebook*, the IATT sub-working group has launched a Global Pilot Programme on STI for SDGs roadmaps, and since the last in July 2019, five pilot countries – Ethiopia, Ghana, India, Kenya and Serbia, together with two international partners, Japan and the European Union – have been participating in the first phase of the programme. Ukraine joined the programme in 2021.

As more countries are interested in joining the pilot programme, new efforts are also underway to initiate a support mechanism for the second wave of countries to join the programme through a new joint initiative called 'Partnership in Action', a concept which is described in a draft outreach note.

At the same time, IATT has developed two background papers, one on international STI collaboration and investment for the SDGs and another providing an overview of methodologies for STI for SDGs roadmapping. These, together with the *Guidebook*, inform of IATT's continuous dialogue with national authorities leading roadmap pilots, and prepare the ground for solidifying respective pilot design as well as peer learning.

Objectives

The objective of this progress report for the Global Pilot Programme is to:

- summarise the current state of the programme in the six pilot countries through country write-ups prepared by the IATT focal points working in each country in coordination with the country teams developing the roadmaps (***Chapter 3***);
- summarise the lessons and implications from the current implementation experience in the six countries as well as those from the three country case studies of successful national examples submitted as of May 2020 and

implications for international STI collaboration (*Chapter 4*);

- draw upon some of the implications from these lessons (*Chapter 4*) for
  - future revisions and sharpening of the Guidebook
  - further work in the pilot countries
  - countries that may join the pilot programme in the future
  - for moving forward.

To put what is being done in each pilot country into context, *Chapter 2* provides a broad snapshot of the STI gaps in the first six countries, as well as their relative positions on the SDG gap index and their innovation capability.

The three country case studies that had been received as of May 2020 are in the Annex.

CHAPTER 2.

Current state of countries and pilot countries

Country contextualisation regarding STI for SDGs

While each country has to perform a detailed assessment of its SDG gaps and it goals depending on its situation and ambition, it is useful to look at broad indicators of where countries stand in order to provide some context for understanding their STI for SDG roadmaps. This is achieved in this section by using two indicators that are available for most countries in the world. In addition, ***Appendix A.1*** presents data on the six countries' relative size, economic structure and social and environmental indicators.

The SDG Index

Although full and robust indicators of SDG gaps are not available at global level[8], a rough idea of each country's position can be obtained from the *SDG Index* produced by Bertelsmann and the Sustainable Development Solutions Network every year. The report is not an official monitoring of SDGs but rather uses publicly available data published by official data providers (World Bank, WHO, ILO, others) and other organisations, including research centres and non-governmental organisations. The *SDG Index* scores countries on the 17 SDG goals. The score indicates a country's position between the worst (0) and the best or target (100) outcomes on each of the 17 SDG goals[9]. While there is some variation, in general, there is a positive relationship between a country's overall SDG Index and its per capita GDP (***Figure A.2***).

The position of each of the pilot countries with respect to the 17 SDGs is presented in ***Figure 2.1***, where the outer part of the circle represents being on target.

Observations

SDG gaps

One of the weakest areas is the SDG 9 index. Although the goal is supposed to cover industry, infrastructure and innovation, the actual indicators used in the index are primarily structured around STI capability. This is the SDG on which all of the pilot countries score the lowest. Similarly, all developing countries score the lowest on SDG 9 in comparison to the other SDG goals. This implies that much more effort needs to be dedicated to improving STI capability in the pilot countries as well as among developing countries in a more general sense.

One of best performing SDGs for developing countries is environmental. However, developing countries are ranked favourably here due to their low level of development. But it should be noted that developing countries do poorly on natural resource depletion as indicated in comparative ESE basic indicators.

8 *There is ongoing work to improve SDG indicators. The UNESCO Statistical Institute, in particular, is working on a broader and more detailed set of STI and SDG indicators. There are also various methodologies for STI roadmapping. The IATT* Background Paper: Overview of the Existing STI for SDGs Roadmapping Methodologies *(2020) provides a summary of such methodologies.*

9 *While data for indicators is missing in many countries, and there is a lack of indicators for some dimensions of important components of SDG goals, particularly for developing countries, the* SDG Index *does provide some useful information that can be compared at global level.*

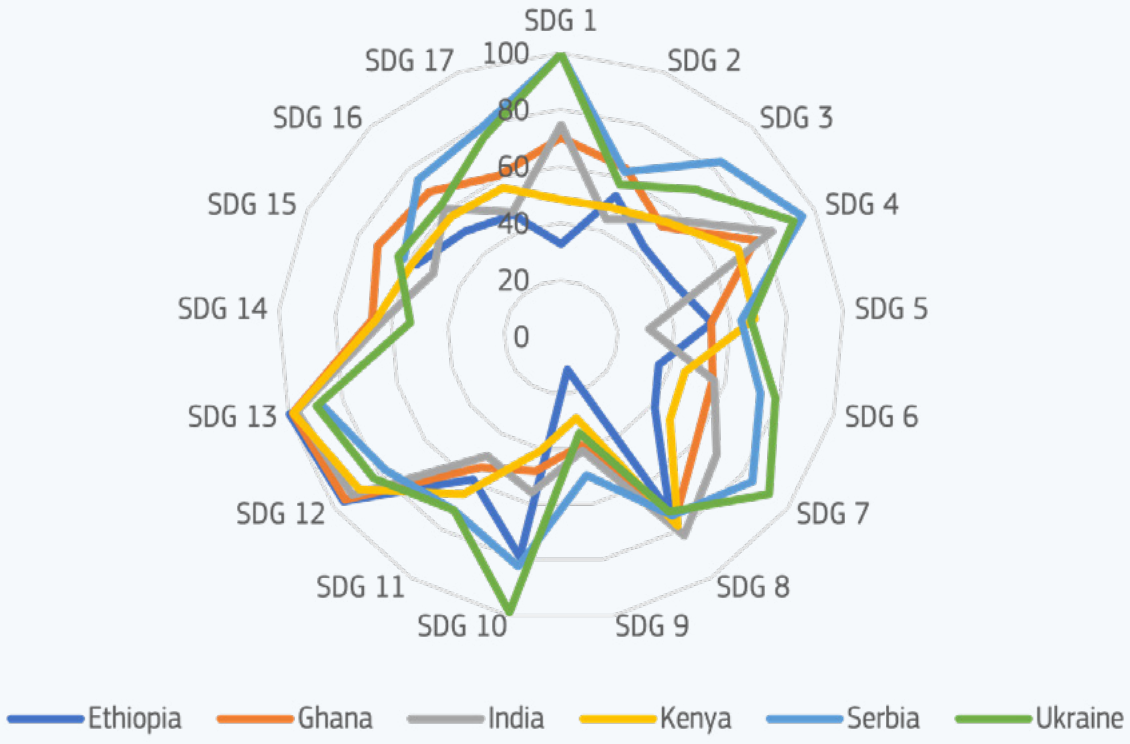


Figure 2.1 *Position of the six pilot countries on the SDG Index*

Source: Bertelsmann and Sustainable Development Solutions Network (2018), SDG Index.

The assessment of the current state of STI for SDGs roadmaps

The assessment of the current state of STI for SDGs roadmaps is based on the updated achievements reported by the IATT focal points in the six pilot countries outlined in the *Guidebook*; their collected data, expertise and stakeholder consultations; as well as their self-reporting challenges and lessons learned.

Table 2.1 presents a review of progress on the development of the STI for SDGs roadmaps by each of the pilot countries, including the key agencies leading the process; other expected stakeholders and the timeline; challenges; and lessons learned.

Chapter 3 summarises what has been achieved so far in developing the STI for SDG roadmaps in the pilot countries.

Chapter 4 draws upon the lessons and implications from their experience to date, as well as that from the case studies on the effective use of STI to accelerate development goals in three pilot countries.

Table 2.1

Summary of pilot countries' approach and progress in developing their STI for SDGs roadmaps *(based on reports from Chapter 3)*

	ETHIOPIA	GHANA
Leading ministry(ies)	Ministry of Innovation and Technology (MINT) is lead agency; Ministry of Science and Higher Education (MOSHE) is interested in joining. Working on modalities of collaboration	Ministry of Environment, Science, Technology and Innovation (MESTI) & CSIR-STEPRI (policy research institute). Technical Oversight Committee co-chaired by President's SDG Advisory Unit and MESTI. Involves Ministries of Finance, Planning, etc.
Objectives & scope	Effort so far has been based on Science Technology and Innovation Policy (STIP) Review concluded in 2019. Key STGS that appear to be planned targets are 1, 2, 3 and 10	Focusing on SDGs 1, 2, 3, 4, 6, 8 and 9. The roadmap discussed these SDGs and the strategies, programmes and activities to ensure STI accelerate the achievement of these prioritised SDGs
Assessment of current situation	Has been done as part of the STIP Review. Included collection of data and knowledge on development situation of country, status of national innovation system, including 22 sectoral technology roadmaps	Largely based on STI Ecosystem survey SDG Baseline Report 2018. An STI situational analysis was conducted and validated by the Technical Task Team, with inputs and contributions from various STI stakeholders

	INDIA	KENYA	SERBIA	UKRAINE
	Office of Principal Scientific Advisor (PSA) of Prime Minister and NITI Aayog (main government policy think-tank)	State Department for Planning in National Treasury and National Commission for Science, Technology, and Innovation (NACOSTI) in Ministry of Education, in partnership with Ministries of ICT, Foreign Affairs, Agriculture and Industry, and is supported by the African Centre for Technology Studies (ACT)	STI for SDGs roadmap being developed from Serbia's Smart Specialisation Strategy (4S), announced February 2020, led by Prime Minister's Inter-Ministerial Working group and operationalised by Ministry of Education, Science and Technology. Participation of multiple ministries, private sector, and academic community	The office of the Deputy Prime Minister for European and Euro-Atlantic Integration of Ukraine, Ministry of Education and Science, Ministry of Economy, inter-ministerial National Smart Specialisation Team
	Focusing on SDGs 1, 3, 6, 7 and 17 (because of India's strong STI capability and interest in partnering with developing countries)	Main objective is to plan for implementation of STI policy and support delivery of President's 'Big Four' agenda, which focusses on agriculture, manufacturing, health and housing and therefore includes SDGs 1, 2, 8 and 9. Gender in STI (SDG 5) has also been included for roadmap development	4S agenda is to foster socio-economic development and transformation based on 6 knowledge-intensive priority sectors (food, creative industries, manufacturing, ICT, key enabling technologies, energy). STI for SDGs roadmap is to be detailed action plan of the 4S. SDGs include: 2, 7, 8	National and subnational Smart Specialisation priority domains and priority SDGs implemented via detailed action plan – STI for SDGs Roadmap
	Detailed R&D assessment at subnational and national level (2019). NITI Aayog constructed SDG India Index for 13 of 17 SDGs on set of 62 priority indicators. Mapping of some key sectors completed	Used indicators from various international and national databases on SDG gaps and country situation. Is undertaking STI Public Expenditure Review aiming to promote R&D and technology adoption and diffusion with increased efficiency and effectiveness	4S plan involved detailed assessment of Serbia's economic, innovation and research potential. EC JRC financed SDG mapping prioritized in the 4S plan, statistical baseline analysis and identification of STI inputs focused on specific SDG goals (2 May)	Preparatory stage (Ukraine joined the Global Pilot Programme in February 2021) – establishing the governance structure

	ETHIOPIA	GHANA
Vision, goals and targets	In process, part of drafting a new national STI policy. Roadmap is to follow preparation of the new STI policy. Linked to strong employment focus in national development plans. Focus on job creation, SDG 8 (decent work and economic growth) which feeds indirectly into improving other SDGs such as 1, 2, 3 and 10	Build strong STI capacity to support social and economic development for sustainable development. The ultimate goal is to fast-track the achievement of the prioritised SDGs (1, 2, 3, 4, 6, 8 and 9) using STI. The prioritised SDGs and targets for the roadmap is elaborated in Chapter 3
Alternative technology pathways	Discussion so far has focused on preparing an implementation plan covering several of 22 sectoral technology maps prepared for Ethiopia	Focusing on university-based technology incubators working on emerging technologies
Detailed roadmap	Under preparation. So far, implementation plans have only been prepared for 3 of the 22 technology roadmaps	The first draft was submitted and discussed within a national Technical Task Team in March 2021. Ghana team will continue collecting inputs in order to finalise the roadmap before the sixth annual STI Forum in 2021.
Timeframe and key milestones	COVID-19 delayed preparation process	1. Finalisation of the STI roadmap for the SDGs; March-April 2021 2. Mobilisation of resources, implementation of programmes/projects/ activities, monitoring and evaluation; May 2021-Dec. 2030 3. Implementation of programmes/projects/ activities developed in the plan; May 2021-Dec. 2030 4. Monitoring and evaluation; May 2021-Dec. 2030 5. Review of STI roadmap for the SDGs; Jan. 2031

INDIA	KENYA	SERBIA	UKRAINE
Overall framework in strategy for a new India @ 75. Vision, goals and targets still under preparation. Some of main initiatives revolve around use of digital technologies to facilitate coordination and implementation of plan	Guided by Vision 2030, which aims to transform Kenya into a newly industrialised middle-income country with a high quality of life in a clean and secure environment by 2030, and President's 'Big Four' agenda (agriculture, manufacturing, health and housing). Within the agenda, it focuses on SDG 2 (end hunger) and those closely related to it, such as SDGs 1, 8 and 9	Vision is 'Serbia creates innovation'. Goals include 5 objectives: 1) R&D focused on 4S priorities; 2) economic growth supported by R&D; 3) education focused on innovation and entrepreneurship; 4) improved business environment through digitalisation in 4S areas; and 5) internationalisation through regional and global value chains in 4S areas	Under development
Analysis of alternative technologies being performed as part of developing roadmap	Within SDG 2, focused on increasing productivity and income for smallholders and technologies for maize, rice and potatoes. Methodology being tested for maize	Entrepreneurial discovery process framed the discussion of alternative targets and solutions. This is documented in separate workshop reports	Under development
Under preparation but various interventions ongoing in agriculture, digital connectivity, health, energy, e-governance, tinkering labs, digital ID, digital banking, health insurance. Plus, PM has announced 8 major innovation missions	Under preparation, but team has identified needs and gaps along six agricultural value chains, and current gaps in STI system. Activities to effectively implement the Kenya pilot project on STI for SDGs roadmap was proposed	Under preparation. Detailed STI for SDGs roadmap will be the action plan for S4. Will focus on specific actions to achieve the prioritised SDGS. Inter-ministerial working group for Agenda 2030 led by PM joined the work of STI4SDGs	Under development. First subnational Smart Specialisation strategies are expected to be finalised in December 2021
Deep dives into specific programmes is next step. Monitoring and evaluation platforms planned. Workshop with Japan planned 6/2020	Team will expand scope and hold consultations to identify what technologies can be delivered; mobilise resources; and incentivise private sector participation	Detailed STI for SDGS roadmap will have detailed indicators and timeframes. Expected to be completed by end of 2020. Progress has been slowed due to the COVID-19 crisis	The process has been launched in 2021 and is expected to take 1-2 years

V

	ETHIOPIA	GHANA
Execute, monitor evaluate, update plan	Not yet applicable	The specific strategies and programmes for each of the prioritised SDGs and their respective targets, the expected outputs and the responsibilities of the lead and collaborating institutions were elaborated in the roadmap. Monitoring will be anchored on the existing national and subnational monitoring arrangement. A mid-term evaluation is proposed for 2024. The feedback will be used to inform the medium-term development plans for 2025 to 2028. A terminal evaluation is scheduled for 2030 to examine the overall impact of the STI roadmap in contributing to the achievement of the SDGs
Inputs/ data/ consultation	STIP Review involved stakeholders in the national innovation system, including government, academia, research centres, private sector and civil society. Potential new stakeholders include the Planning and Development Commission and possibly the line ministries	Multiple consultations, including on-line consultations, online surveys, interviews and quantitative data collection. Partnership with academia (UCL)
IATT focal point	UNCTAD	UNESCO

	INDIA	KENYA	SERBIA	UKRAINE
	Not yet applicable, but planning includes strong monitoring and evaluation and strategic decision system	Not yet applicable as plan is still under preparation	Not yet applicable, but the S4 Strategy will have monitoring and evaluation system based on input, output and outcome indicators.	STI for SDGs roadmap will have a monitoring and evaluation system based on input, output and outcome indicators aligned with Smart Specialisation strategy
	Extensive domestic data inputs and consultations with multiple stakeholders at central government, state and local levels, including with private sector and civil society	Extensive use of data and expertise from national and international sources, including India and Japan. ACTS working with counterparts in Ethiopia, Mauritius, Rwanda, Tanzania, Uganda to develop STI for SDG roadmaps	Extensive use of national and international data including creation of own Analytical Team. EU JRC financed study by Fraunhofer Institute. Extensive consultations with government, private sectors, academics and broader society. Creation of working groups for each priority	Extensive use of national and international data for identification of economic, innovation, scientific and technological potential and SDG priorities
	World Bank	World Bank	EU JRC, UNIDO	EU JRC, UNIDO

V

	ETHIOPIA	GHANA
Challenges/ problems/ lessons	Challenges: 1. Lack of specific budget for the implementation of the STI for SDGs roadmap (UNCTAD has been able to mobilise some support for the preparation) 2. Establishing a smooth mechanism for collaboration across stakeholders that would ideally be involved in the preparation of the roadmap 3. COVID-19 crisis has slowed the entire process	Challenges: 1. Involving broad range of stakeholders for definition of priorities 2. Ensuring shared responsibility and commitment at the highest level 3. Better alignment of STI policies to sectoral priorities and national development plans 4. Inter-ministerial cooperation key to avoid duplications 5. Identifying a team of resource persons involving STI experts

INDIA	KENYA	SERBIA	UKRAINE
Challenges: 1. Obtaining updated data 2. Coordination between agencies 3. COVID-19 crisis has slowed down progress	Challenges: Inadequate data for baseline of SDG targets or to link government programmes to SDG targets Lessons: 1. Importance of Technical Committee to provide guidance 2. Need for external support to develop STI for SDGs roadmaps because of limited skills and funding 3. Need for increased stakeholder consultation 4. Most difficult and expensive step is assessing alternative technology pathways	Challenges: Lack of sufficiently disaggregated data, building trust and involving stakeholders, overcoming government silos and getting focus on SDGs. Balance between setting strategy and actual implementation. Successes: Mobilizing own funding for implementation of 4S with additional EU funding, formation of permanent public private dialogue platform for involvement of high-level stakeholders. Gaining approval of PM.	Challenges: 1. Inter-ministerial and multi-level coordination 2. COVID restrictions hampering meetings and stakeholder dialogue

CHAPTER 3.

Review of progress (inputs from focal points for each pilot country)

Ethiopia – inputs from UNCTAD

1 Leading agencies and national counterparts

Ethiopia's roadmap is being coordinated by its national counterpart, the Ministry of Innovation and Technology (MINT). The Ministry of Science and Higher Education (MOSHE) has participated in several recent IATT events and is interested in participating in the preparation of the roadmap. MINT and MOSHE are the prime institutions responsible for planning specifically related to innovation and technology, and to science, respectively. MINT and MOSHE are bilaterally discussing their modalities for collaboration.

2 Achievements so far, expected outcomes and key activities

The process for the development of STI for SDGs roadmap is ongoing, with two steps out of six completed as part of the preparation of the STIP Review of Ethiopia concluded in 2019. The two steps are 1) the definition of objectives and 2) assessment of the current situation.

The STIP Review process included the mobilisation of the three core inputs for the STI for SDGs roadmap process. Firstly, it mobilised stakeholder's engagement among the main actors of the national innovation system – including government, private sector (sector leaders and business associations), academia and research centres and civil society – through interviews, workshops and capacity building activities. Secondly, it engaged senior policymakers in Ethiopia as well as international and national consultants to identify challenges in and opportunities for using STI for development in Ethiopia. Thirdly, it collected data and knowledge on the development situation in the country, the status of the national innovation system and the critical issues on promoting STI for job creation and inclusive and sustainable development. The STIP Review of Ethiopia presents the findings and recommendations for strengthening the national system of innovation of the country. It also serves as the report for the two initial steps of the STI for SDGs roadmap in Ethiopia.

The development of the roadmap is now at step three (develop vision, goals and targets), which corresponds to work on drafting a new national STI policy. The key activity so far is the discussion of the objectives and scope of the roadmap, and modalities for collaboration between MINT and MOSHE as the most relevant STI-related ministries in Ethiopia. Until now, discussions have centred around preparing an implementation plan covering several of the 22 sectoral technology roadmaps that have been prepared in Ethiopia. To date, implementation protocols (or plans) have only been prepared for three of these technology roadmaps.

The expected outcome is an STI roadmap that covers key aspects of the current high-priority areas in Ethiopia's evolving development plans and the SDGs. This might focus on job creation (most closely aligned with SDG 8 (decent work and economic growth), but which indirectly feeds into improving several other SDGs such as 1 (no poverty), 2 (zero hunger), 3 (good health and well-being) and 10 (reduced inequalities)) as a unifying theme. National development plans and priorities have been rapidly evolving in the country in recent months. The focus on employment recognises the serious challenges created by the high unemployment rate in the country and the high priority placed on creating jobs highlighted in the recent national job creation agenda in Ethiopia.

3 Other expected stakeholders, milestones and timeline

Other relevant stakeholders include the Development Planning Commission and possibly key line ministries. Representatives from the private sector and academia should also play a role in the steps involved in preparing the roadmap.

