

Transformative Innovation Policy Africa Hub Exploratory

International Development Research Centre (**IDRC**) project number: 108940

The lead research organisations involved in the study:

- Science Policy Research Unit (**SPRU**), University of Sussex, United Kingdom
- National Commission for Science, Technology and Innovation (**NACOSTI**), Kenya
 - Science and Technology Policy Research Institute (**CSIR-STEPRI**), Ghana
 - Université Cheikh Anta Diop de Dakar (**UCAD**), Senegal
 - National Research Foundation (**NRF**), South Africa

Locations of study:

United Kingdom, Ghana, Kenya, Senegal and South Africa

Report prepared by:

Dr Chux Daniels

Principle Investigator

Transformative Innovation Policy Africa Exploratory Hub

Research Fellow at SPRU, University of Sussex

Final Technical Report

June 2020



BUSINESS
SCHOOL

SCIENCE POLICY
RESEARCH UNIT



Executive summary

The **Transformative Innovation Policy (TIP) Africa Exploratory Hub** (TIP Africa Hub, henceforth, for short) was conducted over a 12-month period, from November 2018 to November 2019. The research, led by Dr Chux Daniels and coordinated by the Science Policy Research Unit (SPRU) at the University of Sussex; involved four countries in Sub-Saharan Africa (SSA): Ghana, Kenya and Senegal, and South Africa. Alongside SPRU, the lead organisations from the four SSA countries are: the National Commission for Science, Technology and Innovation (NACOSTI), Kenya; the Science and Technology Policy Research Institute (CSIR-STEPRI), based at the Council for Scientific and Industrial Research (CSIR), Ghana; Université Cheikh Anta Diop de Dakar (UCAD), Senegal; and the National Research Foundation (NRF), South Africa. The country research teams were made up of researchers and policymakers. Funding for the research was provided by the International Development Research Centre (IDRC).

The TIP Africa Hub research has provided useful lessons on the prospects for transformative innovation and possible pathways to the formulation, implementation, evaluation and governance of transformative innovation policies in Africa. There were three major lessons from the research which are the following:

- First, in the three country case studies in Ghana, Kenya and Senegal, it was observed that top down approaches to policymaking continue to dominate the SSA innovation policy ecosystem. As a consequence, there is disconnect between policy actors and other stakeholders (for example, grassroots innovators, civil society, and beneficiaries) in the sociotechnical systems, with potential detrimental impacts on the implementation of policy initiatives, due to a lack of buy-in. A possible mitigation in this instance, is to encourage policy learning, and policy experimentation in ways that combine top-down and bottom-up approaches in innovation policymaking and governance. This will improve the prospects of achieving transformative change through innovation.
- Second, the findings reveal that for transformative innovation to be successful, it must recognise and address the concerns of existing local cultures, practices and lifestyle, for example of the pastoralists in Kenya or electronic waste collectors in Ghana. In responding to local concerns, it is important to focus, in particular, on innovation that help to address social, environmental, inclusion and sustainability challenges. Here, from a transformative innovation lens, it is essential that policymakers consider the use of policy instruments that target inclusion and sustainability, that is, focus on SDGs challenges in existing and future policy mixes.
- Third, the co-creation of knowledge, innovation and policy agenda, priority setting and community driven learning, are essential to the success of transformative innovation. Individuals and communities are essential local agents for change, transformation and achieving the SDGs. Based on the lessons from the TIP Africa exploratory research, it is suggested that in formulating, implementing, evaluating, as well as governing transformative

innovation policies, policymakers (likewise funders and researchers) must place strong emphasis on the inclusion of broad base participation of actors who are often excluded in policy processes. In the case of Ghana, electronic waste collectors that represent the informal economy, are excluded; in the Kenya, the nomadic communities are left behind; while in Senegal, the case study on virtual university demonstrates how inclusion can be enhanced. Although excluded actors, such as entrepreneurs from the informal economy, women and youth, may lack resources or access; they are vital to the success of innovation activities.

- Fourth, the findings reveal the need for capacity building in TIP across Africa; and innovation policies that are informed by the TIP thinking, if they are to achieve national development objectives, the African Union Agenda 2063 and the SDGs. Capacity building is required on various fronts, most especially for researchers and policymakers involved in science, technology and innovation (STI) policies. Strengthening the capabilities of researchers and policymakers in TIP, will help to ensure that STI policies in Africa are refocused on addressing the SDGs, drawing on the TIP approach.
- Fifth, the research findings have implications for the Transformative Innovation Policy Consortium (TIPC) research design, process and delivery. The findings reveal that for countries in the Global South, such as those in Africa involved in this project, where for example capabilities in TIP are weak or non-existent; an important lesson for TIPC is the need and adjust the research design in ways that allow for more time for training, data collection and project delivery. While the countries found the process useful and relevant, the core TIP concepts were intellectually challenging, essentially resulting from lack of prior knowledge. Other important areas for TIPC to consider include availability of funds in the Global South for this nature of research, buy-in from governments and key decision-makers, coordination and operational challenges related to project delivery, and differences in governance structures.

Recommendations

Recommendations to IDRC, the TIPC, and SPRU (University of Sussex)

Working together,

- Develop a transnational capacity building program on TIP and experimentation for Africa at regional levels, run in a Hub structure. The programme can be connected to certifications and postgraduate studies (MSc and PhD). The Hubs, in addition to providing a platform for capacity building in TIP across Africa, will also offer opportunities for networking within and among the hubs, and individuals interested in TIP. Work in the hubs may be connected to the Science Granting Councils Initiative (SGCI)¹ thereby accessible to Science Granting Councils (SGCs) that wish to be involved in TIP research and policy engagements in Africa.
- Create a TIP Africa Fund to facilitate the work in the regional Hubs and related activities.

¹ To strengthen the capacities of 15 SGCs in Sub-Saharan Africa in order to: manage research; design and monitoring of research programmes based on the use of robust science, technology and innovation (STI) indicators; support knowledge exchange with the private sector; and strengthen partnerships between SGCs and other science system actors. Source: <https://sgciafrica.org/en-za/home>

- Extend the research beyond the exploratory phase, and support the four participating countries – Ghana, Kenya, Senegal and South Africa – in carrying out a deeper multi-year study. Such study could, among other possible benefits, help to:
 - Embed the lessons learnt from this exploratory phase into innovation policies and policymaking at the national, regional and continental level;
 - Improve SSA actors’ understanding in innovation policy, thereby helping to address the disconnect between policy actors and other stakeholders while improving the chances of implementation of policy initiatives, by enhancing buy-in and ownership;
 - Encourage policy experimentation in the implementation, evaluation and governance of innovation policies in SSA;
 - Foster a greater level of policy and mutual learning among the countries, but also with the wide innovation policy actors in SSA and beyond.

These recommendations are in line with the objectives of the Science Granting Councils Initiative (SGCI). In addition, the recommendations are aligned to TIPC’s goals of mobilising the power of innovation in addressing pressing societal goals by improving the formulation, implementation, evaluation and governance of innovation policies.

Recommendations to TIP Africa Countries

It is clear from the findings of the research that STI policy in the case countries – Ghana, Kenya, Senegal and South Africa – is in need of urgent transformation. Ghana and South Africa currently have explicit STI policies; while in Kenya and Senegal, explicit STI policies need to be formulated. In addition, the weakness in capabilities, the gaps in STI policies are also related to the framing, narrative and resources available for STI policy.

On this backdrop, it is therefore important that:

- STI policies in Africa, focus on SDGs and mobilise the main resource available. This the power of bottom up and inclusive innovation that the case-studies show. The role of the STI national policy should be to mobilise, connect and scale the seeds on ongoing transformations as discussed in the three country cases, and stretch the transformations, making them even more transformative.
- Work with national governments in reforming STI policies and programmes, in line with the TIP thinking. This could help ensure that STI policies are central vehicles for addressing national, regional and continental objectives in line with the SDGs. The potential for STI policy to address the SDGs is enhanced when the SDGs are central in STI policy.
- Develop capacity building programmes in TIP that focus on gaining practical experience.
- Explore avenues to secure the appropriate high-level of support – funding, human resources and others – from the relevant national and regional government agencies, funders and actors. This support is essential to continuing the TIP research and progressing into the next phase of policy experimentation, application of theory of change, transformative outcomes and evaluation in TIP.

- Disseminate the research findings and lessons learnt widely to the target audience including policymakers, researchers, industry actors, and civil society.
- Ensure that the knowledge, capabilities and skills acquired during the exploratory phases are retained, actively applied and incremented upon.
- Engage with TIP Africa Hub countries involved in the exploratory phase and TIPC members, ensure mutual learning.
- Join TIPC as a full member and thereby extend the research capabilities beyond SSA by working with the global partners involved in the consortium.