So far, UNCTAD has provided support as part of its project on implementing an STI policy review for Ethiopia. The roadmap is to be sequenced as a follow-up to the preparation of the STIP Review

(which has now been completed) and the drafting of a new national STI policy. Ethiopia is currently engaged in the process of drafting a new national STI policy, with UNCTAD supporting this process. Roadmap preparation should directly follow the preparation of the new STI policy. Currently, the timeline is being revised due to delays emanating from the outbreak and rapid evolution of the COVID-19 crisis in Ethiopia and other countries around the world. The original timeline was for activities related to drafting a new national STI policy to start in late April, but a new timeline has to be agreed that corresponds to what is possible given the restrictions on travel to and from Ethiopia and other countries. This also implies a delay in starting the roadmap.

4 Lessons learned; challenges/problems encountered so far (if applicable)

One key challenge encountered is the lack of a specific budget for implementing the roadmap. This has slowed the process of planning activities due to the need to provide financing to support planned activities. UNCTAD was able to mobilise some limited resources as part of the follow-up to the development of the STIP Review of Ethiopia.

An additional challenge is establishing a smooth mechanism for generating collaboration between stakeholders that would ideally be involved in preparing the roadmap. The lack of regular meetings by the National STI Council means that getting approval from this inter-governmental body on coordination cannot be achieved easily.

Ghana – inputs from UNESCO

1 Leading agencies and national counterparts

The process for developing STI for SDGs roadmap in Ghana is part of Ghana's current effort to align national STI priorities and the national STI policy (2017) towards achieving the SDGs.

Launched in late 2019, the pilot exercise in Ghana is coordinated by the Ministry of Environment, Science, Technology and Innovation (MESTI) and the Science and Technology Policy Research Institute (CSIR-STEPRI). Additionally, it involves also other ministries such as the Ministry of Finance, Ministry of Planning, Ministry of Trade and Industry, Ministry of Health, etc.

The Technical Task Team – with responsibility for overseeing the process of developing the STI for SDGs roadmap – is co-chaired by the representative from the SDGs Advisory Unit of the Office of the President and MESTI. UNESCO is the IATT focal point agency for the implementation of the pilot roadmapping exercise.

2 Achievements so far, expected outcomes and key activities

Scope and objectives

The country currently has the following national development plan frameworks – **Agenda for jobs - creating prosperity and equal opportunity for all** (2017-2021) and the **Coordinated programme of economic and social development policies** (2017-2024) – which set out the **national priorities** in all sectors of the economy. The objective of the development of the STI for SDGs roadmap is to align and implement STI priorities towards contributing to the achievement of the SDGs. Developing an action oriented STI for SDGs roadmap is also expected to accelerate developing new or adapting existing solutions to meet the SDGs target by 2030, while ensuring sustainability.

The STI for SDGs roadmap impetus is the elaboration of strategies and programmes to use STI to accelerate the achievement of the SDGs. In this regard, the roadmap has been formulated within the broad domain of STI. The national context of Ghana in terms of its natural resource endowments, the social and economic attributes and the political and cultural conditions have been analysed as part of the situational report and have guided the formulation of the roadmap. Certain SDGs were prioritised in the course of the work

on the roadmap, taking account of the nation's present development goals. These are SDGs 1, 2, 3, 4, 6, 8 and 9. The roadmap has been limited to discussions of these SDGs and the strategies, programmes and activities to ensure STI accelerate the achievement of these prioritised SDGs.

The specific objectives of the STI for the SDG roadmap report are to:

(i) define the vision, goals and targets for the STI for SDGs roadmap;

(ii) detail the strategies, programmes, projects and activities necessary for STI to fast-track the achievement of the prioritised SDGs;

(iii) elaborate on the budget, funding and coordination arrangement for the implementation of the STI for SDGs roadmap;

(iv) formulate the partnership and communication strategy to sustain stakeholder involvement and ensure inclusive governance of the roadmap;

(v) design the monitoring and evaluation system to track progress on roadmap implementation.

Assessment of the current situation

As part of the processes leading to the development of the STI for SDGs roadmap, UNESCO supported CSIR-STEPRI in conducting a situational analysis in Ghana. The study reviewed the current STI policy, SDGs and development plans and the interlinkages; assessed the current status of

prioritised SDGs 1, 2, 3, 4 6, 8 and 9; assessed capacity needs in terms of STI human resources requirements; examined institutional capabilities and STI infrastructural needs for achieving the SDGs; and analysed the country-specific challenges and solutions for achieving the SDGs.

The STI situational analysis highlighted Ghana's need for necessary effort from both the public and private sectors to boost research and development; enhance skills based on the current and future workforce; develop new infrastructure; and create capacities in new technologies to establish the launchpad for accelerating the achievement of the SDGs. For effective human capital formation to drive the STI agenda –for the accelerated achievement of the SDGs in particular – there must be a rejuvenation of the educational system with emphasis on stimulating curiosity and creativity and enhancing competence-building. At tertiary level in particular, STI human resources must be well equipped for the tertiary institutions to effectively deliver STEM teaching and learning. Research and development in the established institutions must be enhanced with adequate human resources and infrastructures.

The STI situational analysis study provides the key inputs for the formulation of the STI for SDGs roadmap.

Other advancements include:

(i) the adoption of Ghana's science agenda for agriculture in Africa (S3A) promoted by the Forum for Agricultural Research in Africa (FARA);

(ii) the establishment of the Presidential Advisory Commission for STI and a research fund for scientists and researchers;

(iii) the inter-institutional framework for working towards the achievement of the SDGs through the development plans of ministries, departments and agencies (MDAs) and metropolitan, municipal and district assemblies (MMDAs). Ghana has processed an STI ecosystem survey and an R&D survey whose results and data provide key baseline indicators for STI and the STI4SDGs roadmap exercise. In addition, the national SDG baseline report for 2018 also serves as a baseline for the work.

Activity: Develop vision, goals and targets

The vision for Ghana is to build a strong STI capacity to support social and economic development for the sustainable transformation of the economy.

The coordinated programme of economic and social policies (CPESDP 2017-2024) states the

vision as 'an optimistic, self-confident and prosperous nation, through the creative exploitation of our human and natural resources, and operating within a democratic, open and fair society in which mutual trust and economic opportunities exist for all.'

For the purposes of the STI for SDGs roadmap, the critical part of the vision statement is the 'creative exploitation of our human and natural resources'.

The national vision is further elaborated by other important national documents, including the Ghana 'Beyond Aid' policy. The overall goal is to achieve a 'W.I.S.E.R' Ghana:

- W - Wealthy Ghana;
- I - Inclusive Ghana;
- S - Sustainable Ghana;
- E - Empowered Ghana; and
- R - Resilient Ghana.

Activity: Assess alternative targets

The current STI development trends in the country show that technology incubation hubs are making a considerable impact that significantly contributes to socio-economic development in Ghana, complementing the efforts of actors in the formal R&D system. These hubs are centred around students and young graduates in tertiary institutions. The STI roadmap in Ghana should emphasise promoting these systems. While the formal institutions continue to work on existing and emerging technologies, some of these incubation hubs focus their energies predominantly on emerging technologies such as artificial intelligence and robotics.

Based on the current STI situation, the following policy recommendations were made:

- develop strategies to take advantage of innovations in the agri-food system, health and education delivery systems and regulate Ghana's technological space;
- invest in advance digital production (ADP) technologies and strengthen R&D uptake;
- address infrastructural gaps in irrigation, low adoption rates of climate smart technologies and inadequate human resources;
- invest in STEM education, scientific equipment and e-learning facilities at all levels;
- build local capacity and workforce in industrial equipment maintenance to reduce over-reliance on foreign expertise, and initiate equity law to protect local industries;
- invest in water quality monitoring and management systems as well as behavioural initiatives on sanitation and good hygiene practices.

Activity: Develop detailed STI for SDGs roadmap

Working teams comprised of members of the Technical Task Team were established to draft the different chapters of the roadmap based on the findings and information in the situational analysis report on STI in Ghana. Each chapter was presented by the lead team during the Technical Task Team meeting in March 2021, which aimed to collect additional feedback from the Task Team members. The results of the discussion will be submitted to CSIR-STEPRI – the lead technical institution for the preparation of the STI for SDGs roadmap – to finalise the document for onward submission to UNESCO before the sixth annual STI Forum in 2021.

Activity: Execute, monitor and evaluate, and update plan

Ghana's plan is to implement up to 50 programmes, projects and activities from 2021-2030 by mobilising resources through GoG budgetary supports/donors with assistance from the Ministry of Finance, President of Ghana; in parallel, to constitute an apex-level **Inter-Ministerial Implementation Team** to oversee the implementation of the STI for SDGs roadmap. In addition, the Monitoring and Evaluation Division, with the support of the UN, will request regular reports for each pro-

gramme/project/activity. The monitoring methods below will allow the review and evaluation of the STI roadmap for the SDGs by 2030.

Implementation. The specific strategies and programmes for each of the prioritised SDGs and their respective targets, the activities envisaged to address the respective targets, the expected outputs and the responsibilities of the lead and collaborating institutions were elaborated in the roadmap.

Monitoring. Monitoring of the STI roadmap will be anchored on the existing national and subnational monitoring arrangement. MESTI, with support from the National Development Planning Commission (NDPC), will liaise with relevant ministries, departments and agencies (MDAs) and metropolitan, municipal and district assemblies (MMDAs) to include indicators for tracking the implementation of the STI roadmap in their respective M&E plans. This will ensure that the annual progress reports (APRs) contain information on the agreed set of indicators for tracking the implementation of the roadmap. In addition, private sector organisations, academia and other non-state actors that play important roles in the implementation of the roadmap will be supported to generate data and report on the relevant STI roadmap indicators.

The sector and district APRs, together with reports from relevant non-state actors, will constitute the primary source of data for preparing annual reports to track the implementation of the STI roadmap. The data will be supplemented with information from key informant interviews, focus group discussions and field visits, as appropriate. The annual progress reports on the implementation of the roadmap will be discussed at stakeholder fora and lessons therein will form the basis of revising the roadmap, where necessary.

Evaluation and revision of the roadmap. The purpose of the evaluation process is to answer more in-depth questions about how and why interventions are achieving or not achieving the expected results. It will also identify changes in internal and external conditions (social, political, technology, economic and environmental) that may affect the successful achievement of the targets in the STI roadmap. The evaluations will be based on five criteria: relevance, effectiveness, efficiency, impact and sustainability. A mid-term evaluation is proposed for 2024. The feedback will be used to inform the medium-term development plans for 2025 to 2028. Lessons from this evaluation will influence the revision of the roadmap to ensure the achievement of the targets and objectives. A terminal evaluation is scheduled for 2030 to examine the overall impact of the STI roadmap in contributing to the achievement of the SDGs. It is anticipated that the findings from the terminal evaluation will significantly shape the use of STI in Ghana's development pursuits.

Budget. The key to effective implementation of the roadmap is funding. In spite of the fact that the government of Ghana will definitely be investing in the implementation of the envisaged activities, funding from development partners and other stakeholders is crucial. Implementation activities and corresponding budgets for each prioritised SDG were elaborated in the roadmap.

Inputs: data, stakeholder consultations and expertise

Data. The approach to data collection was the use of four main methods – desk research, interviews, expert group discussion and an online survey.

Consultations and expertise. The 1st national consultation was held in Accra in December 2019, including key national partners and UNESCO, who reflected on the process and the way forward.

The first Technical Task Team consultation workshop was held in Accra, Ghana, in June 2020 to inaugurate the Technical Task Team and finalise the work plans for the roadmap. The second consultation workshop was held in September 2020 to review the situational analysis report, attended by the Task Team, UNESCO and UNDP representatives. The third Technical Task Team consultation was held in March 2021 to review the first draft of the STI for SDGs roadmap in Ghana.

Meanwhile, UNESCO – as the IATT focal point for

the Ghana pilot – has been developing a partnership with academics. A team of students at the University College London (UCL) - Department of Science, Technology, Engineering and Public Policy (STEaPP) contributed to the pilot roadmap project in Ghana under Dr Jean-Christophe Mauduit as mentor. The UCL team's main contribution was desktop research and analysis on STI for SDGs in key priority sectors in Ghana and an online survey. The research resulted in the report reframing STI for SDGs: insights and recommendations for Roadmaps as successful policy tools in Ghana and beyond, which was submitted in October 2020. The report identified four key enablers of successful STI for SDG Roadmaps and for the IATT to consider in its future work. Additionally, it investigated the implications of the COVID-19 pandemic on the pilot programme countries' progress towards the SDGs.

Other achievements

Development of five policy briefs

Ghana has developed five policy briefs based on the findings of the situational analysis report and the preliminary work on the drafting of the STI for SDGs roadmap, which also contributed to the UN IATT's policy briefs. The titles of the policy briefs are:

- Conceptualising STI4SDGs roadmaps: an actionable strategy aimed at accelerating the achievement of SDGs using STI
- Review of the current STI Policy, SDGs and Development Plans and the Inter-linkages
- Assessment of STI capabilities to meet prioritised SDGs
- Harnessing Ghana youth innovation potential for the SDGs
- Fact sheet on current situation with prioritised SDGs.

Ghana has also demonstrated its progress and achievement of the STI for SDGs roadmap process in major UN IATT-related events, including the STI Forum in Africa, held in February 2021.

3 Other expected stakeholders, milestones and timeline

The current work plan for the development of Ghana's STI roadmap for the SDGs involves:

(i) finalisation of the STI roadmap for the SDGs by the Technical Task Team with support from a consultant, March-April 2021;

(ii) mobilisation of resources, implementation of programmes/projects/activities, monitoring and evaluation, May 2021-December 2030;

(iii) implementation of programmes/projects/activities developed in the plan, May 2021-December 2030;

(iv) Monitoring and evaluation, May 2021-December 2030;

(v) review of STI roadmap for the SDGs, January 2031.

4 Lessons learned; challenges/problems encountered so far (if applicable)

(i) The main challenge is involving a broad range of STI stakeholders for the definition of priorities of STI policies and strategies.

(ii) It was of great importance to ensure shared responsibility and commitment at the highest level – MESTI's strategic role and guidance in the development of the STI4SDGs roadmap and intensive engagement with stakeholders, expert group discussions, a validation workshop and virtual debriefing meeting with the Technical Task Team. Inter-ministerial coordination and cooperation, including that with STI agencies within the country, is key to avoiding **duplication of programmes** and activities. Furthermore, it is important to identify a team of STI experts and development practitioners and have effective targeting of sectors to focus on based on developmental trajectory.

(iii) The dissemination of information and consultations are a key aspect of the process.

(iv) Better alignment of the STI policies to the sectoral policies and national development plans is essential.

(v) Strong, cutting-edge STI and expected developmental outcomes are indispensable.

India – inputs by and updates from the World Bank

1 Leading agencies and national counterparts

As part of India's commitment to achieving the Sustainable Development Goals, India is very keen to develop a framework to capture SDGs as outcomes of science, technology and innovation (STI) interventions. With this in mind, the Government of India has launched a major initiative to formulate STI roadmaps for SDGs being led by the Office of the Principal Scientific Adviser to the Government of India (PSA). In this regard, India is also one of the 5 pilot countries in the UN's Global Pilot Programme for STI for SDGs roadmaps, an initiative launched as part of the Agenda 2030 for implementing SDGs under the Technology Facilitation Mechanism (TFM).

The Office of the PSA has entrusted the Research and Information System for Developing Countries (RIS), New Delhi, as the knowledge partner in this initiative, with the primary responsibility towards formulating India's STI for SDGs roadmaps. India's strong innovation capabilities, broader expertise in people-centric affordable technology solutions and more recent ICT-enabled development transformations offer robust foundations for undertaking this exercise.

The STI for SDGs roadmaps in India, as decided, would initially focus on 4 interrelated SDGs, namely SDG 2 (agriculture/nutrition), SDG 3 (health and wellbeing), SDG 6 (water and sanitation) and SDG 7 (affordable and clean energy). India's national STI for SDGs roadmaps shall be achieved through close consultations with all relevant line ministries that implement welfare programmes, formulate policies and determine the regulatory architecture. All key scientific ministries and departments play a major role in providing direction to India's STI efforts and are therefore preeminent stakeholders in the process. All subnational governments – the State governments in particular – also form vital pillars for supporting the formulation of India's national STI for SDGs roadmaps. In this initiative, relevant private sector bodies, companies, startups, social enterprises as well as other development partners would be consulted.

2 Achievements so far, expected outcomes and key activities

a. a. National workshops with line ministries and other stakeholders

To formulate India's STI for SDGs roadmaps, thematic workshops are being conducted on each of the four SDGs to supplement and inform analytical studies and detailed technical assessments. These consultations shall be led by the Office of the PSA and shall bring on board the line ministries, the scientific ministries, the NITI Aayog, other implementing agencies and stakeholders, including the private sector. The consultations are being organised by the Research and Information System for Developing Countries (RIS), New Delhi. The thematic workshops shall lead to drawing upon insights from India's flagship initiatives that have relevance with regard to science, technology and innovation for the selected SDGs.

The thematic workshops are being organised to explore the following dimensions.

- If technologies are available, what could be the appropriate roadmap on deployment after evaluation of existing ownership status (public/private) and operational and feasible models of technology transfer and diffusion?
- At the next level, technology availability status would be highlighted and a roadmap on development and deployment shall be considered. This would also necessitate careful as-

sessment of existing innovation capacities as well as resources and timelines.

- In all areas with promise of indigenous technology development and that are available for technology transfer, in line with the aspirations of the Global Pilot Programme on STI for SDGs roadmaps, detailed mechanisms may be suggested for sharing of STI solutions with other developing countries/LDCs, particularly in Africa.

All information related to India's STI for SDGs roadmap exercise is being documented as part of a newly launched web portal ***https://www.ris.org.in/sti-4-sdgs***.

b. b. Formulation of STI for SDGs roadmaps – The Indian template

The Global Pilot Programme for STI for SDGs roadmaps is expected to evolve into a very useful tool to strengthen national efforts on STI for SDG mapping and also promote international cooperation on knowledge, technology transfer, capacity, networks and finance for operationalisation of the TFM. India has proposed to formulate STI for SDGs roadmaps on four closely interconnected goals (SDGs 2, 3, 6 and 7) under the Global Pilot Programme. It may be noted that STI interventions are desired in areas that are helpful in achieving the defined objective of the SDG/target determined through global/national indicator-based assessments.

Tentative templates for STI for SDGs roadmaps covering all four SDGs is being developed, keeping in mind India's national development objectives and STI for SDGs indicator-based assessment (UN indicators vis-à-vis India's national indicators)[10] as well as incorporating relevant STI indicators that are not part of SDG indicators. This would be followed by the mapping and assessment of technologies for achieving the SDG targets (with innovation and deployment parameters), and finally assessment of institutional preparedness and technology availability/readiness levels. Relevant reference to the UN *Guidebook on STI for SDGs Roadmaps* has also been made. The baseline indicator mapping alongside available and emerging technology mapping shall be used as an input for the process (Appendix 3 and Appendix 4).

The identification of the developmental challenge and decomposition into specific product and process components is crucial for initiating an STI for SDGs roadmap. The same can be undertaken for each target and the underlying indicators. For example, based on the scientific and technological challenges, the associated targets under SDG 2 can be further classified into three principal areas: **(i)** production and nutrition; **(ii)** conservation; and iii) food processing. Similarly for SDG 6 –with regard to water use technologies in particular, the broad classification could be: **(i)** quality of water (filtration/treatment of water sources); **(ii)** access to water (development of distribution systems); and **(iii)** water-use efficiency (reduction of over-exploitation).

3 Other expected stakeholders, milestones and timeline

a. Stakeholders and activities

As elaborated above, as part of the STI for SDGs roadmaps, dialogues have been initiated with relevant line ministries/departments including the NITI Aayog, the New Emerging and Strategic Technologies division of the MEA, DST, CSIR, ICMR and the TIFAC for deeper insights and leveraging the significant work undertaken by these agencies/ departments.

Under the STI for SDGs roadmaps initiative, one suggested key deliverable would also be to work towards formulating a decision support system for mapping resource flows on R&D for greater effectiveness in the Indian context. A scoping study has been initiated in this regard.

10 *In 2018, NITI Aayog developed the first* SDG India Index *based on 62 indicators covering 13 out of 17 SDGs (except for goals 12, 13, 14 and 17). While the* SDG India Index *second edition in the 2019 was more comprehensive with 100 indicators, covering all 17 goals, largely drawn from the National Indicator Framework (NIF). Out of the 100 indicators, 40 were adopted from the 2018 version and the remaining 60 were sourced from the NIF or were suitable refinements.*

One of the very first milestones under the India pilot towards initiating strong foundations for international partnership has been the co-organisation of the Workshop on Developing STI Partnerships for Sustainable Development on 29 June 2020 by the Office of the Principal Scientific Advisor to the Government of India (PSA) jointly with the Research and Information System for Developing Countries (RIS), Cabinet Office of the Government of Japan (CAO) and the United Nations Inter-Agency Task Team on Science, Technology and Innovation (STI) for the Sustainable Development Goals (UN-IATT).

The main theme of the workshop was 'Accelerating international cooperation and actions through the Global Pilot Programme on STI for SDGs roadmaps'. The meeting was joined by high-level representatives of the pilot countries and UN-IATT partner agencies participating in the Global Pilot Programme and other interested stakeholders. The workshop saw participation by senior policymakers and experts from the pilot countries, including India and Japan and other partner agencies.

The workshop deliberated on the following themes:

- formulation of STI for SDGs roadmaps,
- current initiatives on STI for SDGs in pilot countries and key partners,
- STI for SDG partnership in the multilateral arena,
- COVID-19 pandemic and STI for SDGs,
- building partnerships and networks for acceleration and expansion of the pilot programme: role of think tanks / academia, foundations and private sector.