Table of Contents

| | |
|--|------|
| Executive summary | ii |
| Recommendations..... | iii |
| Acknowledgements..... | viii |
| 1 Introduction and background to the research..... | 1 |
| 2 The research problem and purpose | 1 |
| 3 Methodology, Conceptual and Analytical Framework..... | 3 |
| 3.1 Methodology: In Country Work..... | 3 |
| 3.1.1 Phase 1: Mapping of National STI Policy Ecosystem..... | 3 |
| 3.1.2 Phase 2: Case study using the Transformative Innovation Learning History Methodology..... | 5 |
| 3.2 Conceptual and Analytical Frameworks..... | 6 |
| 3.2.1 Conceptual Framework..... | 7 |
| 3.2.2 Analytical Framework | 7 |
| 3.3 Participation in TIPC Engagement Week and Conference 2019..... | 8 |
| 4 Project outputs and synthesis of research results | 9 |
| 4.1 Country STI Ecosystem Mapping Reports..... | 9 |
| 4.1.1 Ghana: Background, STI Context and TIP Mapping | 10 |
| 4.1.2 Kenya: Background, STI Context and TIP Mapping..... | 15 |
| 4.1.3 Senegal: Background, STI Context and TIP Mapping | 20 |
| 4.2 Case Country's Transformative Innovation Learning Histories..... | 24 |
| 4.3 Research Insights Brief summary..... | 27 |
| 4.4 Blogs..... | 27 |
| 4.5 Insights working session training materials | 27 |
| 4.6 Final TIPC project conference | 28 |
| 4.7 Academic journal papers | 28 |
| 4.7.1 Academic journal papers based on individual country case studies | 28 |
| 4.7.2 Academic journal paper incorporating the three country cases | 28 |
| 4.8 Policy brief | 28 |
| 4.9 Webpage and Video..... | 29 |
| 4.11 Research outputs and outcomes | 30 |
| 4.11.1 Summary of outputs | 30 |
| 4.11.2 Summary of outcomes..... | 31 |
| 5 Challenges experienced in the course of the project..... | 33 |

| | | |
|-----|---|----|
| 6 | Overall Assessment, Next steps on TIP Africa Hub, and Future Research | 34 |
| 6.1 | Overall Assessment | 34 |
| 6.2 | Next steps on TIP Africa Hub..... | 34 |
| 6.3 | Future Research | 34 |
| | References | 35 |
| | Annex | 38 |
| | Notes..... | 38 |

Acknowledgements

I would like to thank the organisations and many individuals who contributed in various ways to make this project the great success it was. The first thank you goes to IDRC for commissioning and funding the project. I am particularly grateful to Matthew Wallace and Ann Weston at the IDRC for their support, inputs and advice throughout the project. Thanks also to the Science Granting Councils Initiative (SGCI) team at IDRC, Ellie Osir, Diakalia Sanogo and Loise Ochanda for providing the relevant support from the IDRC side and helping to ensure the appropriate level of linkage between this project and the SGCI.

Thanks to the relevant academic, policy/government and funding institutions and the research teams in the respective countries: Science Policy Research Unit (SPRU), University of Sussex, United Kingdom, the National Commission for Science, Technology and Innovation (NACOSTI), Kenya; the Science and Technology Policy Research Institute (CSIR-STEPRI), Ghana; Université Cheikh Anta Diop de Dakar (UCAD), Senegal, working with CRES (Consortium for Economic and Social Research, *in French, Consortium pour la Recherche Économique et Sociale, Sénégal*) alongside MESRI (Ministry for Higher Education, Research and Innovation); and the National Research Foundation (NRF), South Africa. NRF, South Africa thanks to you for hosting the first transnational working session at the NRF in Pretoria. And CRES / MESRI, Senegal; thanks to you for hosting the second transnational working session in Dakar.

I would also like to express my deep appreciation to the individuals who co-operated with the fieldwork for this project in attending the national workshops, focus group meetings or in giving up their valuable time to be interviewed. Thank you. In addition, many thanks to the staff and management of SPRU and the University of Sussex. In particular, Blanche Ting, for providing excellent research support, administration and coordination. Thank you Blanche.

My final gratitude goes to the TIPC team. There are too many people to mention, but my appreciation goes a few people in particular: Johan Schot, TIPC Academic Director and Founder; Sarah Schepers, Pip Bolton, Vicky Shaw, and Joanna Chataway, who was with us at the University of Sussex and started the project with us but has now moved to UCL, UK. Special thanks to Geraldine Bloomfield, TIPC Communications Manager, and Pip Bolton, Administrative Coordinator, TIPC, for help with editing the report.

1 Introduction and background to the research

Background, Research Problem and Justification

The Transformative Innovation Policy Consortium (TIPC), launched in 2016, is co-ordinated by the Science Policy Research Unit (SPRU) at the University of Sussex, UK. TIPC comprise innovation researchers and policymakers in policy or funding agencies. The founding countries are Colombia, South Africa, Norway, Sweden and Finland and latterly China, Mexico, Panama and Brazil. This group have a long-term vision to work together to give substance to a new framing for science, technology and innovation (STI) policy, termed “Transformative Innovation Policy” (TIP). This approach has the potential to promote transformation of systems and societies in ways that foster environmental sustainability, achieve more equitable income distribution and help address other social challenges including gender, inequality, and exclusion.

The rationale for a new approach to Science, Technology and Innovation (STI) policy is driven by the ambitions of the Sustainable Development Goals (SDGs) which summarise the major challenges for our world. It is clear that addressing the SDGs is a challenge for STI policy, since business as usual will not be sufficient. Within TIPC, members have embraced the challenge collectively, working together transnationally in a co-created five-year programme, (between researchers and policymakers) to provide a new foundation for transformative STI policy. The TIP approach includes work on policy experimentation, directionality, further research and new approaches for evaluation, deep learning, and capacity building as well as developing local implementation projects and a global research network which feeds back into the core work. The current TIPC members would like to welcome new members into the consortium in future years to further build the global constituency behind TIP and share deep learning between countries.

2 The research problem and purpose

Evidence from research, reports, STI policy initiatives and projects (such as the SGCI) has revealed significant gaps Africa’s STI policy ecosystem. These gaps include the need to explore new approaches that help to ensure that STI contributes better to achieving Africa’s economic and development objectives (AfDB, 2020; AUDA-NEPAD, 2019; AUC, 2015, 2014); strengthen the formulation, implementation, evaluation and governance of STI policies in ways that improve Africa’s prospects of achieving transformative change (Daniels et al, 2020; Daniels and Ting, 2019; Daniels et al, 2018); improve research excellence (Chataway and Daniels, 2020; Kraemer-Mbula et al, 2020); address tensions in the science, research and funding systems (Chataway et al, 2019); address weaknesses in STI and policy capabilities and skills (ACBF, 2017; AOSTI, 2013); reconceptualise innovation (Daniels, 2017), and ensure that innovation supports inclusive development (Daniels et al, 2017).

One initiative trying to address the gaps identified above is the SGCI by IDRC. To this end, the IDRC commissioned this research project to support Science Granting Councils (SGCs) in achieving the SGCI goal of improving SGCs ability to manage research; design and monitor research programmes based on the use of robust STI indicators; support exchange of knowledge with the private sector; and establish partnerships among SGCs, and with other science system actorsⁱ. The purpose of this research project, which although exploratory, goes beyond the mandate of the SGCI, was therefore

to support the SGCI objectives by developing a ‘Sub-Saharan African (SSA) TIP Exploratory Hub’, based on the conceptual framing and co-creation work of the TIPC. The next section focuses on the selection of case countries.

Case Country Selection Process

In order to join TIPC countries must have gone through a pilot phase, which includes:

1. A historical analysis of STI (henceforth, innovation) policy in each country and prospects for transformative innovation;
2. Training in transformative innovation policy which helps interested countries to understand the common vocabulary and TIP criteria relevant to the local context; and,
3. Development of a country specific case study using the Transformative Innovation Learning Histories (TILH) methodology (see below for further details on the TILH methodology) and a shared understanding of transformative innovation and policy (Schot et al, 2017).

The three SGCs – Ghana, Kenya and Senegal – that participated in the TIP Africa Hub exploratory research project (i.e. pilot) alongside South Africa, a founding TIPC member, were selected via a closed call issued to the 15 SSA countries involved in the SGCI, inviting them to apply. The call was also extended to countries that have engaged with TIPC through either attending the conference in South Africa in 2016ⁱⁱ, or the workshops held in Tanzania in 2017ⁱⁱⁱ or in Ghana in 2018^{iv}. By attending the conferences or workshops these SSA countries had demonstrated their interest in TIPC but did not yet have the opportunity to participate in a pilot, a prerequisite for TIPC full membership.

The call and selection criteria were designed by SPRU with inputs from the NRF and IDRC. The objective of the call was to request statements of interest from SGCs expressing their willingness to participate in the pilot study and the two working sessions. A key part of the call was a focus on how the countries would ensure gender considerations, not only in terms of representation and participation, but also in the integration of gender and inclusion elements into their research design. This consideration included, for example, the balance of female and male in the research and working groups involved in the co-creation research processes, as well as the opportunity to work with other marginalised groups. In applying for a place in the project, countries also had to demonstrate commitment of time to work on producing some or all of the outputs (see Section 4), and commit some local resources (staff, time, and additional funds where necessary) to support the research. The resource requirements included, for example, providing venue for workshop and focus groups, co-ordinating the invitations, local transportation and support for local actors to attend the workshops.

After the country selection and announcement^v of commencement, local research groups to lead the pilot work were identified. It was imperative that the teams selected consisted of researchers and policymakers. SPRU played a guiding and mentoring role, and provided active support to the national teams in the co-creation process, capacity strengthening and co-production of the research outputs. The teams worked with SPRU researchers, led by Dr Chux Daniels and TIPC in a co-creation effort. Overall direction and TIPC inputs were provided by TIPC Academic Director and Founder, Prof Johan Schot

Finally, to summarise, and reiterate for emphasis, all SGCI members were eligible to take part in the pilot, and insights workshops, and use the open access resources developed and outputs from the

project. SGCI members not participating in the pilot would be able to send two people to each of the training sessions but are required to fund their own travel and accommodation. The three countries selected participated in their own local country case study workshop as well as the insights workshop. They had two fully funded places at the 2019 TIPC Engagement week and conference. The project funds covered the costs of two members of the national team from pilot each country to the transnational workshops and conference. However, countries would need to fund any additional person(s) participation and cover the local costs of participants to attend workshops as required.