The workshop was preceded by very successful preparatory dialogues between India and Japan. Based on the existing close partnership in science and technology between India and Japan, both sides have expressed strong interest in extending their collaboration in STI for SDGs, particularly in cooperating in formulating STI for SDGs roadmaps on 4 specific goals (SDG 2, 3, 6 and 7) through the Global Pilot Programme. The two countries are deepening their collaboration in applying frontier technologies in the abovementioned areas and in collaborating with the UN-IATT in supporting pilot countries from Africa, in particular, and other LDCs in formulating and implementing their STI for SDGs roadmaps by sharing experience, knowledge and capacities with them in the spirit of South-South and triangular cooperation as mandated under the TFM.

b. Key actors for the India pilot and international collaboration

- Knowledge partnerships in India
  - Office of the Principal Scientific Advisor
  - Various line ministries of the Government of India, NITI Aayog, subnational agencies
  - Department of Science and Technology
  - Indian Council of Medical Research
  - Indian Council of Agricultural Research
  - Think tanks / research organisations
  - Private sector / start-ups
- UN agencies and international organisations
  - UN-IATT (DESA, UNDP, ESCAP, etc.)
  - World Bank
  - International Solar Alliance

During the formulation of STI for SDGs roadmaps for India, special attention is being paid to technological opportunities across the border and the experiences of other countries in deploying STI solutions for achieving the SDGs.

4 Lessons learned; challenges/problems encountered so far (if applicable)

Under the India pilot for the Global Pilot Programme for STI for SDGs roadmaps, extensive consultations with all stakeholders are underway to arrive at the most effective templates for SDG-specific technological interventions in the rel-

evant domains. This is expected to further help in identifying broader scientific challenges and shaping the technology deployment roadmap for India under the STI for SDGs roadmaps. At all levels where there is scope for technology transfer and capacity building in adoption/adaptation (based on indigenous capabilities), India expects to develop future knowledge-sharing partnerships with developing countries to fulfil the aspirations of STI for SDGs in the spirit of South-South cooperation.

One important lesson is that STI interventions must be tallied with the scientific challenge emerging from the nature of the development gap and the complexity of the problem (with considerations for access, equity and inclusion as well as sustainability). There should be prima facie reasons to argue that with the use/availability of existing or potential STI solutions, the development/sustainability indicator would achieve desired values at a much more accelerated pace. It could also be the case that the diffusion of already available STI solutions would be a key determinant in achieving the indicator and fulfilling the SDG target. In certain cases, it is obvious that, given the enormity or the complexity of the challenge, existing STI solutions may be grossly inadequate and not all countries will be in a position to develop, acquire or access STI solutions. While ICT tools are increasingly ubiquitous as enabling technologies, the same may not be accessible to all implementing agencies across countries. This is certainly an area that needs to be considered for developing robust STI for SDGs roadmaps.

However, the specific challenges that need to be taken into account for generating generic templates for STI for SDGs roadmaps include the following:

- firstly, there are perceived challenges in terms of mainstreaming SDGs as a development tool and thereafter finding/twinning appropriate technological solutions for implementation and accelerated action;
- secondly, there are challenges in terms of creating the right absorptive capacities for technologies;
- thirdly, there are methodological difficulties in defining the basis for formulating strategies for technology deployment for specific SDGs and associated targets;
- fourthly, there has to be a sense of ownership by all implementing agencies on the larger STI for SDGs roadmaps and enable tracking of progress in that direction;
- lastly, the COVID-19 pandemic has caused significant derailment of the developmental process, adversely impacting action on the ground and coordinated approaches deploying STI for SDGs.

Kenya – inputs from and updates by the World Bank[11]

1 Leading agencies and national counterparts

Kenya's STI for SDGs roadmap is being led by the State Department for Planning, SDP, (which hosts the SDGs Secretariat) in the National Treasury and National Commission for Science, Technology and Innovation (NACOSTI) under the Ministry of Education (MoE), in partnerships with line ministries for ICT, foreign affairs, agriculture and industry. The process is supported by the African Centre for Technology Studies, as a technical and knowledge carrier. A small technical team was established to spearhead the pilot project and prepare draft documents to be used for engagement with wider stakeholders. The World Bank and UNESCO were assigned as the IATT member agency focal points for Kenya's participation in the programme.

11 *This summary is based on a progress report on the pilot programme in Kenya (ACTS, 2019), supplemented by the Kenya focal points discussion with the Kenya team leader.*

❷ Achievements so far, expected outcomes and key activities

Activity: Define objectives and scope

Objectives. In formulating the objectives and the scope of the STI roadmap, the Kenyan Technical Team has been guided by several national and sectorial development policies and strategies. These includes Vision 2030, the third medium term plan 2018-22 (MTP III)[12], as well as the President's 'Big Four' agenda, which covers agriculture, manufacturing, health and housing. The STI roadmap for the SDGs project has been selected to pursue two sectors of the big four – manufacturing and agriculture with ICT as cross-cutting. Based on the experience from piloting, the project will later be expanded to cover all four sectors. In addition, the pilot project has also been guided by the draft STI policy and the recently launched national research priorities (2018-2020). The main objective of the Kenyan STI roadmap is to provide a medium-term timebound and resourced plan for the implementation of the STI policy and to support the delivery of the President's 'Big Four' agenda.

Focus. Accordingly, the STI for the SDGs roadmap focusses on SDG 2 (end hunger) as well as those SDGs closely linked to it, such as SDG 1 (no poverty), SDG 8 (decent work and economic growth) and SDG 9 (industry, innovation and infrastructure).

The specific objectives of the STI for SDGs roadmaps in Kenya were to:

- evaluate the current SDG situation and identify gaps in achieving SDGs;
- develop the STI for SDGs roadmap to address the gaps identified;
- develop a comprehensive STI strategy to implement the SDGs roadmap;
- implement the STI plan for SDGs roadmap;
- monitor and evaluate the implementation of the STI plan for SDGs roadmap; and
- use the STI for SDGs roadmap to support the four areas identified in the 'Big Four' agenda.

Activity: Assess current situation

Analysing the gaps and further prioritisation of the SDGs. The roadmap technical team used indicators from the *SDG Index*, the *African SDG Dashboard 2019 report, the Kenya Department of Planning Status Report 2019*, national statistics, the Global Food Security Index as well as a *Kenyan SDGs Policy Gaps Analysis* (2018). The team thus undertook a detailed assessment of SDG 2, covering all five sub-objectives (2.1, 2.2, 2.3, 2.4 and 2.5). The analysis showed that Kenya was lagging behind in most of the SDG 2 targets. The team prioritised SDG 2.3 (increasing the productivity and income of smallholder farmers) which, if addressed, would bring the highest impact to all other sub-objectives of SDG 2 and also contribute to realising SDG 1, SDG 8 and SDG 9. SDG 2.3 also synchronises well with the aspiration of the 'Big Four' agenda for agriculture and food security.

Identifying the STI needs and gaps. The team identified the following six areas along agricultural value chains that require STI inputs: improved seed varieties; access to quality inputs; irrigation and mechanisation; reducing post-harvest losses; agro-processing; and marketing; with ICT as cross-cutting the value chain. The team has also identified the current gaps in the STI systems, which may hinder effective deployment of the required STI. In addition, supported by the World Bank, the team is analysing – through the *STI Public Expenditure Review* – existing and planned relevant programmes/projects funded by the government and international partners, aiming to promote R&D and technology adoption and diffusion with increased efficiency and effectiveness.

Activity: Develop vision, goals and targets

This STI roadmap for the SDGs is based on: Vision 2030 and its third medium term plan (2019-2022); 'Big Four' initiative (2018-2022); STI policy 2019; national research priorities (2019-2022);

12 *The Vision 2030 is implemented through tranches of five-year medium-term plans.*

and agricultural sector transformation and growth strategy (2019-2029).

The broad vision of the STI for SDGs was framed within Vision 2030, which lays out the long-term priorities for transforming Kenya into a newly industrialised middle-income country with a high quality of life in a clean and secure environment for all citizens by 2030. The STI for SDG pilot roadmap initially focusses on two of the President's 'Big Four' agenda–manufacturing and agriculture – because of the strong interlinkages between them. Accordingly, it focusses on increasing agricultural productivity and increasing the incomes of small farmers since, at the 2019 STI Forum, it was determined that such a focus would have the greatest positive impact on livelihoods. The roadmap aims to mainstream the application of STI for the realisation of SDGs in Kenya. The goal is set to realise 100% food and nutrition security by 2022 through the application of science, technology and innovation in increasing agricultural productivity, increasing the income of smallholder farms and reducing the cost of food.

Activity: Assess alternative technologies

With the prioritisation on agriculture in SDG 2, the roadmap process has started by focusing on three crops: maize, rice and potatoes. To test the methodology, the STI team is focusing on maize with the short-term goal of achieving self-sufficiency in maize by 2022. To achieve this, the team is identifying technologies in new plant varieties; the production and blending of fertiliser; control of pests and diseases; mechanisation; reduction of post-harvest losses; processing technologies; and STI for enhanced market access. Improved seed varieties were prioritised, and various conventional as well as alternative existing technologies were assessed. It was determined to go ahead and develop a roadmap using an existing conventional variety available domestically.

Activity: Develop detailed STI for SDGs roadmap

To develop the detailed plan, the team will map and hold consultations with various stakeholders; identify programmes through which the technologies can be delivered; and agree on what needs to be done by different stakeholders. This will include various government agencies, the private sector and the smallholding farmers. The team will also document how to mobilise the resources required for the deployment of the technologies to scale and incentivise the private sector's participation in technology uptake and deployment. The next steps will be to expand the scope of the STI for SDGs roadmap to the other priority interventions identified; to carry out further consultations with relevant stakeholders and to scale up and harmonise the roadmap; and to plan a communication strategy for the government to announce the roadmap. The Kenyan roadmap draft was presented at a side event during the Tokyo International Conference on African Development (TICAD) in Yokohama, Japan, in August 2019.

The following initiatives can be supported as a means of completing the process that was started.

1. **STI roadmap for SDG 2.** This process had reached the stakeholder engagement stage for the purpose of prioritisation. The technical team had identified the following key entry points for STI: improved plant varieties, fertiliser production and blending, pest, disease and weed control; post-harvest reduction; and smart agriculture. NACOSTI, through technical support from ACTS, is able to coordinate and guide agriculture stakeholders to formulate STI roadmaps for at least three of these prioritised areas.

2. **STI for SDG 9.** For manufacturing, the team identified and prioritised the following areas as potential entry points for the STI: fish value chain, textile value chain, leather value chain, circular economy and digital economy. NACOSTI, through technical support from ACTS, is able to work with the Ministry of Industrialisation, Trade and Enterprise Development and the Kenya Industrial Research and Development Institute to coordinate and guide the relevant manufacturing stakeholders to formulate STI roadmaps for at least three of these prioritised areas.

3. **STI for SDG 4.** In 2019, the Ministry of Education initiated the process of developing an STI roadmap for education. This process, which was started before the UN global STI roadmap project, was being spearheaded by the directorates responsible for planning and research in the Ministry of Education. The process has not been completed. This could be a good entry point for STI for digital education.

Activity: Execute, monitor and evaluate, and update plan

The plan is still under preparation, and explicit mechanisms for monitoring, evaluating and updating the full roadmap do not yet seem to have been put in place. However, the pilot exercise focused on improved maize varieties has helped to identify the importance of the technical committees giving extensive guidance and the need for increased stakeholder consultation.

Inputs: data, stakeholder consultations and expertise

The STI for SDG team has made extensive use of existing national and international data. It has also held some consultations with stakeholders, including various parts of government, the private sector, civil society and farmers. Technical input has involved domestic and some foreign experts and international institutions. However, from the conclusions of the pilot test, one important lesson is the need for a more proactive stakeholder engagement strategy.

The team has made significant progress in terms of forging international stakeholder involvement. The NACOSTI, as the lead agency, and Toyota Tsusho Corporation forged an agreement, which was announced during TICAD7 in July 2019, that the Japanese firm would support Kenya's roadmaps – e.g. in skills development for the 'Big Four' agenda –in agro-processing and value addition initially, as well as improving SMEs' managerial and technology adoption capabilities through the corporation's educational/vocational training platform (Toyota Kenya Academy). The Kenyan team has been active in bilateral/trilateral cooperation with Japan and India to tap into their expertise. The three countries have been discussing concrete ways to forge coordination/cooperation, i.e. through a think tank network between among ACTS, the Research and Information System for Developing Countries (RIS) (India) and National Graduate Institute for Policy Studies (GRIPS) (Japan), and to share good practices and lessons learned in supporting national roadmap-related activities at planned events, including the India-Japan 2-day workshop on STI for SDGs roadmaps. The governments of Kenya and Japan have been encouraging research partnerships among their research institutions, i.e. combating a parasitic plant (Striga) affecting maize production. Additionally, ACTS has been working with the Japan International Corporation Agency in identifying and coordinating at least 16 ongoing/pipeline projects with high relevance to the Kenyan pilot project.

❸ Other expected stakeholders, milestones and timeline

The original plan was that the process would be rolled out as follows from January 2020.

a. Generation of a work plan for the entire process.

b. Mapping of the actors and stakeholders relevant to the various focus areas.

c. Validation of the SDG gaps (SDG focal points).

d. Defining and prioritising in collaboration with (relevant) stakeholders' entry points of STI for the SDGs roadmap. Prioritisation will be done at this stage.

e. Create area-specific technical team to develop the STI for SDGs roadmap for its area.

f. Reviewing of the drafts generated by the area-specific technical committees by the core technical team.

g. Validation by the relevant stakeholder.

h. Consolidation (involves harmonisation) of the various drafts.

i. Strategic communication to relevant authorities (Cabinet Secretaries and Principal Secretaries).

The timelines are currently being revised due to delays emanating from COVID-19 and changes in personnel, both in the Department of Planning and at NACOSTI. The main contact person in the Department of Planning has retired, while there is a new Director General at NACOSTI.

4 Lessons learned; challenges/problems encountered so far (if applicable)

a. The process of developing an STI roadmap for the SDGs is a unique opportunity that has resulted in the government agency responsible for SDGs (Department of Planning) working closely with the NACOSTI, the agency responsible for STI. In the past, such coordinated efforts between the two had never taken place. Such a situation of limited coordination between SDGs and STI may also be found in other pilot countries.

b. The process of developing the STI roadmap is complex, requiring expertise and various stakeholders.

c. The presence of clear government prioritised sectors (like the 'Big Four' agenda) may make the processing of defining the scope easier.

d. Data is a challenge. There is inadequate data to provide the baseline for all targets. There are no direct SDG targets. They can only be inferred from sectoral plans and strategies. Therefore, the gaps were determined using the SDG Index and Dashboard.

e. Most government departments are implementing programmes and projects that contribute to SDGs but have not linked their targets to SDG objectives. As relevant documents of government-funded STI programmes/projects rarely mention which SDGs are relevant, it has been difficult for the team to track down and draw up a list of existing work.

f. Developing the STI roadmap for the SDGs is new and requires skills and capabilities to make use of country diagnostic methodologies and tools for gaps and needs assessment. Such skills and capabilities may not be readily available in the government, the private sector and the NGO. When Kenya initiated its analytical work with the WB, the Kenyan technical team members needed hands-on support and guidance from the Bank in collecting domestic data to be collated in a table, for example. Capacity building is required, and attentive technical support from relevant international partner agencies is essential.

g. Assessing alternative pathways is perhaps the most complex and expensive step in this process. It requires the active participation of carefully selected stakeholders – not only from the government and research institutions but also from the private sector and civil societies – for each of the identified areas of intervention. As mentioned in 2.3, the team has assessed various technologies to achieve self-efficiency in maize by 2022. In doing so, almost a dozen workshops have been held to cover a wide range of sub-topics, e.g. new plant varieties and the production/blending of fertiliser. The knowledge and networks of agricultural experts in the team were essential in mapping out issues and stakeholders, while also putting together a series of workshops and coming up with priorities.

Serbia – inputs from and updates by the EC JRC with UNIDO[13]

Serbia developed its STI for SDGs roadmap based on the Smart Specialisation Strategy adopted by the government in February 2020, followed by its action plan (roadmap) in March 2021. This makes Serbia the first country to finalise the roadmap development. The preparations for the implementation phase have now started.

1 Leading agencies and national counterparts

The Serbian inter-ministerial Smart Specialisation Team has led the process of developing the strategy and the roadmap from the beginning of Serbia's participation in the Global Pilot Programme, with operational leadership by the Ministry of Education, Science and Technological Development (MESTD). A new government was formed on 28 October 2020, with the appointment of H.E. Ana Brnabic as Prime Minister. While recent changes in the government have led to a process of reorganisation of the leadership and mandates and the need to reintroduce pertinent links between different ministries, the inter-ministerial working group lead by the Prime Minister Cabinet office remains in place with a mandate to oversee Serbia's Smart Specialisation Strategy (4S) and the implementation of the 2030 Agenda[14].

At operational level, MESTD continues to lead S4 implementation and head the National 4S Team. The latter team includes staff from MESTD, the Public Policy Secretariat (PPS) and representatives from a public research institution. Additional members may be joining the team in the near future. The following stakeholders were involved in the strategy development process: Ministry of Economy; Ministry of Finance; Ministry of Labour, Employment, Veteran and Social Affairs; Ministry of Trade, Tourism and Telecommunications; Ministry of Agriculture, Forestry and Water Management and Environmental Protection; Ministry of Culture and Information; Provincial Secretariat for Economy and Tourism of AP Vojvodina; Serbian Chamber of Commerce and Industry and Serbian Academy of Sciences and Arts - SASA). The National Statistical Office, Intellectual Property Office, and the University of Belgrade were also involved in the strategy development process at different stages. The EC/JRC provided financial and methodological support for the strategy and roadmap development process and the analytical work leading to the identification of priorities among the 17 SDGs[15], while UNIDO has contributed to the process by providing in-kind support to the development of the STI for SDGs roadmap.

2 Achievements so far, expected outcomes and key activities

Serbia decided to leverage the 4S development process to elaborate the STI for SDGs roadmap. **Following the adoption of 4S by the Government of Serbia on 27 February 2020, the STI for SDGs (STI4SDGs) roadmap adopted in March 2021 became the strategy's implementation plan.** It aims to inform and guide public and private investment in a number of STI priorities with the greatest potential impact on socio-economic

13 *This case builds, among other sources, on the Serbian presentation at Session 10 of the UN-China Ministry of Science and Technology Joint Capacity Building Workshop in Guilin, China, on 9-17 December (see Knezevic and Nedović, 2019), the following presentation in Vienna (February 2020), the official Smart Specialisation Strategy text and progress reports by an EU JRC consultant engaged to support the finalisation of the STI4SDGs roadmap document. The text was prepared by Monika Matusiak (EC JRC) and Fernando Santiago Rodriguez (UNIDO) and reviewed by Viktor Nedović and Tijana Knezevic (MEDST).*

14 *The inter-ministerial working group includes ministries in charge of different development strategies, including inter alia industrial development.*

15 ***https://s3platform.jrc.ec.europa.eu/pilot-methodology.***

development. Thus, an initial achievement is that the STI4SDGS roadmap for Serbia will become the first exercise in extending the scope of traditional research and innovation strategies for Smart Specialisation by introducing a new directionality, which is the alignment of national development and STI efforts to the country's commitment towards the 2030 Sustainable Development Agenda and associated SDGs. As 4S stands at the crossroads between research and development and technological innovation (RDTI) and economic/industry and other policy domains of relevance to Serbia – agriculture in particular – close cooperation by the various ministries and agencies in charge of these policy domains is required for smooth S4 implementation.

The Serbian Government is leveraging the established processes underpinning the 4S to produce an STI4SDGs roadmap, which, as already indicated, became the detailed action plan for the 4S. In line with the methodology elaborated in the STI for SDGs roadmaps *Guidebook*, 4S includes:

- a wide policy framework and synergies,
- the analysis of economic, innovative and scientific potential,
- the selection of policy priorities and targets,
- a vision for the future,
- policy measures,
- a monitoring and financial framework,
- an operational framework for implementation.

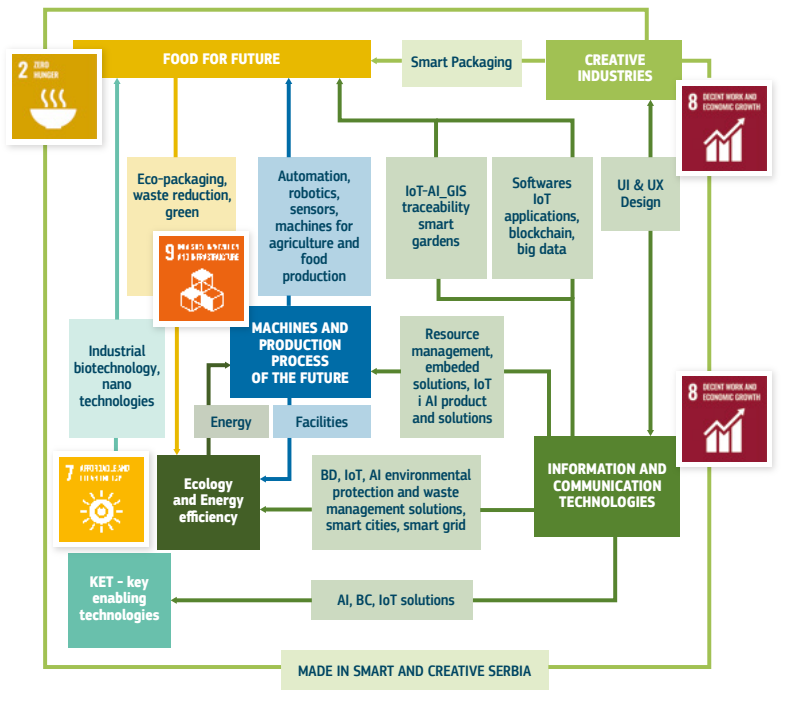
The COVID-19 pandemic and changes in government slowed down the process of developing the STI4SDGS roadmap, which was finally adopted in March 2021. Throughout 2020, the EU JRC and UNIDO worked, with support from an EU JRC consultant, to guide the roadmap development activities.