3 Methodology, Conceptual and Analytical Framework

3.1 Methodology: In Country Work

3.1.1 Phase 1: Mapping of National STI Policy Ecosystem

The first phase of the pilot work was to map the national STI policy development ecosystem of pilot countries using the transformative change (i.e. TIP Frame 3) lens. This exercise, provided the local project team preliminary insights. This then resulted in a five-page paper/report, which set the scene for future work on TIP in the country. The five-page report is useful for building mutual understanding among the key stakeholders, tracing the evolution of STI policy and focussing on how the 3 frames of STI policy present in the country currently interact with each other. It also uncovers existing TIP or emerging opportunities for TIP. This output feeds into the second phase of work, which involves an in-depth case study using the TILH methodology. These two elements of work ensure that the country has undertaken the same exploratory aspects as current founding members of TIPC (Colombia, Sweden, South Africa, Finland, and Norway). Both outputs can feed into future multi-country benchmarking on TIP, and foster opportunities for mutual learning and collaborations between participating countries. The completion of this phase also opened the opportunity for each pilot country to explore possibilities for joining the five-year programme of TIPC, post November 2019 TIPC Engagement week and conference.

TIPC has been mapping innovation policies and instruments, in addition to research funding and innovation initiatives using the '3 Frames' approach outlined in the paper - Framing Innovation Policy for Transformative Change: Innovation Policy 3.0 (Schot and Steinmueller, 2018) – as the basis for discussion and analysis. The Phase One work (i.e. mapping and case study) is achieved through a combination of in country workshop and focus groups, data collection, analysis, and writing of the five-pager, individual engagements, and desk research. It requires the partner to give access to key policy documents and personnel. Furthermore, it involves detailed and committed engagement from a dedicated researcher at SPRU who is knowledgeable on TIP approach, related theories and frameworks, and the TILH methodology as these are new and emerging areas, requiring a level of prior expertise to support the co-creation work.

One of the characteristics identified by authors Schot and Steinmueller (2018) as being associated with Frame 3 approaches is the involvement of a broad and different set of stakeholders, which highlights which actors are included or excluded in the innovation/policy processes, and why. The mapping exercise helps to identify these actors, through for example, actor-network mapping, and construction of "innovation histories". Designed to be approximately five pages in length, this country STI ecosystem mapping report is the starting point for the development (with the local partner) of a

list of possible case studies for deeper review and examination. The list was reviewed during the insights Workshop 1 (see below) according to the criteria developed within TIPC for assessing transformative innovation policy (see TIP Criteria, Table 1). This includes: recognition of directionality, whether policy was led by social or environmental challenge, whether policy aimed at system innovation, whether learning and reflexivity were prominent, and whether there was a recognition of diversity of interests and needs to articulate conflicts as well as consensus. In line with the requirements of the call there will be an explicit consideration of gender in the chosen case.

The outputs from the in-country work are the following (1) Mapping of the principle STI institutions, programmes of the country following Frames 1-3 of innovation policy as articulated by Schot and Steinmueller (2018) to help inform the report, and (2) the Five-page country report (discussed further in Section 4 below). A summary of the complete list of project outputs is presented in Section 4.

Insights Workshop 1: Understanding Transformative Innovation Policy, country specific contexts and general criteria for TIP

The purpose of the first insights workshop (working session), was to discuss the outputs of the three countries mapping exercise, and five pager country report. The expected outcome for this session was to define the case studies, from each country, which could then be investigated further during the field work of the project.

This working session was based on the TIPC pilot year workshops and involve participants in a co-creation process, conducting a detailed review and cross comparison of the three country reports. The activities included detailed reviews and discussions essential to developing a deep understanding of TIP as applied to local country and regional contexts. The participants worked together to select from the possible case studies identified above for deeper review using the TIP criteria developed within the TIPC pilot year. This may also result in additional criteria, applicable in an SSA context and fed back into the core programme. The workshop was held at the National Research Foundation (NRF), Pretoria, South Africa, from 4-5 February 2019.

All three pilot countries participated in the working session, which was co-convened by SPRU's Principal Investigator (PI) (research co-ordination and facilitation) and the NRF (in a mentoring and facilitating role) and was open to all SGCI members to offer an additional opportunity for capacity building and learning through context specific examples. The host country was responsible for co-ordinating invitations, venue, catering and other logistics with some support from the SPRU research assistant.

The outputs from the insights workshop one include: (1) Three country specific blogs written by the country researchers. The blogs focused on the insights from the country reports, which offer thoughts on possible policy pathways to support transformative innovation, and (2) Three Research briefs led by participating country research teams in the three countries, co-produced by the SPRU research team. The blogs and research briefs discussed further in Section 4 below. A summary of the complete list of project outputs, including the blogs and research briefs, is presented in Section 4.

3.1.2 Phase 2: Case study using the Transformative Innovation Learning History Methodology

A second phase of work, was to conduct a case study. This phase included a visit by the SPRU team to the countries to facilitate a case study workshop. The objective was to work together to understand how the respective innovation happened, identify its transformative elements, and to record and reflect on the experience; to then develop insights and ideas for future research and TIP experimentation.

A specific Transformative Innovation Learning History (TILH) methodology has been developed by TIPC (adapted from Douthwaite and Ashby (2005), Hargreaves (2012)). This method is useful for both research and policy reflection and is particularly suitable for processes of co-creation. It involves:

1) Gathering multiple personal accounts and documentation of a transformative innovation process and the role of policy in developing it, including: a review of relevant literature and policy documents, participatory, stakeholder workshops, smaller or focus group discussions and one-to-one engagements.

Supported by SPRU the local researchers constructed written accounts and a timeline of the innovation, and mapped the relevant actor networks.

The following questions were used to guide the case study work:

- What were the most important events or themes relating to the development of this transformative innovation?
- Why was the event/relationship important?
- Was this project or innovation policy engagement 'transformative', and if yes, in what sense? Who was involved in the innovation, why were they involved, and how did they contribute/participate?
- What were the results?
- What was the role of policy (positive, negative or neutral) in shaping the transformative elements of the project?
- Were there specific combinations of policies (policy mixes) that contributed to this project being 'transformative', if yes, why?
- The output presents multiple voices in a narrative format that synthesises empirical data, quotes from participants, researcher reflections, and theoretical insights that helped to uncover the transformative impact of the respective innovation policies and initiatives.

The insights from this TILH helps to develop a mutual understanding of Transformative Innovation Policy, illustrating its characteristics with concrete examples. In addition, this work stream provides clarity on the importance of further TIP work in the future and specify options and recommendations for the country's participation in the five-year programme of TIPC.

The main output from the case study work is production of the TILH report (i.e. case study report) from each of the pilot countries. Related outputs include the three country specific blogs and research briefs. The TILH and related blogs and research briefs are discussed further and presented in Section 4 below, alongside the other outputs and outcomes.

Insights workshop 2: Understanding the criteria for Transformative Innovation Policy through case study examples

The purpose of this workshop was to provide an opportunity for the pilot countries to discuss the findings, insights, lessons learnt, challenges and outcomes of the case studies that they have carried out separately. Insights Workshop 2 focused on using the three country case studies as inputs for developing a deeper understanding of TIP in African context among participants from all the countries present. This workshop, based the discussions and mutual learning on the case studies, also provided an opportunity for developing a deeper knowledge of the six TIP criteria (see Table 1 below) and prospects for policy experimentation. An improved understanding of the six TIP criteria contributes to improving the transformative potential of the cases or participant's ability develop future policies to support transformative innovation. Duration: 2 days. The workshop was facilitated by SPRU and TIPC teams, and involved researchers and policymakers from the pilot countries.

The outputs from the insights workshop include (1) Three country specific blogs on TILH written by the country researchers. The blogs focused on what the country teams have learned about prospects for transformative innovation policy in their context, and possible options for future work, and (2) Three Research briefs (using insights from the three TILH's), led by participating country research teams in the three countries, co-produced by the SPRU research team. A summary of the complete list of project outputs and related outcomes are presented in Section 4.

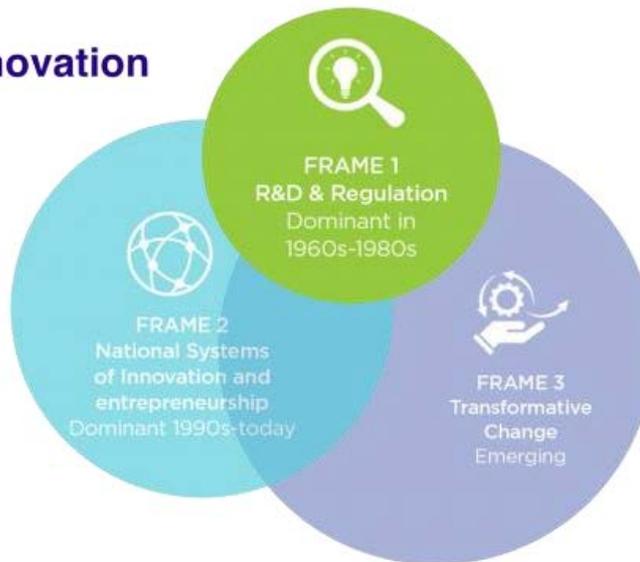
3.2 Conceptual and Analytical Frameworks

Introduction

Science, technology, and innovation (STI) policies play important roles in poverty reduction and sustainable development. However, translation of STI policies which can contribute to a country's socio-economic development, is not an automatic nor linear process. Following, Schot and Steinmueller (2018), there are primarily two established STI frames that have dominated contemporary innovation policies. The first frame, which was dominant in 1960s-1980s, is the emphasis of commercialisation of scientific activities, driven by technological determinism that science-led process can lead to long term economic growth. The second frame, dominant from 1990s to the present and known most commonly as the National Systems of Innovation (NSI), aims at improving the coordination and alignment among different actors in innovation systems (Freeman, 1995; Lundvall, 1992). Both of these frames are more or less co-existing in various forms across varying local contexts.