Activities: Define objectives and scope

4S is an interdisciplinary research and innovation agenda to foster socio-economic development and transformation based on knowledge-intensive activities. It focuses on the following priorities and SDGs.

Information and communication technologies	Food for Future
Custom Software Development	High Tech Agriculture
Software Solutions Development	Value Added Food products
Future Machines and Manufacturing Systems	Sustainable Agrifood Production
General and specific purpose machines	**Creative industries**
Information in the Smart Management Service - Industry 4.0	Creative audio-visual production
Smart Components and Tools	Video Games and Interactive content
	Smart Packaging
Key Enabling Technologies (KET)	
Energy Efficient and Eco-Smart Solutions	

Serbia's Smart Specialisation priorities. Vertical and Horizontal priorities and cross-innovation



Source: Serbian Smart Specialization Strategy

The following STI for SDGs roadmap was based on the support provided by the EC/JRC and UNIDO, which focused on:

1. analysis and methodological advice for moving towards the implementation phase of S4. In particular, guidance on how to further develop the three elements below:
   - policy mix definition and implementation,
   - establishment of a monitoring and evaluation system,
   - governance for the implementation stage of S4.
2. review of successive versions of the draft STI4SDGS roadmap, unofficially translated into English. Focus of the discussion on the more detailed components of the three elements above, for example, individual policy measures and associated performance indicators, or the analysis of such instruments in the context of more comprehensive policy mixes, with examples of the types of instruments from other countries (e.g. industrial PhDs) and on the choice of indicators for the monitoring system.

Assess current situation

Development of the STI4SDGS roadmap slowed down due to the pandemic and by the change in government that took place towards the end of 2020. However, , technical work could still be performed during this period to the extent possible. Members of the National 4S Team continued to function after the change in Ministers, thereby ensuring continuity of the work on the roadmap. The STI4SDG roadmap has been produced, including the following types of policy instruments:

- instruments from the R&D policy sphere, such as the Innovation Fund and Science Fund;
- instruments from the economic/industrial policy sphere such as the transformation of industry from a linear to circular model with reduced CO2 emissions or the increased contribution of scientific and research solutions in the process of development and digitalisation of the domestic industry;
- instruments from other policy spheres: agriculture and food industry R&D incentives or for the development of information technology and the development of artificial intelligence.

Develop vision, goals and targets

The vision for the future has been developed in a wide participatory process as described in the section Stakeholder consultations. Over half of the participants represented the private sector. The accepted vision is as follows.

Serbia creates innovations – Serbia, a country of smart and creative people, globally highly competitive, recognised by its knowledge-based innovations, partnerships in the domestic ecosystem and the creativity of individuals in areas of:

- *the sustainable high-tech production of high value-added food for the future,*
- *sophisticated software solutions for the global market,*
- *inter-sectoral-based industrial innovations with a high degree of inter-sectoral integrated industrial and business solutions and innovations.*

The overall goal is to achieve the 'Serbia creates innovation' vision: development of the Republic of Serbia towards a highly competitive economy through research, development, innovations and entrepreneurial initiatives in the 4S areas. The goal includes 5 objectives:

1. *research and development focused on 4S priorities,*
2. *economic growth supported by R&D and collaboration with the quadruple helix participants,*
3. *education focused on innovations and entrepreneurship,*
4. *improved business environment through optimisation and digitalisation of procedures in 4S areas,*

5. *internationalisation of the economy through involvement in regional and global value chains in the 4S areas;*

and a set of priority-specific targets to be achieved by 2027.

Activity: Assess alternative targets

The entrepreneurial discovery process framed the discussion of alternative targets and solutions. This is documented in separate workshop reports.

Activity: Develop detailed STI for SDGs roadmap

The detailed roadmap became the action plan for 4S, as indicated in the government-approved strategy. It will focus on specific actions to achieve the prioritised SDGs, with detailed indicators and timeframes for achieving the targets.

Activity: Execute, monitor and evaluate, and update plan

The Smart Specialisation Strategy includes a monitoring and evaluation system based on the input, output and outcome indicators. It has been further developed in the roadmap document for specific actions.

Inputs: data, stakeholder consultations and expertise

Data and expertise. The Serbian approach is fully evidence-informed. It includes a mix of quantitative and qualitative indicators disaggregated for the specific purpose of analysis, sourced from the National Statistical Office; Intellectual Property Office; Public Policy Secretariat; Ministry of Education, Science and Technological Development; Ministry of Economy; Serbian Chamber of Commerce and Industry and the University of Belgrade. The country has mobilised its own analytical team and used the external expertise of the JRC and Fraunhofer Institute (financed by the JRC). Additional support from the JRC covered the study on mapping SDGs, including the identification of SDGs prioritised in the national strategic framework, the statistical baseline analysis and the identification of the STI inputs focused on specific SDGs.

Stakeholder consultations. Serbia has conducted an extensive participatory process (entrepreneurial discovery), with over 700 stakeholders; 178 interviews, 17 workshops and 2 conferences were organised to develop the consensus on the joint vision and priorities. More than half of the participants represented the private sector. The entrepreneurial discovery working groups for each priority have been formalised and will be actively involved in the implementation and monitoring process. Each working group is run by the representatives from business and academia, with the government providing a platform for discussions and joint work.

3 Other expected stakeholders, milestones and timeline

The inter-ministerial working group for the 2030 Agenda joined the work on STI for the SDGs roadmap adopted in March 2021. The group proposed to create a subcommittee on STI for SDGs. An area of interest is SDG localisation. UNIDO joined the roadmapping work in partnership with the JRC.

The next steps foreseen after the roadmap development include support for its implementation, continued stakeholder dialogue on STI for SDGs and the piloting of the SDG budget for roadmap implementation.

4 Lessons learned; challenges/problems encountered so far (if applicable)

The development of an interdisciplinary, multi-ministerial document in a transparent and participative way brings several challenges, which include:

- dependence on external financing at the beginning of the process;
- a lack of sufficiently disaggregated data for the analysis of the current state;
- building the trust of stakeholders and convincing them to participate in the government-led dialogue;
- overcoming governmental silos and launching a real inter-ministerial cooperation;

- insufficient familiarity with SDGs and the overall 2030 Agenda for Sustainable Development, which may seem overwhelming for both policymakers and individual practitioners;
- difficulties in operationalising a complex set of targets at macro level, and to link them to concrete policy interventions intended to tackle focused micro-level challenges, requiring a balance between time and effort invested in strategy setting and actual implementation to avoid stakeholder fatigue.

Due to these challenges, the process encountered some delays, but its successes include: the mobilisation of Serbia's own funding for the implementation of 4S, accompanied by additional EU funding; developing a permanent cooperation with the Statistical Office and Intellectual Property Office (IPR) that delivered necessary information; launching a permanent public-private dialogue platform with high involvement of stakeholders; and winning the approval of the Prime Minister who took leadership of the inter-ministerial working group. These achievements show increased institutional capacity that bodes well for the later implementation.

Ukraine – inputs from and updates by the EC/JRC with UNIDO[16]

1 Leading agencies and national counterparts

Ukraine will participate in the Global Pilot Programme in partnership with the Joint Research Centre (JRC) of the European Commission, that will support the development and implementation of the STI for SDGs roadmap based on the Smart Specialisation approach, as well as with UNIDO, that will provide support based on its experience of green industrial transformation.

The office of the Deputy Prime Minister for European and Euro-Atlantic Integration of Ukraine will ensure its leadership in the Global Pilot Programme providing strategic coordination of SDGs and European integration policies.

The Deputy Prime Minister's office will be assisted in this task by the National Smart Specialisation Team, which will ensure the governance of the STI for SDGs roadmap process and enhance inter-ministerial coordination. A ministerial decree will officially establish the Smart Specialisation Team as an advisory body to the Cabinet of Ministers and the necessary policy mandate will be ensured.

The Government Office for Coordination on European and Euro-Atlantic Integration (EU Integration Office) will also be involved in roadmap development. Two resources will be added to the organigram for the Reforms Delivery Office of the Cabinet of Ministers of Ukraine to enhance the EU Integration Office capacity to provide the support required for the STI for SDGs policy coordination. These two resources will work in close cooperation with the EU Integration Office and support the organisational work of the National Smart Specialisation Team on coordinating inter-ministerial efforts.

The Ministry of Education and Science of Ukraine (MES), responsible for the STI policy, will lead the STI for SDGs roadmap development at operational level, in close cooperation with the Ministry of Economic Development, Trade and Agriculture of Ukraine (MEDTA), responsible for the SDGs, innovation in real economy, IPR and regional Smart Specialisation policies, as well as with the Ministry of Digital Transformation of Ukraine, responsible for the digitalisation and business development policy to the stakeholder framework to be included in the development process.

16 *This chapter builds on, among other sources, the report 'Support for the development of Science, Technology and Innovation for SDGs Roadmaps in Ukraine' prepared by Olga Bolibok, expert for the Joint Research Centre of the European Commission and on consultations held with national authorities. The text was prepared by Angela Sarcina (EC JRC), Monika Matusiak (EC JRC) and Fernando Santiago Rodriguez (UNIDO).*

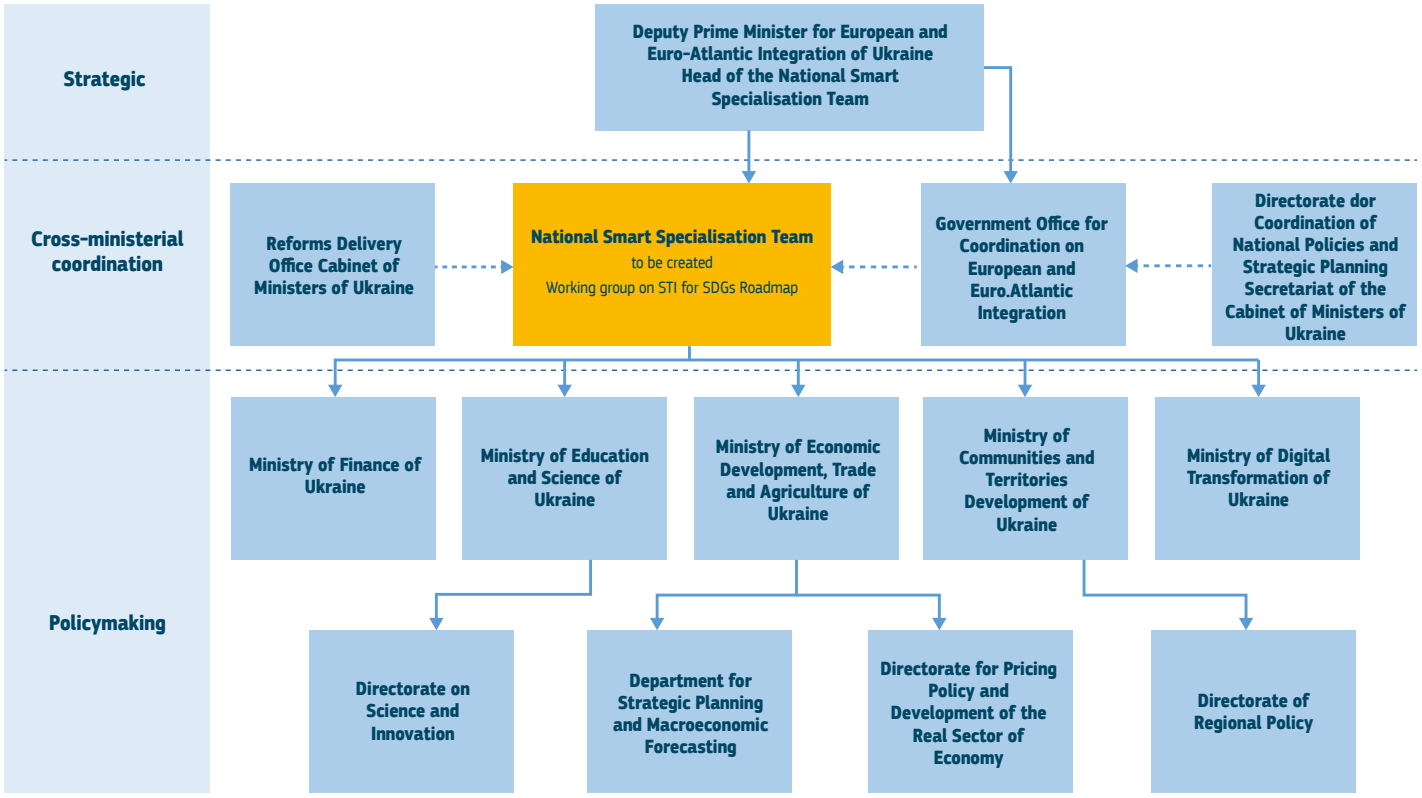


Figure 3.1 *Proposed governance structure. Source: Olga Bolibok (2021).*

❷ Achievements so far, expected outcomes and key activities

Having joined the Global Pilot Programme in February 2021, Ukraine's activities for the development of the STI for SDGs roadmap are in the very preliminary stage of design and are still under discussion by and with the national counterparts. A preliminary list of the proposed activities to be performed includes the following:

- ensuring coordination with the ongoing Smart Specialisation process at regional level and upcoming local initiatives;
- establishing a governance structure able to manage the process and implement the results;
- identifying synergies with other policies: assessment of a national SDG framework in Serbia;
- using the results of Ukraine's *Voluntary National Review* for SDG prioritisation;
- stakeholder validation of challenges;
- identification of existing STI potential for SDGs;
- identification of collaboration networks to deliver change;
- stakeholder dialogue: entrepreneurial discovery for sustainable innovation – discovery for recovery;
- national Smart Specialisation priorities and action plan included in the STI for SDGs roadmap

Activity: Define objectives and scope

The development of the STI for SDGs roadmap in Ukraine will build on the regional (subnational) experience of Smart Specialisation. Since 2016, Ukraine has been working on developing regional Smart Specialisation strategies with JRC support. Coordinated by the National Smart Specialisation Team, the Ministry of Economic Development,

Trade and Agriculture of Ukraine is leading the process in cooperation with the Ministry of Communities and Territories Development and the Ministry of Education and Science, the State Statistics Service of Ukraine and other stakeholders.

In 2018, a Smart Specialisation methodology was identified as the main tool for achieving the objectives included in the 'Regional industrial development' strategy of the national industrial policy developed by the Ministry of Economic Development, Trade and Agriculture, but not yet adopted. In addition, the Cabinet of Ministers adopted a resolution according to which Ukrainian regions have to define at least one goal within the framework of the regional development strategy based on the Smart Specialisation approach that would allow regions to apply for funding from the Regional Development Fund. In addition, the National Smart Specialisation team launched simultaneous training processes in 25 Ukrainian regions. To enhance institutional capacity, the JRC launched expert support in 11 regions in 2019 and in 8 regions at the end of 2020.

Taking into account the ongoing process at regional level, Ukraine will develop the national STI for SDGs roadmap based on a Smart Specialisation approach and supplemented by UNIDO's approach on green industrial transformation using a multi-level approach.

In order to ensure efficient interconnection between the different levels, a corresponding institutional set-up is now under discussion by relevant ministries and directorates. The proposal under discussion is to set up two working groups within the National Smart Specialisation Team – one in charge of the regional Smart Specialisation strategies and the other one for the STI for SDGs roadmap based on national Smart Specialisation. This mechanism would aim at ensuring coordination between levels and projects.

Activity: Assess current situation

As a preparatory work to define the positioning of the STI for SDGs roadmap within the national policy context, an analysis of the strategic policy frameworks has been performed.

It has been assessed that Ukraine has a national SDGs indicators system, which consists of 17 goals and 86 targets, included in the report *Sustainable Development Goals Ukraine 2020*[17]. The report provides a good basis for future monitoring, as well as for the analysis needed for the STI for SDGs roadmap development. In addition, the President of Ukraine issued a decree 'On Sustainable Development Goals of Ukraine for the period until 2030' to promote the achievement of the SDGs. An Inter-Agency Working Group on Achieving Sustainable Development Goals – a temporary advisory body of the Cabinet of Ministers of Ukraine – was established to ensure the coordination of efforts. The *Voluntary National Review on Sustainable Development Goals* was presented online at the High-Level Political Forum on Sustainable Development in July 2020.

At STI level, reforms on science and innovation have been developed and launched since 2016. A complex reform of the state system of support to the innovation ecosystem was launched in 2017 and is not yet fully implemented. A process of reforms of the national science and technology system was launched in 2015, defining the modern legal, organisational and financial basis of the functioning and development of the scientific and technological scopes in Ukraine. Within this framework, the National Research Foundation of Ukraine was established.

To improve policy coherence between science and innovation components, the Directorate of Science and Directorate of Innovation in the Ministry of Education and Science were merged into the newly established Directorate of Science and Innovation.

17 *For further information, see the documents:* Sustainable Development Goals Ukraine 2020 Monitoring Report ***[Eng]*** ***[Ukr]***; Sustainable Development Goals Ukraine 2020 Factsheet ***[Eng]*** ***[Ukr]***; Sustainable Development Goals Ukraine 2020 Data One-pager ***[Eng]*** ***[Ukr]***.

Inputs: data, stakeholder consultations and expertise

The main data source for the national Smart Specialisation strategy is the State Statistics Service of Ukraine that can provide economic and innovation survey data.

Other data sources for the STI for SDGs roadmap may include (but are not limited to) the following:

- UN Global SDG Indicators Database for the statistical assessment of the key challenges resulting from SDGs;
- European Commission's CORDIS database (Horizon 2020 projects), Elsevier's Scopus (scientific publications);
- databases of the National Research Foundation of Ukraine, Ukrainian Startup Fund;
- European and Ukrainian patents, PATSTAT database (patents) for the identification of Ukraine's scientific, technological and innovative potential.

3 Other expected stakeholders, milestones and timeline

In the initial stage of the programme, stakeholders' information and consultations are being realised in the form of individual online meetings carried out by the JRC expert.

On 26 March 2021, the official kick-off meeting on the Global Pilot Programme was held online in the presence of Ms Yulia Bezvershenko, Director General of the Directorate on Science and Innovation of the Ministry of Education and Science of Ukraine and Ms Daria Gaidai, Advisor to the Deputy Prime Minister of European and Euro-Atlantic Integration of Ukraine, as well as other representatives from other relevant ministries and government offices.

Ukraine is expected to define the next steps and timeline by mid-April.

CHAPTER 4.

Lessons and implications from experience to date

This chapter draws upon lessons and implications from the six pilot countries involved to date. The first section summarises the progress on the six steps of the roadmap as well as what they have reported as challenges and lessons learned. The second section reports on the lessons learned from three country case studies – India, Kenya and Serbia. The third section draws upon some of the preliminary lessons and implications for moving forward from progress to date.

From pilot countries

Below is the summary of progress of the pilot countries on the six steps of the roadmap as well as what they report as challenges and lessons learned.

1 Objectives and scope

The objectives have been framed within the context of the country's national development plan and their economic and social conditions. All countries have chosen a narrow set of SDGs (from three to seven) because of the difficulty in tackling all of the SDGs simultaneously.

The most common SDGs, each chosen by four countries, have been SDG 1 (no poverty) and SDG 8 (decent work and economic growth), with a strong focus on jobs. The third most common, chosen by three countries, has been SDG 2 (zero hunger). The next most common, each chosen by two countries, have been SDG 3 (good health and wellbeing), SDG 6 (clean water and sanitation), SDG 7 (affordable and clean energy) and SDG 10 (reduced inequality). Another four have each been chosen by one country. They are SDG 4 (quality education), SDG 9 (industry, infrastructure and innovation), SDG 13 (climate action) and SDG 17 (international partnerships).

As all but Serbia are low income or lower middle-income countries with high poverty rates and have the largest share of employment in agriculture (see Appendix Table A.1), it is not surprising that SDGs 1, 2 and 4 are the most commonly chosen. Serbia, the highest income country per capita, has predominantly focused on using STI to increase its growth and competitiveness.

India stands out in having included SDG 17 on international partnerships in the goals even though it is a lower middle-income country. That, in part, is because of its strong technological capability and its commitment to the TFM to help other developing countries use STI to accelerate their development.

Ukraine, as a new country in the Global Pilot Programme, has an opportunity to draw from the lessons learnt so far. In the case of this country, an interesting challenge will be the coordinated national and subnational efforts for the development of STI for the SDGs roadmap.

2 Assessment of current situation

The assessment of the current situation of both SDG gaps and STI supply/capability requires a lot of data and expertise. The depth of the assessment has varied between the pilot countries. In Ghana, India, Kenya and Serbia, they have been conducted based on assessments of both STI capabilities and SDG gaps, although the data available in each country has varied. In India, a detailed analysis of the technological STI system disaggregated to state level has been carried out. In Serbia, the target-level statistical analysis has been prepared showing the distance from the best performers in the European Union (see Appendix Figure A.4 for the aggregated results of the analysis and Appendix Figure A.5 for a detailed example for one of the SDGs). In Ghana, the assessment has primarily focused on a Science Technology and Innovation Policy Review and detailed technology roadmaps for 22 sectors, but not yet on SDG gaps and goals.

3 Vision

Developing a vision, goals and targets has varied significantly between the pilot countries because of the different institutional set-ups through which they have engaged in the pilot exercise. The most

developed visions have been developed in Serbia, India and Kenya where there has been more involvement of the highest level of government in the process. In Ghana, the vision is still being developed and is mostly driven by the Ministry of Environment, Science, Technology and Innovation. In Ethiopia, a clear vision for STI for SDG roadmaps is still in the development process because the work so far has only been undertaken by the Ministry of Innovation and Technology and will be articulated after drafting a new national STI policy. In Ukraine, from the application stage, the Deputy Prime Minister's office has taken the lead in the process, which is expected to facilitate the development of the roadmap and its later implementation.