Schot and Steinmueller (2018), have advocated for a third frame approach, where STI policies are better aligned to social and environmental challenges of the present and future. In their work, they questioned innovation activities that may actually deepen social inequalities, often reflected as externalities produced by the pattern of growth pursued with the two frames approach. For instance, access to the benefits of innovation is often uneven, there could be unemployment in sectors that are exposed to rapid technological change, the impact of climate change on countries which have less resilience to adapt to contemporary environmental challenges, and the volume of household and industrial waste accumulated in the past to name just a few. As Figure 1 below shows, the three frames co-exist.

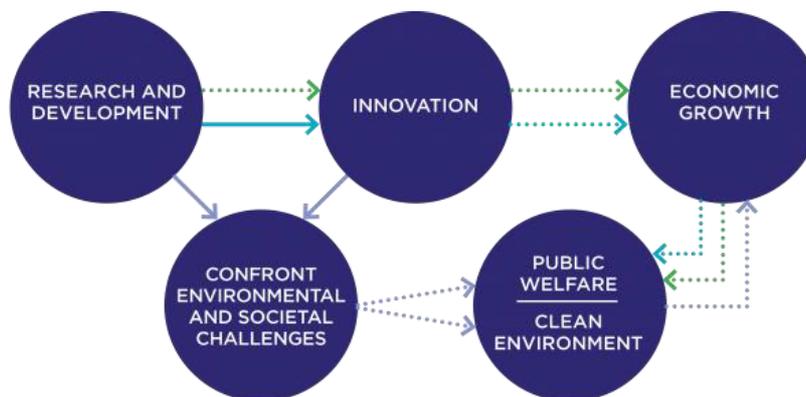
The 3 Frames of Innovation



Source: <http://www.tipconsortium.net/about/>

3.2.1 Conceptual Framework

Following the arguments put forward by Schot and Steinmueller (2018) as described above, the conceptual framework that informs TIP research and policy activities is presented below in Figure 2.



→ Frame 1 → Frame 2 → Frame 3

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

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

Source: <http://www.tipconsortium.net/about/>. See also Schot and Steinmueller (2018) for more discussion of the concepts that inform the framework and Daniels et al (2020) for the application of the framework in prior case studies.

3.2.2 Analytical Framework

The analytical framework is centred on the Frame 3 approach, discussed (Schot and Steinmueller, 2018). The Frame 3 concepts give rise to the six Transformative Innovation Policy (TIP) Criteria. Transformation in the TIP approach is based on six TIP criteria: directionality, societal goals, system level impact, learning and reflexivity, conflict versus consensus, and inclusiveness. These three

countries selected case studies which had potential for satisfying the six transformative elements, as outlined in Table 1 below.

Table 1: Transformative Innovation Policy Criteria

| Criteria | Directionality | Societal goals | System level impact | Learning and reflexivity | Conflict vs consensus | Inclusiveness |
|------------------|---|--|--|---|---|---|
| Elaboration | Innovation is process of accumulation towards a direction. This direction can be changed if alternative pathways are recognised and supported | Transformative innovation policy needs to be directed in line with specific social goals | For innovation to be transformative, it must have a system level impact (i.e. cut across many sectors) | Reflexivity refers to the ability of actors to re-think, un-learn, and re-learn, routines and practices taken for granted | Transformative change requires a broad participation of many actors; and should encourage divergent views | It is essential to consider varying interests - as this reveals issues of legitimacy and accountability |
| Questions to ask | Are social choices chosen over alternative pathways of development? | Does it address the SDGs | Does it have wide impact? | Does it allow for fundamental rethink of how problems are refined and deriving solutions? | Is participation democratised? | Do actors have access and capabilities to participate? |

Source: Daniels and Ting (2019), based on Schot and Steinmueller (2018)

3.3 Participation in TIPC Engagement Week and Conference 2019

Each of the countries undertaking the TIP Africa pilot had two fully funded places at TIPC engagement week and conference, 4-5 in November 2019, held at Valencia, Spain. Participation in the engagement week offered an opportunity to present country specific insights from the case studies, thereby contributing to the overall TIPC work. In addition, the countries had the opportunity to engage with the entire TIPC membership on key aspects of TIP such as experimentation, training, evaluation and research. Furthermore, the conference offered an opportunity to participate in discussions with a wider community of researchers and policymakers involved in TIP work or interested in the TIP approach.

The countries used the conference as an opportunity to present the entire project to the wider TIPC audience and received feedback. TIP Africa Hub country teams shared their lessons from the project. For example, an important lesson focused on what it takes to carry out a TIP research in African context, challenges and opportunities for transformation, resource constraints and issues related to capabilities. In all, the engagement week and conference provided a highly valuable opportunity for capacity building and mutual learning with global actors involved in TIP and STI policymaking. It was a useful platform and good opportunity for TIP Africa Hub country teams to network with TIPC global teams. The final conference report is available on TIPC website.²

² TIP Conference Report 2019 <http://www.tipconsortium.net/tip-conference-report-2019/>

4 Project outputs and synthesis of research results

To reiterate, the approach, as part of the third frame, aims to radically transform socio-technical systems (such as energy, mobility, food, water, and healthcare) in ways that help to tackle social and environmental needs in policy formulation processes (Schot and Steinmueller, 2018). TIP emphasises policies for directing socio-technical systems into socially desirable directions and embeds processes of change in society. TIP provides a lens useful in exploring issues around socio-technical system change in relation to structural transformation in: governance arrangements between the state, the market, civil society and science; experimentation and societal learning; responsible research and innovation; and, finally, a more constructive role for foresight to shape innovation processes from the outset and on a continuing basis (See Table 1 above).

Given that the TIP approach is novel, one of the objectives of this project was to apply the concepts in varying African national contexts while also helping to determine its usefulness in these contexts. The work in Ghana, Kenya and Senegal, as pilot case studies following the work done in the previous year in South Africa, helped to achieve these objectives. The brief discussion of the outputs in this section is based on the methodology, conceptual and analytical frameworks described in Section 3 above. The analysis is in line with the concept of transformation in the TIP approach, which is based on six criteria: directionality, societal goals, system level impact, learning and reflexivity, conflict versus consensus, and inclusiveness. The three countries case studies demonstrated potentials for satisfying the six transformative elements, as outlined in Table 1 above.

4.1 Country STI Ecosystem Mapping Reports

The aim of the country STI ecosystem mapping report, referred to in TIPC terminology as “five-pager³”, was to map the principal STI institutions, actors and programmes in each country following Frames 1, 2 and 3 of innovation policy as articulated by Schot and Steinmueller (2018). The structure of the STI ecosystem mapping country reports, aligns with existing TIPC country-focused papers to allow for cross comparison and benchmarking at a later stage. Each country report therefore contains some common elements:

- Context of STI policymaking in the country
- Evolution of STI policy
- Financing of innovation
- Governance
- Innovation policy within the transformative innovation (Frame 3) context
- Conclusions
- Potential case studies for further investigation

This mapping report, similar to the national case study, is an essential output that every TIPC member country must undergo. Insights from the national case studies of TIPC founding member countries,

³ The five-pager reference is because the report was intended to be short, approximately five pages in length but in reality was longer. This report is the starting point for the development (with the national partner) of a list of possible case studies for deeper review and examination during the course of the research project.

which preceded the TIP Africa Hub country mapping reports, are documented in Daniels et al (2020). The outputs from the country STI ecosystem mapping of the three pilot countries are discussed below.

4.1.1 Ghana: Background, STI Context and TIP Mapping

In 2010, Ghana was declared a lower middle-income country, which was an evidence to its economic and financial reforms, political stability and limited ability to utilise its natural resources for development. Over the past decade, STI funding per annum in Ghana, has been between 0.25 and 0.3% of GDP, which falls short of the AU target of 1% (Quaye et al., 2019b). Hence, to further support their activities, STI Institutions receive grants and donations representing about 20% of their annual budgets.

It can be noted that in terms of Frame 1, Ghana STI development and application was geared towards “tapping the potential of science and technology for prosperity and nurturing mass production and consumption” (Quaye et al., 2019b). This was exemplified in the Kwame Nkrumah era where there was a deliberate attempt to use science and technology. However, it can be argued that aspects of Frame 1 STI policy remains one of the dominant narratives to this day, as evidenced by the goals articulated in the draft 2017 STI policy (MESTI, 2017). The 2017, draft STI policy emphasises the pursuit of national prosperity, enterprises development, and sustained economic growth.

A review of the evolution of STI policy in Ghana reveals three patterns: (i) the era of Ghana’s First President, Kwame Nkrumah (1957-1966); (ii) the era immediately after Kwame Nkrumah (1966 to the 1990s); and (iii) the era of the ‘new dawn,’ which begins in 2000 onwards (Amankwah-Amoah, 2016). At the dawn of independence, Ghana saw the importance of, and the need for, science and technology in the nation’s development process. Consequently, the National Research Council was established (Amankwah-Amoah, 2016). These are outlined according to Three Frames as lenses in which to guide the understanding of the evolution of Ghana’s STI development over time.

Frame 1

At the dawn of independence, Ghana articulated the need for, science and technology in the nation’s development process. Consequently, the National Research Council was established in 1958 to study and develop appropriate technologies to support the country’s development. In 1959, the Ghana Academy of Learning, a learned society that became the Ghana Academy of Sciences in 1961, was established. In 1963 the National Research Council merged with the Academy and assumed responsibility for ten full-time research institutes and projects whose programmes were directly related to the nation’s economic and social development. In 1966 the Academy became the Ghana Academy of Arts and Sciences (GAAS), and in 1996, the Council for Scientific and Industrial Research (CSIR) was re-established in its present form with 13 Research Institutes. In addition to the establishment of these institutions to pursue science and technology for national development, the era of Kwame Nkrumah also saw the establishment of the Ghana Atomic Energy Commission and educational institutions. The educational institutions were to supply human resources to drive the nation’s pursuit of science and technology for economic development. Among key educational institutions were the University of Science and Technology (now called Kwame Nkrumah University of Science and Technology [KNUST]) the University College of Science Education (now called University of Cape Coast). In spite of the many institutions established during this era, there was no single coordinated policy on science and technology. What prevailed at the time were the legal instruments

establishing and designating functions for the institutions that were created, and these served as proxy directions for science and technology in Ghana.

The second era of science and technology development in Ghana could be compared to the “dark ages” in Europe. Indeed, it has been observed that the “seeds for ‘destruction’ and disruption of science and technology...were sown” during this era (Amankwah-Amoah, 2016). Several decades in this era saw political instability, economic decline, and downturns in expenditure on research and government commitments to science. The post-Nkrumah era was also characterised by a lack of clarity and direction for science and industrial policies. Government policies also suffered from lack of financial backing and human capital to ensure effective implementation (Quaye et al., 2019b; Amankwah-Amoah, 2016).

Despite these shortcomings, the shift from the Nkrumah era to the “New dawn” phase was the overwhelming emphasis on large firms and government-backed firms to both large and small firms as key pillars for economic development. Although progress has been made, small firms continue to lag behind large firms in gaining government support. The focus on firms could be seen as the seeds towards Frame 2 type of STI policies.

Frame 2

The third era of STI development in Ghana, can be designated from the year 2000 onwards, because it was during this time, that Ghana first attempted to produce a coordinated policy on S&T. Ever Since 2000, Ghana has had two S&T policies and is currently in the process of finalizing a third STI Policy (2017), which is under cabinet consideration. The first coordinated policy of 2000, though not fully operationalised because it was in a draft form that never made it to Cabinet, was reviewed in 2009. The review ensured the produced document reflected advances in S&T with wide applications, such as innovations in ICT and internet applications as well as emerging trends in biotechnology and nanotechnology (MESTI, 2010). In the process leading to its adoption, the 2009 STI Policy (launched in 2010) had a much broader stakeholder consultation within and outside the science and technology community.

Unlike the 2000 S&T Policy (draft) document, the 2009 STI Policy had innovation as a critical driver for socio-economic and sustainable development. The policy document had a 5-year National STI Development Plan (STIDeP) that delineated 17 programmes and 84 projects to be implemented. With such an articulated policy and action plan, the biggest challenge was the implementation process. Key challenges were lack of institutional framework for implementation, monitoring and evaluation of the STIDeP, lack of funding for implementing projects and activities, and lack of commitment from key institutions and agencies who were to lead or collaborate in implementing programmes and projects, amongst others. In 2017, the Ministry of Environment, Science, Technology, and Innovation (MESTI) reviewed the 2010 STI policy to develop a new one, which is aimed at bridging the gap between STI policies on the one hand and sectoral policies and development agenda on the other. The aim of the new STI policy is to place STI at the centre of Ghana’s national development agenda.

Although STI cuts across all sectors of Ghana’s economy, at the policy level, MESTI is responsible for National STI policies while the Ministry of Education is responsible for the National STI education policies. At the implementation level, there are two Major Public Research bodies, namely the Council for Scientific and Industrial Research with 13 specialized Research Institutes. It is only after the 2000

draft STI policy, that there is evidence of the development of National Systems of Innovation (NSI). For instance, there are objectives of the STI policies for 2010 and 2017 that reflect the need for a framework to coordinate STI activities and development in Ghana and create conditions for STI to flourish (Quaye et al., 2019b).

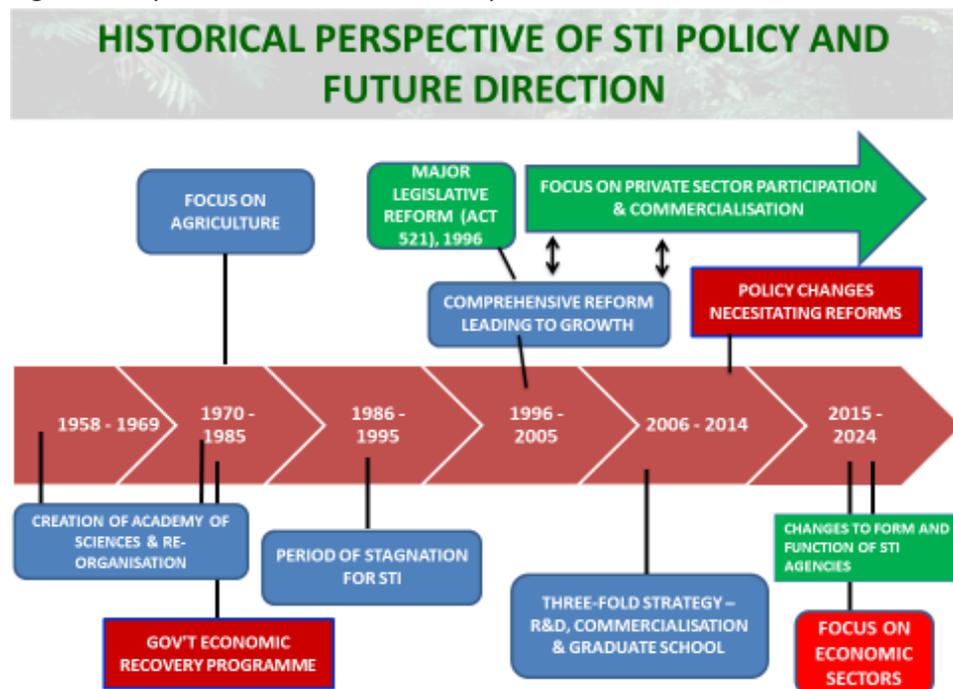
Recently, Ghana's effort and strategies for developing a STI System have involved the development of a National STI Baseline Survey Report, a review of the national STI policy, establishment of a National STI Advisory Apex Body, establishment of the National Research Advisory System and Programmes, consideration of the establishment of the National Innovation/Incubation Programme and considerations for the establishment of National STI Fund. In addition, it is envisioned that the newly established Presidential Advisory Council on Science, Technology, and Innovation (PACSTI) will provide advice to the President of the Republic of Ghana on Science, Technology and Innovation (STI) issues. Especially, with respect to functions of the PACSTI that include advising the President of Ghana on global trends in STI relevant for national development; developing and applying STI for development; appraising various government programmes and projects from the perspective of STI development and application; and advising the President on means to ensure the effectiveness of research and development in Ghana. In addition, MESTI is considering the establishment of the Ghana Innovation and Research Commercialization Centre (GIRC-Centre) as the new partnership between Government, Public Research Institutions, Academia and the Private Sector.

Frame 3

Perhaps the most transformative change in strategic direction for Ghana overall policy, is the recently published Ghana Beyond Aid (Ghana, 2019). It is a broad vision document, which has ambitions for a prosperous Ghana beyond aid, through five goals, wealthy, inclusive, sustainable, empowered and resilient Ghana (or in short W.I.S.E.R) (Ghana, 2019). Part of the strategies in order to achieve these goals is through wider participation of stakeholders, which includes business, labour, civil society, traditional leaders, and government. Ghana is one of the member states that has signed onto the STI for SDGs Roadmaps that looks at a three-tiered approach for foundation of STI Policy framework and enabling conditions, adaptation to emerging technology, and societal preparedness and integration of STI to national sustainable development plan (Quaye et al., 2019b).

Ghana's aspiration to become a developed country depends to a large extent on what it does to improve its technological performance and the dynamism of its innovation system. A review of the evolution of STI policy in Ghana has shown that the country has been through the first two frames of STI policymaking and there is room to consider and adopt the Frame 3 approach for which some case studies could be piloted (Quaye et al., 2019b).

Figure 3: Key trends in Ghana’s STI Policy over time



Source: Quaye et al (2019b)

Table 2: Recent developments in Ghana’s STI policy and references to the three frames

| Date | Key policy and strategy events | Frames |
|-----------|--|---------|
| 2000 | Draft S&T Policy: The basic objectives of the policy include <ul style="list-style-type: none"> i. to seek mastery of scientific and technological capabilities; ii. to develop infrastructures which will enable industry and other sectors of the economy to provide the basic needs of society; and iii. to adopt a science and technology culture | 1, 2 |
| 2010 | STI Policy: <ul style="list-style-type: none"> i. facilitate mastering of scientific and technological capabilities; ii. provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy to provide the basic needs of the society; iii. create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation.[p1] | 1, 2 |
| 2017-2020 | STI Policy 2017: <ul style="list-style-type: none"> i. facilitate mastering of scientific and technological capabilities; ii. provide a framework for inter-institutional collaborations in developing STI programmes in all sectors of the economy to meet the basic needs of the society; iii. create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation; iv. ensure that STI supports Ghana’s trade and export drive for greater competitiveness; v. promote a science, technology and innovation culture in the wider society. | 1, 2, 3 |

Source: Adapted from Quaye et al. (2019b)

Ghana Case study

Waste management is a major challenge in Ghana. Various governments have developed policies and strategies aimed at addressing waste disposal and management in the country. The President, in his quest to solve the waste management issue, established a Ministry for Sanitation and tasked various related ministries such as MESTI, the Ministry of Local Government and other state agencies to work together to develop policies and programmes that will aggressively tackle waste in Ghana. In the light of this, several policies have been formulated, some of which are specifically focused on waste management. These policies include, the Environment Policy, the Plastic Waste Policy, the E-waste Policy and Law, and the Sanitation Policy, to name a few. The TIP approach would be an important lens to review the policy framework surrounding waste management approach in Ghana and to recommend ways for improvements.