4 Assessment of alternative technological pathways

Assessing alternative pathways is perhaps the most complex and expensive step, requiring the engagement of representatives from different parts of the innovation chain, including not only the technology but the agents involved in the value chain to diffusion and use as well as the provision of complementary inputs, including finance and infrastructure. This has not been fully developed in most of the pilot countries except perhaps for Kenya, where the methodology for considering alternative technologies was tested for the case of maize.

5 Development of detailed STI for SDGs roadmaps

Serbia adopted its STI for SDGs roadmap in March 2021. Other pilot countries have not yet fully developed detailed roadmaps, which are at different stages of advancement. In some cases, such as Serbia and India, they are more comprehensive and involve the actions of many stakeholders. In others, they are, to date, more narrowly focused (technology roadmaps in various sectors in Ethiopia, technology incubators in Ghana, the agricultural value chain for three crops in Kenya) and are still in the process of expanding the coverage and developing the details of the policies and implementation actions.

6 Execution, implementation, monitoring and evaluation

As the detailed STI for SDGs roadmaps have not yet been finalised in most of the pilot countries, they have not reached the execution or implementation phase. Serbia already launched its first calls for implementation in association with mobilising STI for COVID in 2020. In 2021, a full-scale implementation is expected. Moreover, some implementation actions have already started in India. In addition, India is putting a strong emphasis on monitoring and evaluation for strategic decision-making in the execution and adjustment of the plan. Serbia has also prepared for implementation with dedicated actions planned, among others, with the Science and Innovation Funds. As noted in the *Guidebook*, monitoring and evaluation is a critical element because the implementation of the roadmap is essentially a learning exercise. It will be important to learn from the implementation experience and to make adjustments as well as take into account the impact of changes within the context, such as the current COVID-19 crisis.

7 Data, expertise and stakeholder consultation

The use of data and expertise has varied considerably between across countries, depending in a large part on what information is readily available as well as how much effort they have put into developing and collecting relevant data. There has also been great variation in the extent to which domestic and international expertise has been tapped into to help develop the roadmap, as well as the nature and depth of stakeholder consultations. The most extensive appear to have been in India, Serbia and Kenya, which are developing broader and more detailed roadmaps. In Ethiopia and Ghana, the consultations have been more limited to stakeholders in the national innovation system. Ghana's project has initiated a new partnership with academic institutions for data collection and analysis.

8 Challenges, problems, lessons

The most common challenge, mentioned by all six countries, has been attaining stakeholder involvement and active participation. In countries involving several ministries and agencies, this has included getting effective coordination. In the case of Serbia, the development of the roadmap has allowed great mobilisation of not only public but also private stakeholders and civil society. In addition – though not always explicitly mentioned in the country write-ups, except for in the Serbia progress report – one related challenge has been getting different parts of government that are involved in STI or general development planning to focus on SDGs. In many cases the plans are still just STI roadmaps, or parts of national development plans, not necessarily an STI for SDGs roadmap. The second major challenge has been the availability of updated data to conduct the assessment to develop priorities.

Another major challenge which has slowed the preparation of the roadmaps has been the COVID-19 crisis, which has diverted the attention of government officials to address the crisis. In addition, another critical challenge has been the lack of a specific budget to develop, and more importantly implement, the STI for SDG roadmap.

Some of the key lessons are the importance of creating platforms for coordination and collaboration between the government and other stakeholders. Other lessons are the importance of getting relevant expertise and secure funding.

Lessons learned from pilot country case studies

This section draws upon the lessons from three pilot country case studies: M-PESA from Kenya; the Ayushman Bharat PM-JAY health insurance system from India; and the Innovation Fund from Serbia.

Key elements of success

1 **Strong collaboration between multiple stakeholders with effective coordination.** Multi-stakeholder engagement with effective coordination is seen in all of the case studies. The three cases also demonstrate the importance of involving relevant stakeholders from different parts of government, the private sectors, technical experts and civil society. While the process of involving stakeholders may be lengthy and complex, it is critical to the successful development and implementation of the project.

2 **Developing a good deployment system is crucial.** All three cases had an emphasis on the development of a deployment system.

- **In India**, for both health systems and Aadhaar (the unique ID system), the key requirement was considerable buy-in from the state government, plus multiple providers of IT and health providers in the case of the health system.
- **In Kenya for M-Pesa**, it was critical to have participation from vendor networks.
- **In Serbia**, a lot of effort was put into developing the capacity of the staff in charge of the innovation fund, including foreign study trips, hands-on training and advice from renowned foreign experts. The case study also shows that it is often necessary to enact new laws and create specialised institutions in order to be able to operationalise the plan.

3 **The ability to adjust to changes is a key to success.** All three cases had to adapt as they were being implemented. In order to adapt to unexpected changed, putting an effective monitoring and evaluation system in place is essential.

4 **Involvement and partnership with private sector.** The private sector can play a very important role. This point was seen clearest in the Kenya M-Pesa case study, where the main driver was Vodafone/Safaricom (international and domestic private sector). This was also the case in India, as

the health insurance system required the participation of the private sector to develop the digital platforms to integrate the system. The India system also required the active participation of private doctors, healthcare facilities and hospitals as part of the system. In Serbia, the establishment of the Innovation Fund helped reorient public research towards the needs of the private sector in order to increase Serbia's industrial competitiveness, and the private sector was the donor as well as the recipient of new funds.

5 **Adequate financing.** Securing adequate financing was also critical, particularly for social programmes provided by the government, such as in India. But it is important to note that public (DFID) financing was instrumental – even in the case of Vodafone (a large multinational) – in the initial development stage. Additionally, it is important to recognise that M-Pesa seemed to be privately financed once its viability was demonstrated. Furthermore, its focus changed, and it seems to be privately financed by users who find value in this application. In Serbia, the innovation fund required international funding from the EU and the WB, as well as from the Serbian government, and co-funding from the private sector for approved projects.

Role of the assessment of alternative pathways

Minimal assessment of alternative pathways was evident in the three case studies, although there appears to have been some in the India case. In addition, there was significant effort to learn from best practices from other countries when setting up the Serbia Innovation Fund.

It should be noted that assessing alternative pathways is generally difficult for any country to do, as there is no readily available system of technological alternative information.

Replicability

Replicability varies depending on many contextual factors, including the capacity of local agents. M-Pesa has had some limited replicability. The case study highlighted the importance of the regulatory regime as well as the deployment system. But it should be noted that M-Pesa was not so replicable in India because of the regulatory system of the banking sector.

Aadhaar potentially has considerable replicability, although there are issues of technical capacity in other countries, as well as important issues of trust, privacy and security.

Universal healthcare is in fact still being expanded in India. It has the potential to be replicated in other developing countries, but some preconditions need to be met, such as vertical and horizontal coordination, multiple healthcare providers and finance.

Serbia's Innovation Fund has some elements of replicability. However, the case study clearly shows how a programme has to be adapted to the specificities of the country. It also requires strong support from the highest level; the creation of strong, independent institutions; strong and extensive stakeholder consultation; changing or passing new legislation; and lots of external technical and financial support and involvement from the private sector.

Lessons related to international partnerships for STI for SDGs roadmaps

The progress reports from the six pilot countries as well as the country case studies present the following lessons for international partnerships, which resonate with the recommendations of the IATT background paper on international cooperation. **The overall lesson is that greater technical and financial assistance from international partnerships for SDG roadmaps will be very**

beneficial in helping countries develop effective STI for SDG roadmaps. More specifically, this includes:

- building the national STI capabilities of developing countries to address challenges underpinning the SDGs and helping to connect national innovation systems in developing countries internationally;
- undertaking concentrated analytical efforts to improve methodologies for assessing synergies and trade-offs among the SDG goals in the challenging context of developing countries, and providing technical expertise and finance to help them design and implement their plans;
- boosting international flows of relevant knowledge and technology between countries and supporting cross-country STI collaborations, addressing the SDGs;
- brokering international collective STI actions with an ambition to tackle global challenges, namely global public Goods as technological advances can help developing countries tackle their SDG challenge more effectively.

Implications and recommendations for moving forward

The following is a list of lessons learned from the current state of pilots as well as from country case studies for further strengthening of the *Guidebook* and the pilot countries as well as for expanding the pilot activities to other countries.

1 For the *Guidebook*

- Countries cannot tackle all of the goals and follow all of the steps at once. The Guidebook should be more explicit that they should start when there is enough political support and capability and then expand as experience is acquired.
- Beyond the country progress reports, it should be noted that in no country, other than Serbia, does it appear that any explicit effort was made to assess trade-offs and synergies between or among different SDGs in the particular country context. In Serbia, the synergies between different priority domains and related SDGs have been discussed during the entrepreneurial discovery process and included in the Smart Specialisation strategy and later addressed in the dedicated analytical exercise. Methodologies for helping countries assess such trade-offs and synergies could help countries decide which key SDGs they may find it most effective to pursue, and to organise their objectives and scope accordingly.
- The case studies do not strictly follow the six steps. They are developed more organically through trial and error rather than as part of a planned project. However, following the steps can help to speed up the process.
- It is important to take stock of the strategic framework and existing policies in order to avoid duplications of policy processes and fill the gaps. This has been done in most pilot countries. The six steps can then serve to understand what has been sufficiently developed and where there are areas for improvement.
- More guidance would be useful on how to get more international assistance on:
  - existing technology and innovation that can be harnessed;
  - expert advice and technical assistance on how more effective use of technology and innovation can help to accelerate the goals;
  - where to find finance for developing the roadmaps, but more importantly for the implementation of the roadmap;

- international efforts to build, boost and broker STI collaboration for the SDGs;

■ providing more guidance on how to set up the roadmap as a learning experience to be adapted and updated as experience is gained;

■ providing more concrete examples on how more effective use of technology and innovate can help achieve the goals in order to stimulate excitement and commitment to developing STI for SDG roadmaps as well as illustrating what is required. The illustrative case studies from India, Kenya and Serbia included in this progress report – which provide concrete examples of how STI can contribute to achieving SDG goals and what is required in terms of getting stakeholder involvement, expertise, planning, implementation, monitoring and evaluation and adjustment as experience is acquired – is helpful in this respect. Such concrete successful experiences should be reflected in a future version of the Guidebook;

■ providing more guidance on how to create high-level interest, buy-in and commitment to implementation and improvement;

■ setting up a community of practice of countries developing and implementing roadmaps;

■ updating the Guidebook as more experience is gained.

2 For current pilot countries

This is not directed at any specific country but rather provides general suggestions that countries may wish to consider as they move forward in fleshing out their STI for SDG roadmaps and beginning to implement them.

■ Draw more on existing national and international information, technical and financial resources.

■ Get greater stakeholder participation and ownership.

■ Improve coordination across relevant ministries/government agencies and other stakeholders in the private sector and civil society.

■ Consider potential synergies and complementarities as well as trade-offs between the SDGs targeted in the STI4SDG roadmaps in order to make the most effective use of limited financial and human resources.

■ Take advantage of the many opportunities offered by new digital technologies and the convergence between digital, physical and biological technologies, but also address the potential negative effects of these disruptive technologies, such as the tendency of increasing inequality, the risk that there are serious issues of privacy, security, and autonomy that need to be addressed as more personal data becomes digitised.

■ Move to developing strong implementation plans with clear assignment of responsibilities for the different agents and stakeholders.

■ Build monitoring and evaluation systems into the roadmaps, as it is certain that there will need to be adaptations and changes in the implementation of the roadmaps in light of the implementation experience, as well as major changes in the global and local context (for example, the disruption caused by the COVID-19 pandemic and other expected climate-related stocks such as extreme weather, flooding, droughts; as well as unknown and unexpected shocks).

■ Partner with academia to add academic robustness to the STI metrics and enhance M&E in general.

■ Participate in a community of practice among countries that are developing STI for SDGs roadmaps, which is likely to be set up to share experiences.

■ Do more to take advantage of positive synergies between SDGs and targets.

■ Country-specific observations implementation [for IATT discussions and modification/ refinement if necessary]

- ***Ethiopia.*** A key challenge is expanding the scope beyond STI to STI for SDGs. This requires more active involvement of the ministries beyond MINT and MOSHE and should ideally include the Ministries of Finance, Planning, Agriculture, Industry and other key sectorial ministries, as well as the involvement of the President or Prime Minister's Office.
- ***Ghana.*** A key challenge is to expand objectives and scope beyond STI and currently focus on university-based technology incubators to develop more comprehensive STI4SDG roadmaps for the SDGs chosen.
- ***India.*** There is great potential to use its considerable digital skills to improve the coordination, monitoring and evaluation of STI and STI for SDGs. India also has many compelling examples of using STI to accelerate the achievement of many SDG goals, which have potential applications in other developing countries.
- ***Kenya.*** Kenya has taken a deep dive into developing a plan for improving maize technology to increase the income of poor farmers. Now that it has acquired some experience in assessing alternative technologies, it needs to broaden its scope and for that it will need to mobilise more stakeholders and expertise and make concrete implementation plans.
- ***Serbia.*** Serbia first developed an ambitious 4S Strategy with an initial focus on priority SDGs and is now moving to incorporate SDG goals into its implementation plan. Based on the additional SDG mapping, other important SDG goals have been discussed to be addressed within the STI for SDGs roadmap.
- ***Ukraine.*** Ukraine should use the lessons learned from the experience of other pilot countries. The country seems well prepared for this effort and has already requested a peer learning exercise, with a particular focus on Serbia.

3 For expanding to other countries

- Disseminate compelling examples of how the effective use of STI can speed up the achievement of SDGs. This should include examples such as those from the country case studies in the Annex, which are good examples of what can be accomplished by focusing STI on attaining SDGs despite not being explicitly developed as STI for SDG roadmaps.
- Organise another call for pilots:
  - a. ask for high-level commitment;
  - b. require a strong high-level coordinating body.
- Build a community of practice to share experiences in developing STI for SDG roadmaps and invite potential member countries to join.
- Boost more active involvement of UN IATT, other international and national agencies and the private sector to help developing countries develop their STI for SDGs roadmaps.
- Broker more technical and financial support from the international system.

4 For the international community

In light of relative slow progress to date:

- raise the alarm that goals are not going to be met and that we are entering critical tippling points;
- undertake greater advocacy of the benefits of STI for SDGs roadmaps;
- provide more concrete compelling examples;
- create and participate in the upcoming community of practice;
- strengthen the STI online platform of available technologies;
- create a platform for technical and financial assistance;

- build more STI for SDG roadmaps in developing countries; be careful not to just support STI for its own sake, but to contribute to the SDGs;
- involve the private sector more. Refer to case studies such as M-Pesa and other examples and build on efforts such as the WEFs 'Frontier 2030 – a New Fourth Industrial Revolution Platform for Global Goals Platform' (see WEF 2020);
- broker more international coalitions to create technology and innovation relevant to the goals (see the IATT background paper *International STI collaboration and investment for Sustainable Development Goals*);
- the above includes the need to manage the downsides of technology (see GSDR 2019).

Appendix I

Table A.1: Basic indicators for pilot countries

In 2019, unless otherwise indicated.

GNI/capita (2019)
GNI (billions) (2019)
GDP growth 2000-2018
Population (millions) (2019)
Fertility rate, births/woman (2018)
Agriculture as % of GDP (2019)
% employment in agriculture male/female (2019)
Agricultural value added/worker in constant 2010 US$, (2019)
Access to electricity 2018
Access to internet 2017 (%)
Expenditure on R&D/GDP (2017)
Life expectancy at birth (2018)
Population below $1.90/$3.20 (%) (2015)
Gini coefficient (latest available 2015-2019)
Maternal mortality rate/100,000 births (2017)
Under-five mortality rate/1,000 live births (2019)
HIV/1,000 uninfected population ages 15-49 (2019)
Adult literacy rate male/female (latest available 2016-2019)
Primary completion rate male/female (2015)
Lower secondary completion rate male/female (2015)
% of population using safe drinking water (2017)
Natural resource depletion as percentage of GNI, (2019)
Renewable energy consumption as percentage of total (2015)
Ambient air pollution-micrograms per m^3 (2017)
CO2 emissions, metric tons per capita (2016)
CO2 Kgs/2011 $PPP GDP (2016)

Source: World Development Indicators 2021.

	ETHIOPIA	GHANA	INDIA	KENYA	SERBIA	UKRAINE
	17,611	4,857.5	105,444	94,144.6	675,222.3	64,013
	94.9	67.5	2,890	91.8	48.8	141.6
	9.9	6.6	6.8	5.0	3.2	2.6
	112.1	30.4	1,366.4	52.6	6.9	44.4
	4.2	3.9	2.2	3.6	1.5	1.3
	33.5	17.3	16	34.1	6	9
	73.4//58.7	36.3//21.1	39.5//54.9	59.5//59.3	17.7//13.2	15.9//11.4
	588.5	3,301.8	1,972	1,128.3	6,935.8	5,733.3
	45	82.3	95.23	75	89.57	100.00
	18.6	37.9	32.0	17.8	70.3	58.9
	0.3	..	0.7	..	0.9	0.4
	66	63	69	66	76	71.7
	30.8//68.9	..	..	37.1//66.5	6.6//11.6	0.0//0.5
	35.0	43.5	..	40.8	36.2	26.6
	401	308	145	342	12	19
	50.7	46.2	34.3	43.2	5.3	8.4
	0.2	1.1	..	1.5	0.1	0.6
	59//44	83//74	82//66	85//78	99//98	..
	55//53	99//98	95//100	99//100	101//101	..
	30//29	76//72	83//88	79//78	102//102	..
	11.4	36.4	..	..	74.7	92.0
	3.9	3.5	1.0	0.6	0.5	0.5
	92.2	41.4	36.0	72.7	21.2	4.1
	39.0	34.7	90.9	28.6	24.7	20.3
	0.1	0.6	1.8	0.3	6.4	4.5
	0.1	0.1	0.3	0.1	0.4	0.4

Appendix II

Figure A.2. Technology mapping for SDG 2 in India
(ongoing with inputs from national consultations)

Table 1: Technology mapping for SDG 2 (ongoing with inputs from national consultations)

SDG TARGET	UN INDICATOR	MoSPI NIF	
2.1 By 2030, end hunger and ensure access by all people – in particular, the poor and people in vulnerable situations, including infants – to safe, nutritious and sufficient food all year round	2.1.1 Prevalence of undernourishment	2.1.1 Percentage of children aged under 5 years who are underweight	
	2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale (FIES)	2.1.2 Proportion of population (marginalised and vulnerable) with access to food grains at subsidised prices	
2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including, through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment	2.3.1 Volume of production per labour unit by class of farming/pastoral/forestry enterprise size		
	2.3.2 Average income of small-scale food producers by sex and indigenous status	2.3.2 Gross value added in agriculture per worker (in Rs.)	
2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production; that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters; and that progressively improve land and soil quality	2.4.1 Proportion of agricultural area under productive and sustainable agriculture	2.4.1 Proportion of net sown area to cultivable land	
		2.4.2 Percentage of farmers issued Soil Health Card	
		2.4.3 Percentage of net area under organic farming	

	NIF VALUES		TECHNOLOGIES
	2018	2019	
	35.7 (2015-16)		**POSHAN Atlas** is an agro-food database initiative being led by the Ministry of Women and Child Development, Government of India, that will link comprehensive information on which foods are traditionally consumed, which crop varieties are currently grown, etc.
	97.62		**AgNext** has been using AI, data analytics, internet-of-things and spectral analytics to analyse food quality to ensure effective trade, production, warehousing and consumption.
			MyCrop has developed an 'agriculture platform as a service' approach which provides for the utilisation of algorithms and big data to facilitate informed access to markets for farmers. A 'farmer mitra' delivers analytical insights and expertise to farmers to increase profitability by reducing the cost of cultivation, increasing yield and finding suitable marketplaces.
	68 531 (2017-18)		**Agricx** has developed an AI-enabled software-as-a-service stack for entities for the production, trade, storage, transport, processing or financing of agricultural commodities. Its services provide an opportunity to digitise the entire procurement process. **Arya**, an integrated agri-tech platform, offers storage, warehouse management, embedded finance and market linkages to agricultural producers and buyers across India through its digital collaboration platform.
	77.04 (2015-16)		**AgriStack** is a public digital repository of farmer, farm and crop data. It aims to enable access to credible data for agricultural entrepreneurs to channel their investments in the right locations and for the government to improve service delivery and plug subsidy leakages.
	91.7 (2015-17)		**FASaL App.** Fasal, an agri-tech startup, captures real-time data on conditions in farms through IoT devices that deliver farm-specific, crop-specific and crop-stage-specific actionable recommendations to farmers through an app. Each device is equipped with sensors that monitor rainfall, wind speed and direction, solar intensity and micro-climatic factors such as temperature, humidity, leaf wetness and sub-soil parameters. The system helps in managing irrigation based on specific crops at specific stages, protecting the roots and improving yields. The device keeps an hourly track of the water tension at the primary root zone, and if the water level exceeds a certain level, the system triggers an action alert through the Fasal app.
	1.383		

Appendix III

Figure A.3. Technology mapping for SDG 6 in India

Table 2: Technology mapping for SDG 6 (ongoing with inputs from national consultations).