In the last few decades, there has been an increase in the consumption of electrical and electronic equipment that are used for various purposes including for communication, entertainment, education, and productivity (Quaye et al., 2019d; Quaye et al., 2019c). Associated with this increase in consumption of electronic and electrical equipment is the amount of electronic waste (e-waste) produced (Quaye et al., 2019c; Amoyaw-Osei et al., 2011). Moreover, the concern for e-waste is not only limited to the quantum of waste generated, but also the challenges related to effective means of disposal and the accompanying health and environmental implications (Baldé et al., 2015). In some instances, as in the case of Ghana, e-waste is improperly disposed of by open burning at dumpsites which releases hazardous and toxic substances, which places the people and environment at high risk. The e-waste is burned in order to extract aluminium, copper, ferrous metals for profit (Atiemo et al., 2016). Furthermore, in Ghana, the importation of second-hand e-waste has resulted in a thriving formal and informal sector (Amoyaw-Osei et al., 2011). It has been stated that Ghana has an unregulated and unrestricted import for second e-waste. Although, Ghana has ratified the Basel Convention that limits the trans-boundary movement of hazardous wastes and their disposal, there is no existing national legislation that supports the agreement (Amoyaw-Osei et al., 2011). Consequently, cognizant of various uncoordinated activities for managing e-waste in Ghana, and as part of measures to ensure the proper management of e-waste, the Hazardous and Electronic Waste Control and Management Act of 2016, ACT 917, was enacted by Ghana's Parliament in 2016. Subsequently, the Hazardous, Electronic and other Wastes (Classification), Control and Management Regulations (LI 2250) was formulated to direct the application of ACT 917. These regulations provide key frameworks to formalize and ensure the proper management of e-waste in Ghana.

The operationalisation of a well-integrated and environmentally sound and sustainable e-waste management system will certainly have challenges. With the passing of the ACT 917 and LI 2250, a goal of the existing legal framework on e-waste management in Ghana is to formalize the informal micro and small enterprises. This will entail the registration of collectors that are in the informal sector as a means to regularise their activities. This comes with the fear of job losses. As captured in the interactions with the scrap dealers, the small-scale entrepreneurs need protection and assurance of jobs considering the youth employment generation potential in the e-waste value-chain. There is the need to create the necessary awareness and build the informal operators' capacity in environmentally sound and best practices of handling e-waste (Quaye et al., 2019c; Quaye et al., 2019a). The challenge here is finding innovative ways of integrating re-cyclers and those whose livelihood depend on scrap

business into the new concept of channelling hazardous materials into registered and sound treatment facilities.

Table 3: Insights from Ghana’s transformative innovation policy case study

| Criteria | Directionality | Societal goals | System level impact | Learning and reflexivity | Conflict vs consensus | Inclusiveness |
|--------------|--|---|--|--|---|---|
| Ghana | Health, safety and the environment. Air, water, and land pollution. Waste is a key issue | SDGs: 3,6,8,11,12,14 Agenda 2063: Ghana 7-year Co-ordinated Programmes of Economic and Social Development Policies (2017-2024) | Integration of e-waste policy with environmental sanitation and STI policies | Coordination, outcomes and impacts are being questioned (alongside duplication of roles among gov institutions). | Recognised the fear in job losses and regulating the informal economy as a challenge. | Bottom up approaches lacking in ability to challenge the more power actors. |

Source: Daniels and Ting (2019)

4.1.2 Kenya: Background, STI Context and TIP Mapping

Kenya is one of Africa’s fastest growing economies; with sustained average levels of growth over the past 10 years, the World Bank re-categorized Kenya from a low-income country to a lower-middle income country. Kenya ranks high on key science and technology indicators compared to other regional democracies. The current expenditure on R&D (% of GDP) stands at 0.48 percent, which translates to \$20 million (Ayisi et al., 2019a). The country’s long-term development blue print, The Kenya Vision 2030, envisions a newly industrialized middle-income country by the year 2030 (Kenya, 2007). By recognizing Science, Technology and Innovation (STI) as an essential component for incentivizing industrialization and economic diversification, the Vision envisages a globally competitive knowledge-based economy. In this context, science must translate into technologies and innovations that focus on addressing societal problems. Based on that, the current policy trend in the country recognizes STI as an enabler for Vision 2030 and therefore a key strategic instrument for realizing the government’s Big 4 agenda of food security, manufacturing (mainly focusing on job creation), affordable housing and access to affordable universal health care to address sustainable development, through economic and social transformation. Similarly, the constitution of Kenya as promulgated in 2010 also recognizes the role of science and indigenous technologies in national development and promotes the Intellectual Property Rights (IPR) of the Kenyan people (Ayisi et al., 2019a). Finally, the 2013 STI Act was enacted to re-align STI programmes to national goals and to strengthen the national system of innovation (NSI). Instead of one organization, the act created three strategic organizations, namely, National Commission of Science, Technology and Innovation (NACOSTI), National Research Fund (NRF) and Kenya National Innovation Agency (KeNIA). The three organizations are responsible for managing and promoting STI activities including research (Ayisi et al., 2019a).

Frame 1

Kenya's STI foundations based on Frame 1 is over 100 years old. In early 19th century, the colonial government while responding to the needs of the settler community set up pioneer research services and laboratories (Ayisi et al., 2019a). This set the stage for the country to start its R&D investment with a focus in agricultural and health research. This approach which prioritized investment in agricultural and health R&D as a strategy for fighting hunger and diseases remained in force up to the time of independence. Following independence in 1964, it was evident that there was "no centralized responsibility for the formulation of scientific policy in the country". This contributed to poor coordination of scientific research activities and hence inadequate integration of research finding into national development. For that reason, Kenya established a National Council for Science and Technology (NCST) and an appropriate number of Scientific Advisory Research Committees (SARCs) via the Science and Technology Act (Cap 250) of 1977. Against the backdrop of the colonial era research institutes, the review of the Science and Technology Act (Cap 250) in 1979 ushered in the establishment of specialized research institutions

It can observe that, Kenya's 50 years of post-independence investment in R&D with a focus on building institutions have indeed resulted in a linear model of innovation. Under this model, universities and research institutes concentrated on basic research. Generally, there was an assumption that scientific discoveries had the potential to be commercialized. Furthermore, in order to achieve value from its investments, the government had the role to play in balancing between locally generated innovations and imported ones. This had contributed to the delay of progress of R&D in key areas including engineering and manufacturing (Ayisi et al., 2019a).

Frame 2

Prior to 2013, Kenya's innovation policy landscape was characterized by large institutional fragmentation, weak coordination of government efforts, donor driven financing and poor linkages between universities, research institutes and the industry (Ayisi et al., 2019a). Early attempts to address these critical issues started with the development of the Kenya Vision 2030 and various strategies aimed at enhancing technology transfer, promoting links between academia and industry through incubators and entrepreneurship.

The Kenya Vision 2030 was initiated in 2007 as the country's development blue print with the goal of transforming the country into an industrialized middle-income nation by the year 2030 (Kenya, 2007). The Vision is being implemented in five-year Medium-Term Plans (MTPs) since 2008. The first two MTPs (MTP I-2008-2012, MTP II-2013-2017) (Kenya, 2008; 2013b) have already been implemented and the country is currently implementing MTP III (2018-2022) (Kenya, 2018). Kenya's Vision set out STI as a key foundation on which social, political and economic pillars of national development are anchored. The first major achievement of the Vision 2030 was the promulgation of the 2010 Constitution of Kenya which recognized the role of science and indigenous technologies national development; and promotes the intellectual property rights of Kenyans. In line with the 2010 constitution, the STI sector in MTP II had an overarching theme on STI. The theme emphasised policies that support the establishment of regional systems of innovation through analysis of gaps and opportunities which promotes first order learning. The plan further intensified the coordination of STI through flagship programmes. Therefore, Vision 2030 and the 2010 Kenyan constitution significantly addressed systematic challenges in the innovation policy system in Kenya.

Aligned to MTP II of Vision 2030 and the constitutional requirements, the government ratified the Science, Technology and Innovation (STI) Act 2013 (Kenya, 2013a), mainly to address deficiencies found in Kenya's innovation policy landscape. The STI Act was enacted to re-align STI programmes to national goals and to strengthen the national system of innovation (NSI). The Act mandated NACOSTI to act as a regulator, an adviser and coordinator of STI activities in Kenya. NRF mobilizes and manages financial resources on R&D (2% of the country's GDP) and KENIA manages innovation activities including facilitating commercialization of discoveries. The three organizations are responsible for managing and promoting STI activities including research (Ayisi et al., 2019a).

Frame 3

Kenya, like most countries, is adopting Frame 3 elements through clean technologies (in energy sector), pro-poor innovations (exemplified by Mpesa mobile money), inclusive innovations (such as community health strategy including beyond zero campaigns and improved health accessibility through NHIF insurance for all), grassroots innovations and social innovations (which focus on elements such as behavioural change) are also emerging. Applying Frame 3 lens into Kenya's STI policy, it can be argued that the STI Act of 2013 has sought to broaden key actors in the system which includes civil society and citizens.

Moreover, the country's most recent Big 4 agenda emphasises on environmental and social benefits that move beyond public-private partnerships to embrace co-creation, directionality, societal goals and reflexivity (Kenya, 2018; Ndakala et al., 2019). Considering inclusivity as the starting point, the constitution of Kenya (2010) articulated the expansion of social appropriation of knowledge production programmes to include communities and civil society and to promote effective dialogue between experts and communities. This borders on Frame 3 thinking, which underlie the importance of consolidating an innovation culture that includes diverse actors in the "design and the implementation of ideas for the solution of social, cultural, economic and environmental problems" (Ayisi et al., 2019a). The social innovation programme represents a very different approach to hitherto STI policy making. Within a social innovation approach, technology is conceived as an instrument for development and social transformation that works outside of market dynamics. The programme aims "to increase participation of actors in the solution of their needs by articulating the results of R&D and traditional knowledge from local communities". The Big 4 mainly focus more on policies and projects that directly impact the life of ordinary Kenyan citizens who are usually marginalized and isolated sections of society. Importantly, the Big Four vision is their resonance with issues that are pro-poor, inclusive, grassroots-based and encompass social innovations that directly affect the common person such as cost of living, jobs, shelter and health care and can be considered as a strategy to "localizing the SDGs" by aligning with Vision 2030 for their easier achievement (Ndakala et al., 2019). Frame 3 raises questions about the shortcomings of STI in addressing issues of social and environmental challenges. Thus, its focus on innovation is search process on the system level. This is guided by social and environmental objectives and does not imply that governments should completely abandon Frames 1 and 2, but re-examine challenges associated with the two frames.

Table 3: The evolution of Kenya’s STI policy and strategy, relative to the three Frames

| Date | Key policy and strategy events | Frames |
|------|--|--------|
| 1903 | First research institute opens in Kenya | 1 |
| 1963 | Kenya gains independence | 1 |
| 1970 | University of Nairobi, the country’s first public university opens its doors | 1 |
| 1977 | Enactment of the first Science and Technology Act | 1 |
| 1979 | Amendment to the S&T Act set up the first public research institutes | 1 |
| 2005 | Creation of an Inter-ministerial taskforce on STI and Sector Working Groups including stakeholders from outside government | 1 |
| 2008 | Launch of Kenya Vision 2030, a national developmental plan where STI is seen as a foundation stone to success | 1, 2 |
| 2010 | Kenya adopts a Constitution devolving power to counties and includes STI as fundamental requirements for the country’s development | 2, 3 |
| | Nairobi’s I Hub opens its doors | |
| 2013 | Enactment of a new Science, Technology and Innovation Act which creates new structures to assist the promotion, regulation and funding of STI in Kenya | 2 |
| | Launch of a Vision 2030 STI sector plan | 2, 3 |
| 2018 | Big 4 development Agenda | 2, 3 |

Kenya Case Study

For decades Kenya has been committed to providing quality education (SDG 4) for all as the foundation to creating sustainable development. However, the education system has largely remained highly structured. Classrooms are fixed and timings and locations are inflexible. In 2010, there was an increased pressure from non-state actors and adaptation of ICT in education contributed to the development of policy frameworks that led to Kenya’s experience of various elements of Frame 3 including social-technical change and inclusion in the education system (Ayisi et al., 2019a). So far, Kenya has made excellent commitments to nomadic education- the development of Nomadic Education Policy Framework set out the main features, challenges and strategies for the inclusion of nomadic populations into conventional formal education system (Ndakala et al., 2019). The educational strategy for nomads has continued to combine different delivery methods (boarding and mobile schools, radio broadcasts) together with new approaches and strictly adheres to the national curriculum to ensure equivalence with the rest of Kenya.

To bring about social technical change in the structured sedentary conventional system of education, the nomadic framework has led to the expansion of mobile schools in the form of tents, boats or buses depending on the local terrain. The Kenyan Government in conjunction with UNICEF and other non-state actors have established hundreds of mobile schools for nomadic Kenyans. To improve on the inclusion, these mobile schools allow teachers to move with the groups of nomads and set up temporary schools and tents in different places. They plan their school calendar around the rainy seasons when the students do not have many household chores to carry out (Ndakala et al., 2019; Ayisi et al., 2019b). Mobile teachers are selected by the community and after training, they continue to live and move with the community as they provide continuous education for nomadic children. As a result, children can attend secular lessons for two hours in the morning and two hours in the evening.

The project was transformative as it aimed to use science and technology in form of “socio-technical system changes” to meet social needs and addresses the issues of sustainable and inclusive societies (Ayisi et al., 2019a; Ndakala et al., 2019).

In Kenya, the nomadic regions in the country are generally arid and semi-arid (ASAL) with high temperatures and low levels of annual precipitation. These regions are amongst the most marginalised districts in the country. Moreover, these communities live a lifestyle which involves frequent resettlement in search of fresh water and pasture for their livestock. Due to the pastoralists' constant resettlement, children from these communities have found it difficult to formally access the Kenyan stationary and formal education system. In Kenya, existing government policies for improving access and equity of education are aimed at addressing an imbalance in enrolment, completion rates and academic achievement between children of ASAL and the rest of the country. However, these issues are usually addressed through a single delivery approach, where the norm is to teach in fixed classrooms, timings and locations. This is inflexible and in conflict with the nomadic lifestyle (Ayisi et al., 2019b; Daniels and Ting, 2019).

As a potentially transformative innovation initiative, mobile schools are essentially temporary structures and materials that are portable and can be easily be transported by camel as communities travel in search of water and pasture for their livestock. In this type of educational strategy, there is a recognition and respect for the social, environmental, cultural fabric and religious norms in the nomadic lifestyle. The implementation of the nomadic education framework has led to the expansion of mobile schools, as outlined, in the form of tents, boats or buses. In addition, mobile school teachers are derived from within the nomadic community and are trusted by the community elders to handle their children. This contributes to addressing sustainability concerns and inclusion, among other issues.

Table 4: Insights from Kenya’s transformative innovation policy case study

| Criteria | Directionality | Societal goals | System level impact | Learning and reflexivity | Conflict vs consensus | Inclusiveness |
|--------------|--|--|---|---|--|--|
| Kenya | Access to quality education is a priority. Mobile schools complement the nomadic lifestyle, contributes to formal education and support national development. | SDGs 1-6, 8, 10-13, 16-17 Agenda 2063: Science, Technology and Innovation Act, 2013 and the Big 4 Agenda (2018-2022) | System level impact in education, health, environment, peace, security and justice. | Existing routines and practices are being questioned, because sedentary schooling may not be appropriate for nomadic population | Recognition that there are differences in nomadic life. Trade-offs are recognised. | Parents and local community are involved in the delivery |

Source: Daniels and Ting (2019)

4.1.3 Senegal: Background, STI Context and TIP Mapping

Senegal’s evolution of its STI policy developments, can be delineated into four phases. These are the following: i) a period after colonisation (before 1965), ii) the period of increasing interest on STI from the public authorities (1965-1986), iii) the period of structural adjustment policies (1986-1994), iv) the period of ‘Renewed interest in science and technology ‘which begins from 1995 onwards (Cissé et al., 2019b).

Senegal does not have a formal STI policy document that is in line with international standards. However, Senegal has actively participated in the development and adoption of the STI policy of the Economic Community of West African States (ECOPOST) and the ECOWAS Research Policy (ECORP). Senegal is also participating in the African Initiative for STI Indicators (ASTII) (Cissé et al., 2019a). At present, the STI policies are executed at the level of the Ministry of Higher Education, Research and Innovation (MESRI).

Frame 1

Senegal expenditure of R&D to GDP has seen a marked increased trend over the years, from 0.45% in 2008, 0.54% in 2010 to 0.91% in 2012, 0.73% in 2013 and 0.8% in 2015 (UNESCO, 2015; Cissé et al., 2019b). Expenditure of R&D mostly comes from the government,⁴ usually through a grant from the parent Ministry. However, it has been noted that more than 85% of this allocation goes to salary payments. Furthermore, Senegal has put in place a policy of upgrading the university lecturer and researcher function through one of the highest average pay levels in Africa (Cissé et al., 2019b). Included in this policy, is the support for study and research trips, laboratories and scholarships for all

⁴ <http://uis.unesco.org/en/country/sn?theme=science-technology-and-innovation>

PhD and Masters students. From a Frame 1 perspective, Senegal has numerous financing instruments for its STI activities, and these include:

- Scientific and Technical Publication Fund
- National Fund for Agricultural and Agro-Food Research
- Fund for Financing Professional and Technical Training)
- National Bank for Economic Development-financing SMEs
- Funds for Rapid Entrepreneurship- reduce youth and women's unemployment by promoting entrepreneurship and employment

Frame 2

To enable STI to play a greater role as a driver of socio-economic and cultural development, a National Council on the Future of Higher Education (CNAES) was convened in 2013. Consequently, a 2013-2017 reform program priorities in Senegal and a Higher Education and Research Development Plan (PDESR) have served as an impetus into presidential decisions, which are in the process of being implemented (Cissé et al., 2019b). From a Frame 2 perspective, there seems to be a fundamental systems failure in Senegal's NSI. This is because, there is currently no coordinating national framework in which to unify the numerous ministries, implementing agencies and research institutes. This lack of coordination has contributed to the dispersion and fragmentation of research and innovation through a duplication and competing priorities. Added to this is a weakness and fragmentation of funding sources and a lack of visibility, consultation and synergy between the stakeholders. Nevertheless, efforts are being made to improve governance through the implementation of sectoral consultation frameworks such as agriculture and health (Cissé et al., 2019b).

Frame 3

Despite significant investments in Frames 1 and 2, Senegal is unable to resolve social and environmental problems in a sustainable manner. Expenditure on R & D has not translated well into the economy because of the lack of applied research and the valorisation of research results. Similarly, the systems put in place to facilitate interaction between the actors of research and innovation have shown their limitations. To this end, in 2012, Senegal has decided to adopt a new development model to accelerate its progress towards emergence. This strategy, known as *Plan Sénégal Emergent* (PSE), is a new development model to accelerate its progress towards economic growth. The PSE is the country's developmental plan to achieve an upper middle-income status by 2035. The PSE aims to improve the well-being of the population through inclusive growth. In this sense the PSE is align with the aspirations as outlined in Frame 3 on directionality in that it seeks to put in place "a process for setting collective priorities" (Schot and Steinmueller, 2018). Relatedly, as part of operationalising the PSE, major investment program in thriving sectors, capable of stimulating strong and sustained growth momentum has been articulated. These are implemented in strategic orientations:

- a structural transformation of the economy through the consolidation of the current drivers of growth and the development of new sectors that create wealth, employment, social inclusion and strong export and investment attraction capacity.
- a significant improvement in people's living conditions, and more sustained fight against social inequalities while preserving the resource base and promoting the emergence of viable territories, and

- strengthening security, stability and governance, protecting rights and freedoms and consolidating the rule of law in order to create the best conditions for social peace and to promote the full development of potentialities.