SDG TARGET	UN INDICATOR	MoSPI NIF
6.1 By 2030, achieve universal and equitable access to safe and affordable drinking water for all	Proportion of population using safely managed drinking water services	Percentage of population getting safe and adequate drinking water within premises through pipe water supply (PWS) (similar to 1.4.1)
		Percentage of population using an improved drinking water source (Rural)
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Proportion of population using (a) safely managed sanitation service(s) and (b) a hand-washing facility with soap and water	Proportion of households having access to toilet facility (urban & rural)
		Percentage of districts achieving open defecation free (ODF) target
		Proportion of schools with separate toilet facility for girls

NIF VALUES		TECHNOLOGIES
2018	2019	
37.85 (rural)	40.50 (rural)	**Grundfos AQpure.** This is an easy-to-install ultrafiltration-based water treatment system. It produces drinking water by filtering bacteria, viruses and particles from the raw water source (such as ground water, rivers, lakes and ponds). It can also be attached to a sedimentation system or a sand filtration system. It is fully solar-powered, requires very little maintenance and has a remote sensing feature that makes it a very suitable centralised supply of water in remote, off-grid locations.
95.81	-	**Agua Clara.** This organisation aims at innovative solutions targeted at improving global access to affordable and safe drinking water. It facilitates the construction of a water storage, treatment and distribution system in rural areas through community labour/participation and materials/resources available locally. It also trains the local community on the operation and maintenance of these simple technologies developed by their researchers for simplicity and affordability. It has partnered with the Tata-Cornell Institute for Agriculture and Nutrition (TCI) and its projects are active in Jharkhand and Odisha in India. They have provided filtered and disinfected tap water in remote areas at one third of the standard cost. In their latest project in Odisha, the systems are designed to be sustainable for the villages, costing around $1-2 per household per month. **JanaJal Water-on-wheels (WOW) water ATMs.** This is a portable, solar-powered water kiosk technology. The product itself is a mobile water ATM built on a battery-operated e-vehicle enabling last metre delivery to residential locations in both rural and urban areas. So far, however, its projects have only been operating in major cities (Delhi NCR, Mumbai and Surat). Its business model primarily relies on contributors/CSR activities but also allows individuals to rent these water ATMs and run them as their own ventures.
50.90% (2015-16) for rural		***Toilets.*** **Eram Scientific's smart toilets.** Along with having self-cleaning automatic washing mechanisms, Eram Scientific has product variants with solar technology and portability features. Its toilets need a water supply and can be attached to any septic tank. The prices of its toilets range from Rs. 2 lakh to 20 lakh and maintenance costs between Rs. 3 500 to Rs. 5 100 per month/per unit. The company specialises in making public toilets with useful features such as remote sensing, automatic washing and napkin dispensing/destroying technologies being aimed in this direction. As a result, they have been installed for public usage in some municipalities in India. However, these toilets have to be maintained regularly in order to remain operational. A lot of these public toilets are now out of operation because their annual maintenance contracts (AMC) have not been renewed.
88.13	-	
97.52 (2015-16)		***Sanitation treatment plant.*** **DRDO's Biodigester.** A biodigester is an anaerobic multi-compartment tank with inoculum (anaerobic bacteria) which digests organic material biologically. This system converts faecal waste into usable water and gases in an eco-friendly manner. It can be connected to the toilet or a series of toilets. No power supply is required and it is also cost-effective and maintenance-free. Biodigester installation is 50% cheaper than a septic tank and gives out natural methane and carbon dioxide (minimal air and water pollution) and requires 25-30% less space compared to septic tanks. Costs Rs. 30 000-50 000 per biodigester unit per household based on the location. This technology is being used as part of the Swachh Bharat Mission.

SDG TARGET	UN INDICATOR	MoSPI NIF	
6.3 By 2030, improve water quality by reducing pollution, eliminating dumping and minimising the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Proportion of domestic and industrial wastewater flows safely treated	Percentage of sewage treated before discharge into surface water bodies	
		Percentage of industries (17 categories of highly polluting industries/ grossly polluting industry/red category of industries) complying with wastewater treatment as per CPCB norms	
6.5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation, as appropriate	Degree of integrated water resources management	Percentage area of river basins brought under integrated water resources management	
	Proportion of transboundary basin area with an operational arrangement for water cooperation		
6.b Support and strengthen the participation of local communities in improving water and sanitation management	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	Percentage of developed irrigated command area brought under the Water Users Association (WUA)	
		Proportion of villages with Village Water & Sanitation Committee [VWSC]	

NIF VALUES		TECHNOLOGIES
2018	2019	
		The water technology initiative is an ongoing DST programme that aims to promote R&D activities aimed at providing safe drinking water at an affordable cost using appropriate S&T interventions evolved through indigenous efforts.
a) 87.63 (red category)		
b) 86.25 (17 category)		
c) 88.99 (GPI category		
(2017-18)		
		Groundwater Estimation and Management Software (GEMS) is a tool developed by the Central Ground Water Board that digitises groundwater level and quality data for India The **national aquifer mapping and management (NAQUIM)** programme under the groundwater management and regulation (GWMR) scheme aims to provide high-resolution aquifer maps of the country
		Agua Clara. This organisation aims at innovating solutions targeted at improving global access to affordable and safe drinking water. It facilitates the construction of a water storage, treatment and distribution system in rural areas through community labour/participation and materials/resources available locally. It also trains the local community on the operation and maintenance of these simple technologies developed by their researchers for simplicity and affordability. It has partnered with the Tata-Cornell Institute for Agriculture and Nutrition (TCI) and its projects are active in Jharkhand and Odisha in India. They have provided filtered and disinfected tap water in remote areas at one third of the standard cost. In their latest project in Odisha, the systems are designed to be sustainable for the villages, costing around $1-2 per household per month.

Appendix IV

Figure A.4. Serbian indicators

The median distance in the statistical indicators for each SDG goal with respect to the EU-27 frontier (top 10% countries).

Source: European Commission, Joint Research Centre.

V Appendix

Figure A.5. Analysis of the Serbia pilot

Example of the target-level analysis for Serbia – SDG 3.

Goal 3: Good Health and Well-being

Analysis of main challenges at the target level

	Target	Priority In Serbian SDG-related assessments and policy documents	Distance to frontier Statistical assessment of the gap in the SDG indicators with EU countries, 100 =wider gap. *Serbia is represented by the coloured bar*
3.1	By 2030, reduce the global maternal mortality ratio to less than 70 per 100,000 live births	Medium	97
3.2	By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births	High	96
3.3	By 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases and other communicable diseases	Medium	7
3.4	By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being	Medium	85
3.5	Strengthen the prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol	Medium	52
3.6	By 2020, halve the number of global deaths and injuries from road traffic accidents	-	-
3.7	By 2030, ensure universal access to sexual and reproductive health-care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programmes	High	53
3.8	Achieve universal health coverage, including financial risk protection, access to quality essential health-care services and access to safe, effective, quality and affordable essential medicines and vaccines for all	Medium	100

Source: European Commission, Joint Research Centre.

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ANNEX 1 Case studies from pilot countries

India - Ayushman Bharat PM-JAY health insurance for the Poor

Introduction

Ayushman Bharat is a federal government initiative in India that seeks to improve access to healthcare for the poorer and more vulnerable households in India. One major novel component of the programme seeks to address the issue of catastrophically high out-of-pocket expenses for a largely uninsured population that is estimated to drag 60 million people into poverty every year. The ambitious programme targeting 500 million people (107 million households) was announced by Prime Minister Modi in February 2018 and officially launched in September of the same year, making it particularly notable for the speed of its rollout. The programme is reported to have enrolled 680 000 patients in its first 100 days and over 2 million in the first 200 days.

The performance of India's health system has been a source of disappointment, especially in terms of rampant inequities (e.g. income, gender) in access to services. Emblematic of this problem is the country's 1/3 share of global maternal deaths. Although there have been a few visible successes in various initiatives such as the eradication of polio, overall, the situation has stubbornly not improved and India remains a laggard as regards SDG 3 and, until recently, the idea of universal health care (UHC) was considered a pipedream. It is beyond the scope of this brief note to provide an analysis of the historical experience of various national health missions or even a rudimentary diagnosis of the Indian health sector, which has been extensively studied both within the country and internationally. Instead, our limited objective is to recount the dramatic impact of the concerted deployment of technology and innovation to improve healthcare and avoid the impoverishment of vulnerable sections of the population in India. Equally important, STI has been a game-changer in a profound paradigm shift for government intervention and mobilising political will for UHC.

Background & context: genesis, actors, objectives (political/institutional)

Healthcare in India is a state subject, but the dismal state of the sector led to federal programmes being launched over the past decade, such as the national rural health mission (2005) and the national urban health mission (2014). Both of these supply-side interventions sought to expand public health facilities. The Rashtriya Swasthya Bima Yojana (RSBY) was initiated in 2008 as a rare demand-side intervention to provide health insurance for the population below the poverty line. The track record of these has been uneven at best, although the RSBY did catalyse similar public insurance schemes at state level.

The consolidating consensus around healthcare as a development priority in India and its increasing political salience prompted the government to announce the Ayushman Bharat (AB) in the national budget in February 2018, with the Prime Minister himself soon visibly becoming its champion. Indeed, the timing, a year before the next national elections, was a source of scepticism for some observers who considered it just another electoral gimmick. That was, however, soon belied by the attention given, speed of critical decisions, appointment of a dynamic CEO and resources provided.

AB actually has two pillars; one on the supply side is an investment programme for the central Ministry to set up 150 000 health and wellness centres. Our focus is on the second pillar, PM-JAY, a demand-side intervention to provide insurance coverage up to Rs. 500 000 (approx. $7 000) per year to each of the 107 million eligible households in the country.

The programme is funded entirely from tax revenues, which is partly justified by the government's commitment to substantially raise the low level of public spending on health in India (around 1% of

the GDP). Fiscal, economic and administrative considerations prevented universal coverage at this juncture and the benefit is targeted at 40% of the population that is the poorest and most vulnerable – according to the last Socio-economic Caste Census conducted in 2011, which has the widest acceptance as a basis for determining key parameters for such assessments and benefit transfers.

While AB-PMJAY is a federal programme and combines many of the federal programmes before it, healthcare in India remains a state subject; implementation responsibility therefore lies with state governments, which were also free to supplement their existing schemes, if any, with it or fold them into PMJAY. Moreover, states can choose whether to implement the programme through a public trust fund, private insurance companies or a mixed model. Financing is arranged as a 60:40 split between central and state governments, except for the Himalayan and North-eastern states where the federal share is 90%.

A National Health Agency was established to manage the programme and was upgraded to a National Health Authority with an inter-ministerial governing board chaired by the Union Health Minister. The Chief Executive Officer has the rank of Secretary to the Government of India and has full executive and spending authority required for the execution of NHA's responsibilities, which include policy decisions, clinical guidelines, benefit packages, operational norms and standards, managing the IT platform, hospital enrolment and claim management.

Lastly, the vast scale of the programme and large share of private sector supplies in the field of healthcare made it necessary to extensively consult with a variety of stakeholders, such as private insurances and hospitals, in order to assess the feasibility of the programme and develop key parameters. Such consultations also functioned to promote the programme among these stakeholders. Not surprisingly, price caps or reimbursable costs that would be accepted generated the most spirited debates, and the controversy lingers even as the programme appears to have been largely accepted and a large number of private hospitals have been accredited.

STI as a critical enabler

As indicated earlier, it is beyond the scope of this note to provide a comprehensive analysis of the overall scheme or the key decisions alluded to above. We confine ourselves to discussing how the unique features that made the AB-PMJAY programme technically feasible, economically viable and operationally workable are critically dependent on the effective deployment of science, technology and innovation.

Firstly, the system needed to be able to identify individuals and authenticate their eligibility. Secondly, the system needed to be able to be able to add and monitor service providers in a decentralised environment. Thirdly, admission, treatment, claims and financial settlements needed to be processed and tracked again in a vast geographically dispersed context. Fourthly, the system needed a dashboard – indeed several at different levels – to pull together relevant information for tracking progress and taking corrective actions as well as shared learning across states and stakeholders to maintain momentum. Fifthly is the importance of eliminating fraud and abuse and, consequently, also monitoring trends related to moral hazard and adverse selection that may need corrective action.

A beneficiary identification system (BIS) developed by the National Informatics Centre, which had previous experience with the RSBY programme, addressed the first issue aided by the Aadhaar identification system, as well as the inclusion of the SECC database.

In order to meet the second and third requirements, the existing systems in 5 states were evaluated for their possible use for AB-PMJAY through in-depth testing of the various systems for compatibility with the requirements of Ayushman Bharat; the Telangana state system was ultimately chosen as the most suitable to build upon further. It is the foundation for modules of the hospital empanelment system, which allows

for healthcare providers to be added to the system and monitored for quality, and the hospital transaction management system, which allows for the tracking of treatment, claims and payment for each patient. Together, these sub-systems form the core of the AB-PMJAY system. One key feature is their inter-state nature, which allows beneficiaries to use the system anywhere in the country (i.e. not just in their home provinces) yet ensuring that annual benefit limits are not exceeded. Such a provision of service across state lines is highly relevant for less affluent workers migrating across India, e.g. for construction jobs that have provided a livelihood to the largest number of entrants to the labour force. The hospital empanelment system ensures the consistency and transparency of processes for the licensing of healthcare services across state lines and is likely to be a key element in maintaining the quality of care.

A PMJAY dashboard was created to address the fourth requirement and uses the existing application programming interfaces (APIs) of the other systems to create a 'big picture'. Even though this module may not be strictly essential to run the insurance programme, its ability to show demand for healthcare services, across rural regions and for migrant workers in particular, is a highly important component for the secondary prong of Ayushman Bharat, as the supply of new public and private healthcare centres will be strongly based on the information it aggregates and presents.

Lastly, another 10 modules have been created or are in the process of being created in order to give wide ranging access to information to citizens (e.g. mobile app, citizen portal, call centre), facilitate operations (e.g. AB-PMJAY portal, grievance management system) and avoid fraud (e.g. data privacy checkpoints, anti-fraud measures, social media monitoring). Some observers believe that PMJAY can unleash a data revolution in the Indian heath sector and more generally promote evidence-based policy in the country. In addition to data analytics to minimise fraud and waste, the information collected can be useful to improve quality of care particularly by detecting inappropriate use as well as positively by identifying local anomalies or geographical specificities. Of course, real-time monitoring would be invaluable for epidemiological purposes, especially in developing countries such as India.

Technological and other challenges going forward

While the above systems have served to run and scale the scheme for almost a year, the overall scheme has reached a certain level of acceptance, is leaving its proof-of-concept stage and moving towards a future as a mainstay of the Indian health system. Consequently, the government is looking towards increasing the robustness of the system, allowing for more scalability (potentially up to billions to cover the entire population), and the possibility of innovation with existing or emerging technologies, such as A.I.

At this stage, however, the rapid rollout of the system is starting to catch up with its ambitions. Since none of the current core systems were originally designed specifically for their use in AB-PMJA and are largely licensed from vendors hired by the state governments, improving on the current system could present a major challenge. In particular, the increasing need for interfacing of the various modules and design of overarching functionalities could compromise robustness and data protection, ultimately limiting innovation. Beyond that, the licensing agreements and ownership of intellectual property are limiting the long-term sustainability of the system.

In light of these issues, a full redesign and rebuild of the system from scratch will likely be considered. While this would present a major undertaking, it will indubitably benefit from the existing political momentum behind AB-PMJAY, while being able to benefit from the lessons of the first system on a technological level. The existing interfaces would continue working throughout such a change, making it possible to replace one module at a time with ones that would be both inter-operable with the old system, and designed to have greater functionality with the new one.

Even though a scheme of the size and ambition of AB-PMJAY is bound to run into many challenges, the initial design and the government's flexibility in adapting to the challenges so far has led the programme to being more successful than widely expected by early observers, while still picking up momentum. The Indian parliament has already approved the required allocations for Ayushman Bharat in the latest budget (64 billion rupees (approx. USB 900 million for 2019-2020), and the government has reiterated its goal of spending 2.5% of the GDP on healthcare by 2025. The government has also proposed the national digital health blueprint, a roadmap to create a digital ecosystem to support and extend quality healthcare to all Indians.

Conclusion

While healthcare and health insurance considerations, as well as programmes to address them exist in most countries, the case of India is unique for its scale and ambition. Having started with very low government spending on healthcare of only 0.93% of GDP, vast out of pocket costs for its citizens and a medium score on the healthcare-related SDG 3 (of 58), the government's commitment to a fully tax-funded insurance scheme for 107 million families presented a dramatic ambition. Nonetheless, rapidly deployment of its resources combined with technological prowess and organisational effectiveness allowed the programme to be rolled out speedily. While many challenges still remain, its use of technology and organisational innovation has been notable in overcoming many of the hurdles that were once considered insurmountable.

Kenya - M-Pesa

Introduction

M-PESA is a mobile money service that was officially launched in March 2007 by Safaricom, the leading mobile phone operator in Kenya and an affiliate of UK telecom giant, Vodafone. Customers do not need to have a bank account and can transact at any nationwide agent outlet without fees.

M-PESA was initially developed by Vodafone, and the six-month pilot phase of the project in 2005 was partly funded by the UK DFID, with the aim of allowing customers of a micro-finance institution (Faulu) to repay small business loans using their smartphones; generally, by a few dollars a week. However, Safaricom representatives noted that the M-PESA was being put to other uses, including the payment for trading between businesses, purchasing airtime for relations in rural areas and depositing cash to be withdrawn at some other destination. After the pilot phase, Safaricom redesigned the M-PESA services, expanded the agent network and began a massive and culturally compelling 'send money home' marketing campaign. Within one month of M-PESA's official launch, over 20 000 customers registered with the service. In July 2007, around 268 000 people subscribed to M-PESA. One year later, subscription increased by about 30 times to around 7 388 000.

The product's success was phenomenal– between July 2016 and July 2017, the number of transactions processed over M-PESA was around 1.7 billion and 3.6 trillion Kenyan shillings processed over M-PESA. There are around 120 000 M-PESA agents across Kenya, where people can exchange cash for virtual currency and vice versa. Beyond its role as a money transfer tool, M-PESA now offers services to purchase airtime, withdraw cash from an ATM, pay bills online, make purchases at partner outlets, transfer money internationally (through partners such as Western Union) and make charity contributions or raise funds.

More recently, new products based on M-PESA – such as M-Shwari – allow users to open interest-earning bank deposit accounts and access microcredit loans electronically. Thus, M-PESA functions not only as a steppingstone but also as a direct instrument to promote bank account adoption and increase credit access, which contributes significantly to Kenya's financial inclusion progress. As a result, the overall access to formal financial services and products improved up to

82.9% in 2019, from 26.7% in 2006 (see Figure 1 below). According to Suri and Jack's (2010) analysis based on survey data, the implementation of this financial inclusion project is estimated to have lifted as many as 194 000 households – 2% of the Kenyan population – out of poverty (SDG 1) and has been effective in improving the economic lives of poor women and of members of female-headed households (SDG 5).

The impacts appear to be driven by changes in financial behaviour – in particular, increased financial resilience and saving – and labour market outcomes, such as occupational choice, especially for women who moved out of agriculture and into business. Mobile money has therefore increased the efficiency of the allocation of consumption over time, while allowing a more efficient allocation of labour and higher-risk but higher return income-earning strategies, resulting in a meaningful reduction of poverty in Kenya. There is also growing evidence that mobile money impacts the majority of SDGs as a critical enabler.

M-PESA has an iconic status in the international community which has actively promoted its virtues to countries around the world. More recently, criticism has also emerged – such as its role in driving Kenya's over-indebtedness. Due to the simplicity of accessing funds via M-PESA and the rapid development of microcredit and fintech institutions, there are more than 15 million M-Schwari accounts in a country of 50 million people. Very few checks and balances exist to restrain M-PESA clients who may wish to misuse funds received via M-PESA for purposes such as gambling (Bateman et al., 2019). Many mobile lending companies are also accused of dodging the legal interest rate well below its annualised cost of a round 100% since the services fell outside of the purview of state regulations.

What is M-PESA?

M-PESA is an electronic money transfer product Vodafone originally developed for Kenya that enables users to store value in the SIM card of their mobile phone – a mobile account, in the form of

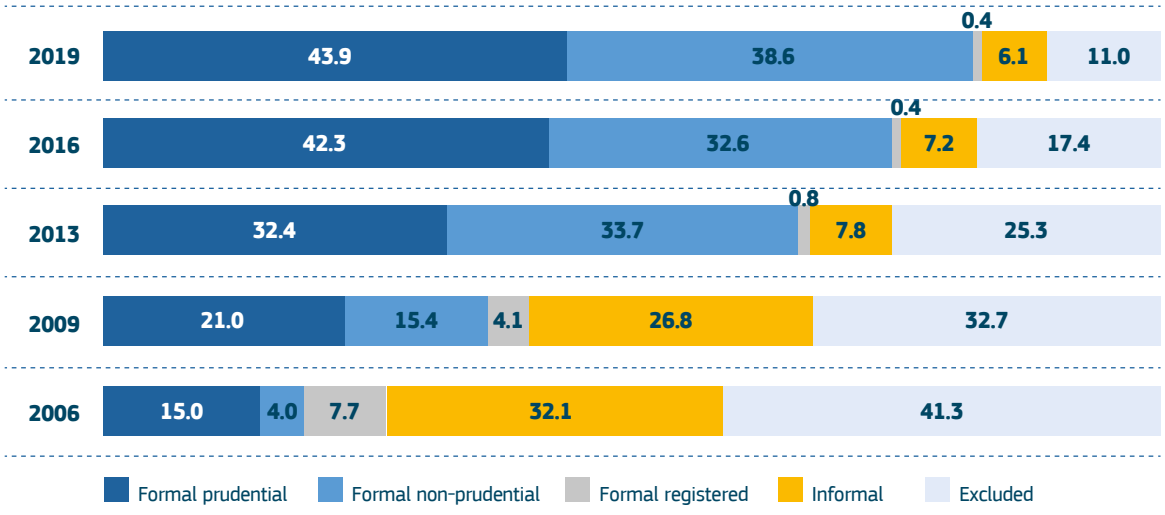

Figure AN.1: *Access by category (%)*

Source: The 2019 FinAccess Household Survey.

electronic currency that can be used for multiple purposes, including transfers to other users, payments for goods and services and conversion to and from cash. The product menu is driven by a SIM card toolkit that is standard software on all SIM cards. The consumer interface is very simple and can be used on basic mobile phones. Users use PIN-secured SMS (text messaging) to instruct M-PESA to send a balance from their account on SIM cards to the receivers. Users are charged a small fee for sending and withdrawing money using the service. M-PESA is a branchless service so customers need to deposit or withdraw money from a network of Safaricom's airtime sellers or retail outlets acting as banking agents. All monies (e-float) are held in the M-PESA money transfer trust account at the Commercial Bank of Africa, a private bank (Figure 2). Customers use their national ID or passport to verify their identity with the agent to send and receive money. In short, the SIM card is the ATM card and the agents are the ATMs in the original M-PESA model.

Based on M-PESA's success, Safaricom partnered with Equity Bank and KCB Group, which are the biggest banks in Kenya in terms of customer base and asset base, to launch M-KESHO and KCB M-PESA. These products allow customers to deposit, withdraw or transfer money from their existing bank accounts. In partnership with the Commercial Bank of Africa, Safaricom also launched M-Shwari, which allows customers to save and borrow money through their mobile phone while at the same time earning interest on the money saved. The M-PESA agent network has been open to other telecommunications companies and banks since 2014.

Who are the major stakeholders?

Safaricom & Vodafone

Safaricom is the leading mobile communications provider in Kenya and is a publicly traded company registered on the Nairobi Stock Exchange. 40% of its company share is owned by Vodafone. The Government of Kenya owns 35% and the retail in-

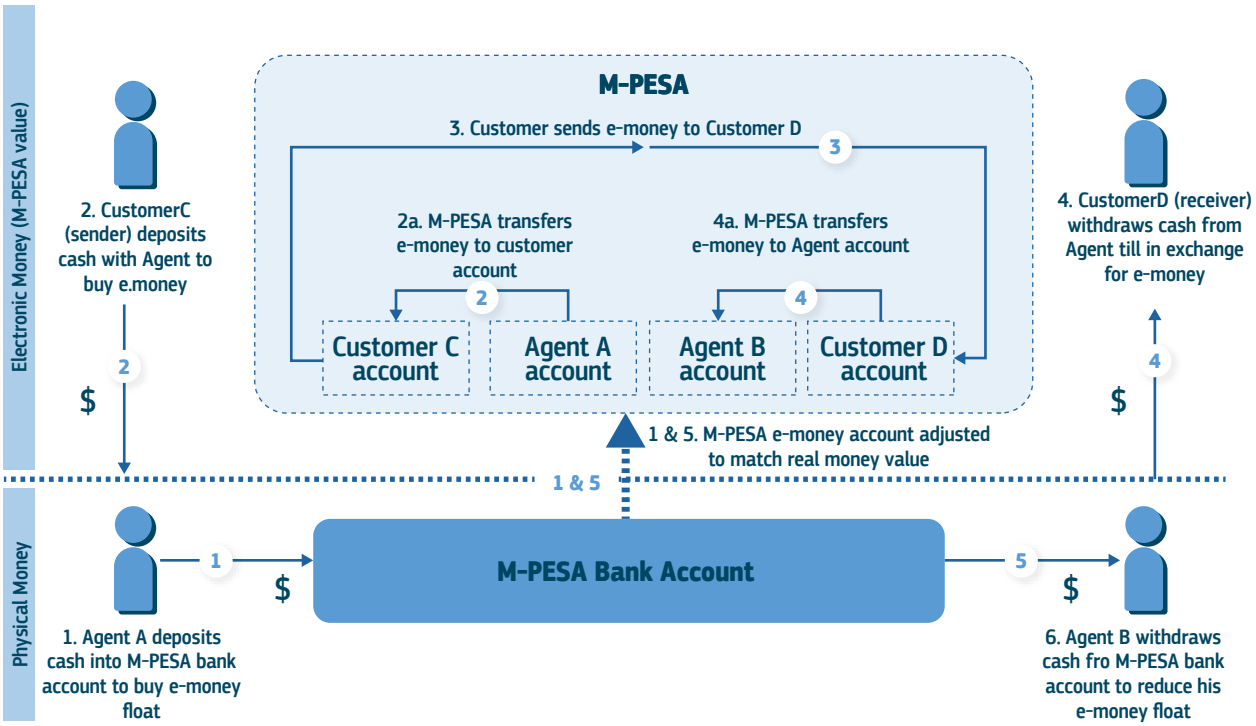

Figure AN.2: . *M-PESA service flow*

Source: http://www.nixdell.com/classes/Tech-for-the-underserved/m-pesa.pdf.

vestors own the 25% (called free float) through the Nairobi Stock Exchange. Safaricom is the operator of the M-PESA programme. To use the M-PESA service, all customers need to do is register with an authorised M-PESA agent by providing their Safaricom mobile number and their identification card.

Vodafone is a world-leading telecommunication group based in the UK. In 2003, one of its executives, Nick Hughes, agreed to use a DFID grant to pilot a mobile fund transfer service. Following the success story in Kenya, Vodafone has partnered with other operators across the world to expand M-PESA services.

Government of Kenya (the Central Bank of Kenya)

The Central Bank of Kenya (CBK) and its payments system group, in particular, let a mobile operator take the lead in providing payment services to the bulk of the population. In 2006, the CBK had been made aware of the very low levels of bank penetration in the country by the first FinAccess survey, and it was determined to explore all reasonable options for correcting the access imbalance. The CBK worked in close partnership with Vodafone and Safaricom to assess the opportunities and risks involved prior to the launch and as the system developed. They were persuaded that premature regulation might stifle innovation, so they chose to monitor closely and learn, and formalise the regulations later.

UK Department for International Development (DFID)

In 2002, researchers at Gamos and the Commonwealth Telecommunications Organisation, funded by UK DFID, documented that in Uganda, Botswana and Ghana, people were spontaneously using airtime as a proxy for money transfers. DFID introduced the researchers to Vodafone who had been discussing supporting microfinance and back-office banking with mobile phones. Furthermore, DFID funded the organisations that made the FinAccess survey possible – the Financial Sector Deepening Trust in Kenya. At that time, donor agencies such as DFID were seeking innovative ways to deliver funds efficiently to those who need it most, so that the capital is productively deployed. DFID believed that if the amount of money necessary for a programme's initial investment could be sufficiently reduced, poverty alleviation might become a profitable endeavour that would unleash the creative energies and logistical resources of some of the UK's largest companies, such as Vodafone. Thus, DFID granted Vodafone almost £1 m from its Financial Deepening Challenge Fund on a matched basis (50% of the total costs) that helped Vodafone put together a pilot in partnership with the Commercial Bank of Africa (CBA) (providing local banking services and interface to the regulatory system) and the local microfinance company, Faula Kenya (providing local expertise).

Key lessons learned from policy-making and implementation

According to literature, M-PESA's success was attributed to a number of characteristics of Kenya's population and culture that generated a unique demand for remittance services such as great disparity but strong ties between rural and urban households; very limited local remittance services; a young but highly literate population; and a high mobile phone penetration rate. Traditionally, in Kenya many people spend a significant amount of time working in the urban areas away from home and this rural to urban migration creates high demand for domestic remittance services. Prior to the M-PESA launch, there were limited options, including commercial banks, post offices, forex bureaus, bus companies and friends and family. Almost all of these options entailed high security and reliability risks.

In addition, almost 83% of the population who are fifteen years or older have access to a mobile phone in Kenya, which was a critical pre-condition for launching the mobile money programme.

International partnership

International donor engagement played an active role in initiating the M-PESA programme. The original research indicating the potential of

mobile payments in African countries was funded by the UK's DFID. In 2003, it approached a Vodafone executive and proposed funding a small innovation project that was not typical of Vodafone's own R&D portfolio. In 2000, UK DFID had established the Financial Deepening Challenge Fund (FDCF), making £15 m available for joint investments with the private sector on projects that help improve access to financial services, which was one of the Millennium Development Goals (MDGs).

Alternative pathways

Vodafone developed an innovative product using existing technology to tackle the financial inclusion challenge in a new market with big potential. Considering the ease of usage and wide coverage, Vodafone chose to build the consumer interface on a basic model mobile phone and took SMS (text-messaging) as the main channel for sending and receiving money. The menu-driven access backed by a SIM toolkit available on all mobile phones paved consumers and agents the easiest road to learn and use M-PESA. Internet and smartphone penetration were still low at that time.

Institutional arrangements

Kenya's regulators enabled the mobile money take-off through a cross-sector collaborative approach. Safaricom, as a telecommunication company, was an entity licensed by the Kenya telecommunication regulator, the Communications Commission of Kenya (CCK). However, according to the Central Bank of Kenya Act, the proposed M-PESA service from Safaricom is a kind of banking service that could only be provided by a licensed bank, so the Central Bank of Kenya had the mandate to regulate Safaricom's payment system. This unusual situation required the CBK and the CCK to collaborate to ensure their respective roles and responsibilities were clearly defined when dealing with a mobile money provider, and to avoid unnecessary overlap or arbitrage.

Develop vision, goals and/or targets

The Central Bank of Kenya (CBK), in particular, played a very progressive role and allowed 'regulation to follow innovation'. In Feb 2007, incentivised by the low financial inclusion rate revealed by the 2006 FinAccess survey, the CBK issued Safaricom a letter of no objection authorising it to launch M-PESA under the supervision of the CBK pending a complete regulatory framework. The non-objection letter acted as a special license that provided a form of certification, legitimating M-PESA in the policy sphere. The CBK had to make sure that Safaricom would not be intermediating M-PESA customer funds. The letter requested that all customer funds had to be deposited in a regulated financial institution with interest on deposits going to a not-for-profit trust and the e-float (e-money) could not be invested. As a result, the money in the trust fund was safe from claims by creditors in the event of solvency. In addition, there were limits put on transaction sizes in order to deal with money-laundering concerns.

The Government of Kenya continued to support M-PESA by validating existing business models through the passage of new regulations. In December 2009, more stringent regulations were imposed with the passage of the Proceeds of Crime & Anti-Money Laundering Act (AML Act), which explicitly criminalised money laundering, provided enforcement measures to GOK and imposed severe penalties on money launderers. In 2011, in consultation with stakeholders including Safaricom, the CBK issued its Electronic Payment Guidelines of 2011 and Retail Electronic Transfer Guidelines of 2011. In December 2011, the National Payment System Act (NPSA) was enacted, bringing all payment services providers – including mobile payment providers such as Safaricom – into one regulatory framework. The NPSA provides CBK with the right to directly oversee the providers to ensure their efficiency and safety.

In 2014, the Cabinet Secretary for the National Treasury issued a legal notice officially giving life to the National Payment System Regulations of 2014. The NPS Regulations permit both banks and non-banks, including mobile operators, to provide mobile money services. The regulations also provide a stronger compliance and risk mitigation

regime and help to drive competition and collaboration within Kenya's payment market, as well as addressing some 'second generation' issues that have emerged as the mobile money has matured. For example, the anti-money laundering regulatory framework for mobile money services was finalised and enacted. Better consumer protection was detailed – service providers needed to have disclosure mechanisms, open channels for consumer redress and clear terms and conditions for the service – and must maintain the privacy and confidentiality of customer data.

International replication experience of M-PESA

In order to replicate M-PESA's success in Kenya, many developing countries around the world partnered with development organisations and private companies to launch similar mobile money products. But the results varied: some countries' mobile money developments flourished, while in other countries mobile money failed to gain any traction for several years. For example, until a few years ago, mobile money transfer was stalled in India due to a rigid regulatory environment whereby only regulated banks could collect deposits and transfer money.

On the other hand, despite a slow start between 2008 and 2012, mobile money has grown fast in Tanzania, where a conducive regulatory environment played the critical role in the greatest mobile money success story in recent years. Unlike Kenya, Tanzania has no dominant mobile network operator like Safaricom and within the competitive market, no company holds more than a 30% market share. Tanzania's financial system was far less developed than that of Kenya, with less than half as many bank branches per 1 000 citizens. Moreover, Tanzania is a large country with a dispersed population, so reaching dealers in rural areas quickly was difficult. Even with the rapid growth rate of mobile phone penetration, the mobile phone subscribers' percentage was relatively low when mobile money launched (around 25%). While these factors caused the initial slow uptake, the impetus for its turnaround can be traced back to the policy changes beginning in 2011-12.

Following Kenya's example, the Government of Tanzania adopted a 'Test and Learn' approach and let regulation follow innovation. Lacking relevant regulations, Tanzania's central bank issued no objection letters that permitted Vodacom and Zantel to offer mobile money (M-PESA and Z-PESA) without being subjected to the know your consumers (KYC) and anti-money laundering (AML) rules that made it impossible for them to reach poorer rural citizens, as well as requiring no official partnership with a bank. In 2011, laws on agent banking were also relaxed, significantly reducing the KYC-AML requirements and moving responsibility for ensuring agents were complying with existing laws from mobile networks to their sponsor banks. In addition, the Central Bank and Tanzania Communications Regulatory Authority cooperated in overseeing the mobile financial service (MFS) regulatory framework. This resulted in an exponential increase of MFS access – from less than 1% of the adult population having access in 2008 to 90% having access by 2013.

Another prominent success story in recent years is that of Uganda, which also took a 'light touch' on mobile money regulations and successfully achieved rapid growth. Between 2011 and 2013, the Bank of Uganda (BoU) and the Ugandan Communications Committee released a series of guidelines modelled on the enabling policies in Kenya and Tanzania. These guidelines allowed multiple e-money issuers to enter the market, offering basic payment and financial services, and allowed banks to partner with mobile network operators (MNO) under significantly simplified KYC-AML laws. The BoU has authorised mobile money services by issuing no objection letters to the commercial banks who partner with the MNOs and requires the bank to hold the balances recorded in the mobile wallet in an escrow account. Under the condition of the 'light touch' regulation, the number of mobile money subscribers in Uganda rose from 2.9 million in 2011 to 22 million by 2018, compared to around 5 million registered accounts in traditional banks. The five largest MNOs in Uganda have partnered with commercial banks and now offer mobile banking accounts. These enabling policies

have resulted in an unprecedented rise in financial inclusion in Uganda.

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Classification	Definition	Institution type	FinAccess survey cycles				
			2006	2009	2013	2016	2019
Formal (prudential)	Financial services and products used through prudentially regulated and suervised financial service providers by and indipendent statutory Government Agency including CBK, CMA, IRA, RBA and SASRA	Commercial banks including mobile phone bank products offered by banks in partnership with MNOs such as KCB M-PESA, MCo-op Cash, M-Shwari, Eazzy loan, Timiza and HF Whizz	✓	✓	✓	✓	✓
		Microfinance banks including mobile banking products offered by microfinance banks			✓	✓	✓
		Insurance service providers	✓	✓	✓	✓	✓
		Deposit Taking SACCOs			✓	✓	✓
		Capital markness intermediares			✓	✓	✓
Formal (non-prudential)	Financial services and products offered through service providers that are subject to non-prudential regulation and supervision (oversight) by Government Ministries/Departments with focused legislations	Mobile money		✓	✓	✓	✓
		Postbank	✓	✓	✓	✓	✓
		NSSF	✓	✓	✓	✓	✓
		NHIF		✓	✓	✓	✓
Formal (registered)	Financial services and products offered through providers that are leggally registered legal persons and/or operate through direct Government interventions	Credit only microfinance institutions (MFIs)	✓	✓	✓	✓	✓
		Non-deposit taking SACCOs	✓	✓	✓	✓	✓
		Hire purchase companies	✓	✓	✓	✓	✓
		Development financial institutions (DFIs) e.g. AFC, HELB, ICDC & JLB	✓	✓	✓	✓	✓
		Mobile Money Apps/Digital Apps				✓	✓
Informal	Financial services offered through different forms subject to regulation, but have a relatively well-defined organizational structure	Groups e.g. ASCAs, chamas & ROSCAs	✓	✓	✓	✓	✓
		Shopkeepers/supply chain credit	✓	✓	✓	✓	✓
		Employers	✓	✓	✓	✓	✓
		Moneylenders/shylocks	✓	✓	✓	✓	✓
Excluded	Individuals who reported using financial services and products only through family, friends, neighbours or keep moneu in secret places or not using anu form of financial service	Social networks and individual arrangements (e.g. secret hiding place)	✓	✓	✓	✓	✓

Figure AN.3: *Classification of the access to finance*

Serbia – Innovation Fund

Introduction. Critical issues to be addressed

About ten years ago, the industrial capacity of the Republic of Serbia was severely weakened by the Yugoslav Wars throughout the 1990s and further diminished by the lingering effects of the financial crisis. Although Serbia's R&D spending was higher than other Balkan nation-states (but well below the European Union (EU) average) in 2012, it was dominated by basic research conducted by public institutions, which received funding without going through much of a competitive process[18]. Those publicly funded R&D activities by the research institutions were mostly delinked from industry needs, generating little to no economic value[19]. At the same time, the national innovation system and composition of R&D funding did not support enterprise innovation at any significant level, and the research sector modernisation agenda was still in its infancy.[20]

To reorient public research towards the needs of the private sector in order to increase Serbia's industrial competitiveness, the Government of Serbia (GoS), supported by the EU and the World Bank (WB), has been working on renewing its policies and implementing relevant policy measures since 2011. The GoS's Ministry of Education, Science and Technological Development (MoESTD), with support from the two multilateral donors, has been undertaking structural reforms to improve the innovation ecosystem by 1) building up a key institution called the Serbia Innovation Fund (IF), which is an independent national agency under the MoESTD with the mandate to finance enterprise innovation and 2) formulating new policies and regulations. While much work remains, Serbia's efforts in pursuing – primarily SDG 9 industry, innovation and infrastructure (and simultaneously other goals that are especially relevant to environmental and social management issues[21]) – illustrate a number of useful insights in terms of STI for SDG roadmap exercises.

18 *MoESTD conducted its last call for proposals in 2010. Although it was a competitive call with independent international evaluators, the success rate was almost 90%, and the awarded researchers continued to receive annual payments for these projects for nearly a decade, until a pilot call for grants opened in June 2019. See Tatalovic, M., 'Serbia passes controversial science reforms to modernise research',* Chemistry World, *13 July 2019 (**https://www.chemistryworld.com/news/serbia-passes-controversial-science-reforms-to-modernise-research-/3010733.article**) and Dauenhauer, N. J, & Tatalovic, M., 'Serbia is rethinking science – but the reforms could cost hundreds of jobs',* Nature online, *11 January 2019 (**https://www.nature.com/articles/d41586-018-07872-2**).*

19 *At the time, around 0.9% of the GDP was invested in R&D, well below the EU average of 2.03%. R&D spending by the public sector was almost double that of the business sector. Science infrastructure improvement had been the main focus up to that point, while the stimulation of private-sector-led R&D and innovation had been negligible. R&D institutes were the primary recipients of financing (80% of funds intended for science projects continue to be spent on researcher salaries), with private firms receiving funding only under the technological development component. Few mechanisms were implemented to incentivise private-sector R&D and innovation. Output from the R&D sector was not commensurate with the public resources being invested and did not support modernisation of the Serbian economy.*

20 *Bank financing was available for SMEs but not for startups with higher risks. No private seed financing or venture capital was available not only in Serbia but also in the Western Balkan region. MoESTD had a grant programme with an annual budget of €1 million available to support individuals (not companies) in pursuing their scientific discoveries with a disbursement of €1-2 000 per person, which was insufficient to effectively incubate startups. There was one incubator at Belgrade University with some companies, but no funding was available; other than that, there was a minor bilateral donor activity by the Swiss.*

21 *The IF financial instruments have generally emphasised merit and commercialisation potential and do not specify particular technologies or sectors/issues, but they have been effective in producing products and services that tackle a wide range of social, economic and environmental issues, such as renewable energy, education and waste management. In particular, the most recent EU fund (IPA 2014 Direct Award) for the GoS requires that all implemented projects be environmentally and socially sound and sustainable. See: **http://www.inovacionifond.rs/cms/files/medunarodni-projekti/20190315-IPA-2014-MiniMatching-ES-MF-ENG-draft.pdf**.*

Institutional setup of the Serbian Innovation Fund

The establishment of the IF by strong political leadership

Serbia's journey to focussing more on applied and industry-focused research was spearheaded by a Minister for Science and Technological Development appointed in 2008[22]. He also happened to hold the position as Serbia's Deputy Prime Minister for EU integration. Unlike most of the previous science ministers, who were scientists themselves and therefore interested in promoting basic research[23], this Minister had a strong business and finance background and had served as Minister for Finance and Economy a few years back and vigorously pursued linkages between science and innovation and Serbia's social economic needs to make firms competitive. Luckily, there was no political opposition to this idea at the time; therefore, his ministry was able to develop and formulate a science strategy, which led to the modification of two governing laws: the Law on Scientific Research Activity and the Law on Innovation Activity, which operationalised the IF[24]. Meanwhile, the Minister secured investment loans for science from the European Investment Bank and the Council of Europe Development Bank, as well as a grant for the IF from the EU Instrument for Pre-Accession Assistance (IPA). This sequence of establishing a strategy, amending laws and securing funds for the activities was done quickly within the three years that the Minister was in power.

Independent governmental agency under a ministry

The IF's success cannot be explained by this strong leadership demonstrated by a politician alone, as his other ideas and initiatives did not survive through four successors and the advent of a new administration after he stepped down. Two key elements for the IF's institutional setup seemed to be crucial: 1) keeping a level of independence from its parent ministry and 2) securing strong support from international financial institutions.

Being an independent agency[25] under MoESTD means that the IF receives its operational costs[26] as well as strategic guidance from the ministry. The operational cost is approximately €500 000-700 000 annually to cover expenses such as staff salaries, rent and electricity[27]. The ministry's strategic framework for R&D and innovation defines the IF's priorities and activities for a five-year period. Meanwhile, the IF's level of independence from MoESTD is ensured in its institutional setup. First

22 *Minister Božidar Đelić grew up in France, graduated from Harvard Kennedy School and was a partner at McKinsey & Company before he became a politician. See:* ***http://www.djelic.net/en/bio_long.html****.*

23 *One exception was Prof. Dragan Domazet, who served as Minister for Science, Technology and Development in 2001-2004; he tried to change the system to be able to respond to society's needs.*

24 *The IF was established in 2005 by the Innovation Law (2005), but it was not operational until 2011 after the Law was amended to define its form, governance and activities so that the organisation could encourage entrepreneurship and manage financing for innovation. See, for example: page 2, Aleksandar Caslav Miletic, 'Development of Innovations Infrastructure – Benchmarking the Leading Organizational Solutions with Serbia', April 2019.* ***https://www.researchgate.net/publication/332448072_DEVELOPMENT_OF_INNOVATIONS_INFRASTRUCTURE_-_BENCHMARKING_THE_LEADING_ORGANIZATIONAL_SOLUTIONS_WITH_SERBIA***

25 *When the idea of IF first emerged, Serbia had no choice but to make it semi-public as there was no other real alternative. An ecosystem and market for innovative firms did not exist in the country, as there was no private seed fund that the government could invest public money in. Legally, the GoS was unable to set up an entirely private company with the public funding. Meanwhile, establishing a special window in a Serbian commercial bank was not a feasible option at the time as the banks had no experience and expertise in investing in startups or implementing/managing financial instruments for innovative firms and startups.*

26 *A total of €3.86 m was provided by the GoS for the period between 2011 and 2015 (p. 24,* Implementation Completion and Results Report for the Innovation Serbia Project, *8 October 2016).* ***http://documents.worldbank.org/curated/en/394131476361888907/Serbia-Innovation-Serbia-Project***

27 *In 2014, the GoS failed to provide an operational budget in time and, as a result, the IF employees were without salary for three months. But in addition to the operational cost, MoESTD began to inject project budgets for grant funding, starting in 2017 with €3 m, €5 m and €6 m (ICR for the Innovation Serbia Project, p. 1 of Annex 8).*

of all, IF was deliberately mandated to co-finance innovation through cooperation with international financial institutions, organisations, donors and the private sector so that the agency would not have to depend on the government entirely and would therefore not be vulnerable to political/domestic turbulence and influence. The IF's Managing Board, which has the authority to approve or reject a list of projects to be funded, is represented by the GoS but not necessarily MoESTD.

It is important to note that the Managing Board and its government representatives do not have the power to delete individual projects from or add them to the list, which is submitted as one package by an Independent Investment Committee. In addition to ensuring the independence of the Managing Board, the IF publicises its financial decisions, monitoring and evaluation (M&E)[28] results and any other information and data needed by its clients and donors, in accordance with international standards. The transparency of these institutional decision-making processes has helped the IF build its reputation within the Serbian research and business communities and has led to the success of launching and managing the financial instruments. Furthermore, the IF is designed to be able to receive input from other ministries besides MoESTD; more specifically, the Ministry of Finance and Ministry of Construction, Transport and Infrastructure represent the government in the aforementioned Managing Board[29]. The Ministry of Finance and Ministry of Economy are involved in the strategic direction and management of the IF's financing instruments and projects as they are represented on the Supervisory Board and Steering Committee, respectively. Lastly, one of the biggest merits of being an independent agency is that the IF is able to set its wages at the level necessary to attract and secure highly eligible staff and experts. In fact, the IF staff generally gets paid approximately double the amount of Serbian public servants. In addition, with internationally competitive salaries, international talent has been recruited and hired as Investment Committee members as well as Strategic and Operational Advisors.

International partnerships and global expertise

As mentioned earlier, the GoS began its reform in the R&D sector through the establishment of the IF with the help of two international partners: the EU, which provided IPA funding, and the WB, which administered the fund; a Trust Fund Agreement was forged between them. This arrangement was the first of its kind, initiated by the aforementioned Minister, who served as chief negotiator for Serbia's accession to the EU and as chief governor of Serbia in relation to the WB Group at the time. He worked hard to set up this institutional arrangement as he was keen to draw on the WB's extensive networks and expertise in managing projects based on solid data, analysis and international good practices. It was a rather painful process in the beginning as the two international organisations were unfamiliar with the policies and procedures of their counterparts, resulting in some delays during project preparation. It took the highest political effort to resolve an administrative issue[30], but once they became comfortable with each other as partners, implementation began to progress smoothly[31].

28 *An internal M&E system was designed and built to constantly monitor and report on 50 indicators from all projects and programmes (i.e. # of people hired in the beneficiary companies, revenues generated by the companies). Meanwhile, two series of independent financial instrument evaluations were conducted for two financial instruments. The results are reflected in the IF programmes and operations, i.e. resulting changes in the % of match (as other financial options emerged), % of grant required to be allocated to researchers in CGS projects.*

29 *IF Managing Board members are listed on the IF website.*

http://www.inovacionifond.rs/fond/our-organization/managing-and-supervisory-board

30 *There was a heated argument over whose procurement procedure to use. In the end, it required the highest political efforts of the EU Commissioner, Bank Vice President and Deputy Prime Minister to resolve this administrative issue, to use the Bank procedure.*

31 *Since then, the WB and the European Commission have signed a Trust Fund and co-financing framework agreement, dealing essentially with the operational aspects of the cooperation between both organizations.* ***https://ec.europa.eu/europeaid/funding/procedures-beneficiary-countries-and-partners/fafa-world-bank_en***

Once on board, the WB brought global brains to the IF. Most importantly, the Bank was able to convince a prominent international figure in the innovation sphere to serve as IF's Strategic Advisor. He had vast experience and knowledge – including as Chief Scientist of Israel's Ministry of Industry and Trade in the 1990s, managing over $1.5 billion in grant programmes to promote R&D activities in the Israeli high-tech industry, which began to grow during his term in office. The Strategic Advisor was deeply committed and devoted to his responsibilities; in fact, he was in the country for a week at least four times a year. He was in charge of designing and implementing grant instruments, and much of the IF's programme design was modelled on Israeli programmes and adapted to the needs of the Serbian market.

Another prominent international expert brought into the IF was an Operational Advisor, who dealt with issues related to human resources and operational infrastructure (including ICT and financial management). With rich international connections provided by the WB staff and the advisors, the IF built its system for staff training, including one or two weeks in the leading countries of innovation, such as Israel, Finland and the USA, where they had hands-on training in managing funds. Through this training abroad, the IF staff could learn in detail how relevant documents and contracts are formulated and stored, how IT systems are set up to help manage calls for proposals, and how they conduct daily operations in running projects. A high-spec IT system was built using the almost €1 million allocated for capacity building[32], including an online portal for applications to be accessible by reviewers, who can log in from anywhere in the world. The Independent Investment Committee, consisting of five international experts, including two diaspora members, were selected through an international competitive open solicitation process, and the majority of them had finance/investment backgrounds. Additionally, with help from international experts, the IF built its internal M&E and training system for startups as well as the capacity to hold networking and educational events for enterprises and researchers to interact with one another. The IF capacity building went well, as by the end of 2015, ten IF managers had gone through training and were applying the acquired skills; 51 startups had benefitted from monitoring; and 22 networking events had been held to promote public-private partnerships.

A series of financial instruments to support innovative firms

While institutional capacity was being built, the IF launched five programmes[33] to support innovative firms under the guidance of the Strategic Advisor. The sequences of the following financial instruments were planned and executed with careful consideration: the first grant programme (a mini grant) is designed to help innovators in the incubation stage to develop prototypes; the second grant programme (a matching grant) supports enterprises in the next stage to manufacture and market products; then the IF established a special unit called a tech transfer facility (TTF) to stimulate and coordinate technology transfer from public R&D institutions to the private sector with small grant and advisory services; two newer grant programmes (collaborative grant scheme and innovation voucher) promote business-academia partnerships with different award levels. Having learned from international practice how to weed out 'serial grant writers', these grant programmes require entrepreneurs to provide a match in cash.

32 *See the figure for 'Grant Financing for Component 1 (Capacity-building)' in the second table for 'Final Project Cost', p. 25 of the* Implementation Completion and Result Report of Innovation Serbia Project. *The figure for 'Government Financing' is the IF operational cost.* ***http://documents.worldbank.org/curated/en/394131476361888907/pdf/P126229-Serbia-Innovation-Project-ICR-4-Portal-10-0-P126229-2016-10-08-11-25-10112016.pdf***

33 *Most recently, in September 2019, the IF launched its 6th programme as a new service line of the Technology Transfer Facility: proof of concept. The programme is designed for researchers who require support to prove that there is a new product emerging from the research and for which there is a need in the market. It offers financial and mentoring support to existing research efforts to establish the proof of concept of an idea generated during the course of previous R&D efforts.*

The levels of IF co-financing in these programmes were determined by the World Bank's analysis, drawing from lessons learned in other countries, e.g. in Israel. Generally, the matching contribution level of the beneficiary firms goes up as they get closer to the market. Meanwhile, as the Serbian innovation ecosystem has gradually developed with new investment options through private banks/ funds becoming available, the matching levels required for IF-funded enterprises have become higher. Details and characteristics of those financial instruments are summarised below.

All financial instruments are designed to tackle different stages of technologies to be brought to the market.

Support for innovative enterprises

MINI GRANT	
Issues to be solved	There was a lack of seed funding to support startups with ideas to develop a prototype
Objective and stage	Proof of concept, prototyping stage (except in high-tech areas like nanotech), IP protection, business plan preparation for mobilisation of initial capital
Recipient	Incorporated entrepreneurs, innovative startups, spin-offs, micro and SMEs, existing for no longer than three years at the time of application
Grant size	Up to €80 k for projects to be completed within 12 months
IF co-financing	Up to 85%
Calls for proposals	7 calls: 2012 (twice), 2013 (twice), 2017, 2018 and 2019 (twice)
# of projects supported	41 (out of 341 applications) in 2016 + 20 (out of 137) in 2017 + 13 (out of 143) in 2018

MATCHING GRANTS	
Issue to be solved	Support mechanisms did not exist for the next stage of startups, which already had prototypes but lacked money to manufacture or market products
Objective and stage	R&D (technology development) and commercialization projects for new or improved technologies, products and processes
Recipient	Incorporated entrepreneurs, innovative startups, spin-offs, micro, small and medium enterprises
Grant size	Up to €300 k for projects to be completed within 24 months
IF co-financing	Up to 70% (company contribution is higher because prototype has been already tested and expectations are higher (the IF receives 20% of sales revenue within the 2 years)
Calls for proposals	6 calls: 2012, 2013 (twice), 2017, 2018, and 2019
# of projects supported	11 (out of 119 applications) in 2016 + 5 (out of 100) in 2017 + 9 (out of 75) in 2018

Support for public research organisations to commercialise their research

TECHNOLOGY TRANSFER FACILITY	
Issue to be solved	Serbian research institutions and faculties lacked technology transfer capacity; there was a need to centralise knowledge, expertise and resources in one place to be accessible for researchers who could benefit from receiving help in commercialising their research
Objective and stage	Eliciting invention disclosures from researchers, evaluations (of technologies, markets, teams), last-mile R&D grants (e.g. patent attorneys, prototyping, external expertise, testing), commercialisation support, legal support and contract negotiations
Recipient	Public academic R&D organisations; other accredited R&D organisations, including private ones
Grant size	Up to €50 k for projects to be completed within 6 months (if commercial partner co-finances, then within 12 months)
IF co-financing	Up to 100% (below €20 k), or up to 70% in cases of commercial partnership (for above €20 k)
Calls for proposals	Throughout the year
# of projects supported	19 (out of 28 applications)
Outcomes	3 tech transfer deals facilitated (and an additional 2 underway)

Support for public-private partnerships

COLLABORATIVE GRANT SCHEME (CGS)	
Issues to be solved	According to international experience, great innovations often come from research; but in Serbia, there was a big problem with connecting the research community and the private sector as existing ties were destroyed during the wars
Objective and stage	Joint R&D projects between academic R&D and SMEs aiming to create new products, services and technologies
Recipient	Consortium consisting of a lead private sector MSME (lead applicant) with at least one public scientific research organisation (co-lead applicant)
Grant size	Up to $87.2 k (€80 k) for projects to be completed within 24 months
IF co-financing	Up to 70% for micro/small enterprise; up to 60% for medium-sized enterprise
Calls for proposals	3 calls: 2016, 2018 and 2019
# of projects supported	14 (out of 96 applications) in 2016 + 9 (out of 67 applications) in 2018

Outcomes (from the 1st cycle)	12 new products have been successfully created; 5 advanced prototypes have been developed, 3 new technologies and technological processes have been confirmed and given awards for the production of high-added-value products; while 5 projects have started achieving commercial results by selling their innovations* **http://www.inovacionifond.website/news/ulaganje-u-inovacije-je-ulaganje-u-nasu-buducnost*
INNOVATION VOUCHERS	
Issues to be solved	As the number of projects receiving CGS awards is limited, there is a demand for more opportunities to help the private sector and researchers to meet and get to know each other in order to generate new ideas for collaboration
Objective and stage	Industrial partners to conclude service contracts with public research organisations to improve products, processes, skills and services
Recipient	Private micro, small and medium enterprises
Grant size	Up to €6.5 k for projects to be completed within 6 months
IF co-financing	Up to 80% (max. of 2 vouchers allowed per MSME)
Calls for proposals	4 calls: 2017, 2018, 2019 (twice)
# of projects supported	325 (out of 411 applications)
Outcomes	Over 95% of the beneficiary enterprises indicated satisfaction

Source: *Author, based on WB and IF documents*

Formulation of new research and innovation policies

Extensive and lengthy stakeholder involvement process led by the ministerial level

The reform of Serbia's R&D sector has been accelerated in recent years, especially in transitioning its research funding system to a mixture of highly competitive project-based funding and performance-based institutional funding. While the Prime Minister took on the reform as one of his priorities, the EU provided additional IPA money and the WB approved new loan projects. With the WB's technical assistance, the GoS has developed and delivered two sets of policy documents:

1. Research and innovation (R&I) strategy (2016-2020) (March 2016) with accompanying action plans (adopted in 2018), which led the GoS to pass two relevant laws;
2. Research infrastructure roadmap and corresponding action plans (adopted in December 2018).

The R&I strategy (2016-2020) called for reform in the public R&D and innovation sector while reinforcing enterprise innovation as well as technology transfer for the economy, including the kinds of support provided by the IF. The government set up a committee to receive domestic experts' input for the R&I strategy. At the same time, a series of events and roundtables were held with stakeholders to take stock and address the concerns of the research community. However, adoption of the strategy was delayed until March 2016. An accompanying action plan which spelled out the detailed programme of reforms was even more controversial and time-consuming. The original plan was to adopt the accompanying plan within a few months after the adoption of the strategy,

and the World Bank experts helped the GoS finalise the draft based on consultations with stakeholders and the government. But for better or worse, the majority of the draft action plan ended up being altered by ministry staff before it was finally adopted two years later. It took that much time because the action plan included technical details of the reform, including detailed steps on how to introduce the new financial mechanism and what would be done during the transition period so that institutions/universities and their researchers would be properly paid with minimal disruption to their life and R&D. What happened was that, to enable full-scale stakeholder involvement, MoESTD top management, including the ministerial level, ended up meeting with all members of the Academy of Sciences, faculty deans and directors of research institutes to receive their feedback and to address their concerns. The action plan was finally adopted after being updated to reflect much of the input from these one-on-one conversations with stakeholders.

Since then, two key steps have been taken to further advance the reform. The first step in operationalising the strategy was the adoption of the Science Fund Law in December 2018. This law established a new independent funding agency (called the Science Fund) for research funding. This sister organisation of the IF is crucial for Serbia to improve its research funding model for competitive and performance-based funding. Another law, called the Law on Science and Research, adopted in July 2019, established institutional funding for public R&D institutions while defining all of the actors in the national research system so that their researchers would not have to depend, as before, on whether they worked on a project or not[34]. The law also recognised open science as a fundamental principle of science and research, mandating open science for all publicly funded research programmes and projects with the intention of making public research output accessible to the private sector. This development made Serbia the first country in the Balkan region to recognise open science in a national law[35].

Reliance on the expertise of international partners for collecting data and analysis

While MoESTD and its minister spent much time and effort on adopting the R&I strategy, the accompanying action plan and the two laws, Serbia relied on the expertise of the World Bank in formulating the research infrastructure roadmap, including its action plans. Such a roadmap will be necessary in order for Serbian research communities to have access to EU structural funds, if and when Serbia becomes an EU member. The original plan was to conduct an extensive bottom-up consultation involving the entire R&D community by launching a call for proposals. However, the formulation of this set of policy documents happened to coincide with the aforementioned highly sensitive time of systematic reforms in the research sector. MoESTD decided not to alert scientists with the call and chose a relatively low-key process to adopt the roadmap. As a result, the GoS, with technical support from the WB, established a working group consisting of 15 committee members representing the research community with experience in either working on EU research infrastructure projects or managing large facilities in the country. The committee met several times, receiving two rounds of comments during the drafting period of 8 months to reflect these experts' input and data. Meanwhile, to be included in the research infrastructure roadmap, EU best practices were collected through a series of interviews with European practitioners. The interviews were conducted by the WB team, often accompanied by the ministry officials, who indicated their interest in getting involved in the process as much as possible. The draft text of the roadmap was closely shared with the MoESTD as the WB team had weekly meetings with top management, often including the ministerial level, to get comments and feedback. Serbia's research

34 *http://www.nip.rs/en/news/141-the-law-on-science-and-research-has-been-adopted*

35 *https://www.sciencefordemocracy.org/open-science-included-in-new-serbian-law/*

infrastructure roadmap, which was necessary to improve the country's readiness to join the EU, was adopted in December 2018.

These laws and policy documents have further encouraged Serbian public research institutes to shift to R&D based on excellence and relevance as well as innovation based on partnerships with the private sector.

Ongoing work

Continued STI reform and STI for SDG roadmap activities

MoESTD is currently working on operationalising the aforementioned laws through bylaws, defining, for example, the details of institutional funding and the independent assessment of public R&D institutions. At the same time, with support from the EC's Joint Research Centre, MoESTD has been leading the work on formulating Serbia's research and innovation strategy for specialisation (RIS3), which aims to increase the competitiveness of the Serbian national/regional economy in order to contribute to the economic growth and advancement of society by linking research and innovation forces and resources to a number of priority economic areas.[36] So far, Serbia has gone through an extensive bottom-up stakeholder consultation process (called EDP) by holding 17 workshops between March and May 2019, attended by approximately 900 participants and identifying four priority research areas.[37] Meanwhile, the GoS set up a governance structure involving:

- an inter-ministerial National Smart Specialisation Team,
- a joint coordination group for Smart Specialisation and industrial policy under the Prime Minister,
- a national analytics team gathering local experts for data analysis, and
- working groups of stakeholders (business, academia, local and national authorities and civil society) for each of the Smart Specialisation priority domains.

These will be the foundation of Serbia's UN STI for SDGs pilot programme[38]. In the coming months, the WB is planning to operationalise the sister organisation of the IF – called the Science Fund –while supporting the new fund's design and the implementation of programmes/activities, including competitive research grants with incentives to enhance the Smart Specialisation strategy and infrastructure support for public research institutions. The support for the new fund for research funding will be done in a similar manner as the support provided to the Serbia Innovation Fund described earlier. In other words, the new Science Fund will be one of the means to implement the RIS3 Strategy, as the new organisation focuses on funding-applied research on the four priority sectors already identified.

Conclusion

Over the years, a lot has been done in Serbia to formulate new laws, policy documents and programmes to mobilise STI for achieving SDG 9 in industrial innovation and infrastructure as well

36 *See more details on the Serbian RIS3 homepage:* ***https://pametnaspecijalizacija.mpn.gov.rs/****.*

37 *Identified research priorities are: 1. ICT (custom software development, software solutions development); 2. machines and production processes of the future (machines for specific purposes, information in smart management service - Industry 4.0, smart components and tools, combustion devices for eco-friendly and sustainable fuels); 3. food for the future (high-tech agriculture, value-added food products, sustainable food chain); 4. creative industries (creative audio-visual production, video games and interactive content, smart packaging).*

38 *Serbia's pilot is to link its SDG process, STI policy reform and development of the EU-supported Smart Specialisation Strategy (RIS3), which is based on national or regional priorities that aim to build comparative strengths by linking research and innovation forces to the needs of the economy, as an EU candidate country. Serbia launched its preparation for RIS3 Strategy in 2017. The process is led by the MoESTD and the Ministry of Economy, with the support of the Public Policy Secretariat and the technical assistance of EU JRC. The country is currently going through the Entrepreneurial Discovery Process (EDP), which is a bottom-up consultative process among academia, government, private sector and civil society in defining the priorities.*

as other SDGs related to social and environmental issues. It has taken time and much political leadership, government effort and extensive support from international partners to come this far. Serbia has yet to formally reflect the STI reform in formulating its SDGs policy, but so far, the country's experience seems to have generated at least two good practices and lessons learned. Firstly, for a key institution such as the IF, a level of independence and the ability to work with international partners are crucial in building a foundation and core institutional capacity. Secondly, major reform takes years of extensive stakeholder involvement activities, led by several political leaders. Looking at a decade of Serbia's work, it seems realistic and strategic for countries to start small by building the capacity of core institutions and financing pilot programmes under one ministry, but eventually, policy environments need to be enhanced through relevant stakeholders while more government agencies need to be brought into the efforts in order to ensure sustainability and real impact.

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