In sum, despite the political will of the Senegalese state to promote human capital, research and innovation through multiple initiatives, various challenges remain. These challenges include i) the fragmentation of research and innovation institutional framework resulting from the lack of a single consolidated strategy, ii) the weakness and fragmentation of funding sources, iii) the lack of effective engagement between researchers and decision-makers, which constitute obstacles to the development of a transformative innovation policy to both foster and support transition to sustainable development and transformative change (Cissé et al., 2019b).

Senegal Case Study

The Senegal team chose to work on the use of ICTs in higher education through the example of the Virtual University of Senegal (UVS). The transformative history of the UVS aims to trace the process of its creation, discuss the role of political actors and leadership in the various stages of its creation, analyse the mechanisms that favoured transformative innovations, but also constraints encountered, challenges and perspectives (Cissé et al., 2019a).

Faced with the growing and sustained trend in the number of students opting for traditional public universities and the shortage of spaces; the Senegalese authorities decided to integrate distance education into higher education. In this regard, the Virtual University of Senegal (UVS) serves as a case study on transformative innovation through the use of ICTs in higher education through (Diallo et al., 2019; Daniels and Ting, 2019).

The UVS is a public digital university, which aims to provide Senegalese population, youths in particular, with equitable access to higher education. The UVS takes into consideration the population growth and rapid trends in ICT, which will require new ways of equipping students in the digital age. In the implementation of the UVS, the Ministry of Higher Education, Research and Innovation (MESRI), has provided the Espace Numérique Ouvert (ENO) (open digital spaces). The ENOs are physical infrastructures, facilitating access to digital materials for students and providing ICT equipment. Learning at the UVS combines in person (i.e. physical presence) with online training, and progressively decreasing in person session as the student advances in its curriculum (Diallo et al., 2019; Cissé et al., 2019a; Cissé et al., 2019c).

The conceptualization of the UVS started in the 2000s. It was eventually established in September 2013, by presidential decree. The university started with an initial student registration of around 2050. By 2018, the number of students associated with UVS has grown to more than 28 000 and the first cohort has since graduated. The UVS slogan in Wolof, “foo nekk foffu la” means literally “where you are, is where it happens” signifying that its aim is to socialize education within the local communities where students live, and in so doing, ensure that students are local agents for change (Diallo et al., 2019). The UVS is a significant innovation in higher education in Senegal due to a dual need to absorb the growing number of new graduates and to consider societal concerns through the integration of technology enhanced teaching and learning.

Table 5: The four phases of STI policy development in Senegal’s history

| Year | Institutional activity |
|--|--|
| PHASE 1: Before 1965 | <ul style="list-style-type: none"> • Heritage of colonization • Research institutions inherited from colonization |
| PHASE 2: 1965-1986 | <ul style="list-style-type: none"> • Increasing interest on STI from the public authorities • 2nd National Development Plan I: Creation of the first national research and education institutes • Political engagement to coordinate and monitor scientific and technical research • Enhanced cooperation to offset weak internal resources with external funding |
| PHASE 3 1986-1994 | <ul style="list-style-type: none"> • Structural Adjustment Policies • Poor appreciation of the importance of STI due to • Structural adjustment policies |
| PHASE 4: 1995-1998 1998-2012 2012-2019 | <ul style="list-style-type: none"> • Renewed interest in science and technology • Period before political alternation: beginning of renewed interest in science and technology • First political alternation: high frequency of ministerial reshuffles • Second political alternation: increased interest in science, technology and innovation |

Source: Cissé et al., 2019b

Table 6: Insights from Senegal’s Transformative Innovation Policy Case Study

| Criteria | Directionality | Societal goals addressed | System level impact | Learning and reflexivity | Conflict vs consensus | Inclusiveness |
|----------------|--|--|---|--|---|---|
| Senegal | <p>Reduce (1) inequality of access to higher education; and (2) digital divide, in line with market demand (ICT)</p> <p>Education viewed as part of a knowledge economy</p> <p>Improving (1) access to higher education (enrolments) and (2) youth employability</p> | <p>SDGs 1-5, 8, 8-10, 16-17</p> <p>Agenda 2063:</p> <p>Plan Senegal’s Emergent (PSE), 2014</p> | <p>Strong focus on regional development- (revitalizing particularly rural, landlocked or remote areas).</p> | <p>Historically, distance learning projects in Africa have often been aimed at passing on courses created in European or American universities to African students.</p> <p>UVS courses entirely designed and delivered by Senegalese teachers.</p> | <p>Parents at first hesitant or lack understanding of distance/virtual learning. Over time this perception had changed. Parents’ teachers association critical for bridging this divide (parents association and unions).</p> | <p>Reducing gender inequalities in access to education.</p> |

Source: Daniels and Ting (2019)

4.2 Case Country's Transformative Innovation Learning Histories

The major insights obtained from the Transformative Innovation Learning History reports from each of the three countries are briefly discussed and summarised below, starting with Ghana.

Ghana

The TILH examined transformative innovation based on the E-waste case study in Ghana (Quaye et al., 2019c). The following are major insights.

- We observed that the e-waste management case study had opportunities for learning and reflexivity as the business as usual approach remains inadequate. There was a need to interrogate current practices, particularly the importance of including a broad participation of stakeholders in the decision making. These actors can include policy makers, researchers, civil society, and collectors in the informal sector, scrap dealers, small scale entrepreneurs, private sector, amongst others. In this way, a truly transformative innovation, takes into consideration a whole socio-technical systems approach.
- A top down approach, whereby regulations and enforcement of by-laws in e-waste management alone are inadequate. It was imperative that alongside these approaches, education and awareness creation on e-waste segregation, as well as health and environmental risk factors was critical. In this way, raising the capabilities of all actors, particularly beneficiaries, can facilitate support or buy in, during implementation stages.
- As part of the top down approach, there are attempts to regulate the informal micro, small and medium sized enterprises (MSMEs), which had raised fear of job losses. In this instance, small scale entrepreneurs in the e-waste value chain need protection and assurance of jobs in channelling hazardous materials into registered and sound treatment facilities. Relatedly, effective management of conflicts and tensions in ways that help to reach an understanding and consensus among stakeholders is essential to transformation in the e-waste management ecosystem.
- A transformative innovation approach, will require, new business models/partnerships/collaboration, to attract the much-needed investment or other means of support in e-waste management infrastructure in Ghana. If done correctly, an efficient e-waste management has the potential to contribute to Ghana's job creation drive and transformational agenda.
- Awareness of social responsibilities of re-cycling companies, Extended Producer Responsibility (EPR) and progress in carbon financing should be vigorously pursued.
- Data challenges of efficient e-waste management in Ghana are many and acute. Data gaps on the ratio of imported vs in-country generated e-waste, quantities of e-waste generated in Ghana annually, and composition of e-waste, are some examples of the challenges that need to be urgently addressed.
- Finally, there is the need to integrate the e-waste policy with the Environmental Sanitation Policy and handling conflicts of interests among various institutions. Addressing the duplication of roles among government institutions, through adequate coordination mechanisms will go a long way in improving the situation. Speedy completion of the formulation of the e-waste policy and effective implementation will be vital to Ghana's

strengthening efforts in e-waste management, thereby improving the prospects for transformative change across systems, structures and societies.

Kenya

The following are major insights from the transformative innovation based on the Nomadic education case study in Kenya (Ayisi et al., 2019b).

- In order for innovation to produce societal / social impact and lead to transformative change, alignment with existing culture and lifestyle is vital. We observed that a local champion, in this instance, a representative of the County Commissioner attributed to a high enrolment in mobile schools (MS) by the Samburu community, because the mobile schooling approach does not pose a threat to their cultural lifestyle. Moreover, the mobile schools provide affordable education to the community in ways that compliments their way of life and economic livelihood
- Bottom-up approach plays a significant role and is essential to innovation for transformation. The mobile schools in Samburu is a “community-led / owned initiative” previously identified in the region in 2003 through Participatory Rural Appraisal (PRA) methodology in collaboration with UNICEF to ensure proper needs analysis and ownership.
- Inclusion, in this case via ownership by the Samburu (local) community, is essential to the adoption and diffusion of transformative innovation intervention. The Samburu MS initiative has led to the adoption of education by children and adults in the rural area, with spill overs to formal education. As a result of the MS initiative children in the rural areas and pastoralists are able to read and write. At the same time, children are able to assist their parents in herding the livestock, while acquiring education alongside.
- Incumbents and established actors, such as governments, can have a decisive role to play in transformative innovation. This must be encouraged and utilized with application. In this case study, the County Government of Samburu built an Early Childhood Development (ECD) Centre in Locho area and a road. The ECD Centre serves as a shelter during rainy seasons while the road provides transportation access to the rural area.
- Connecting transformative innovation to existing initiatives facilitates scaling up, sustainability and transformative change with long-term societal impacts. The Samburu community mobile schools, which are informal in nature, now act as feeders to formal schools. Hence, there is enhanced enrolment in formal schooling and transition to formal schools/education and with improved performance in national examinations across the country.
- Inclusive innovation contributes to achieving national development priorities and societal goal/impacts. This in turn leads to transformative change and improved well-being. The transformative nature of the mobile schools has resulted in positive impact on peace, security, and stability in the region with implications for the nation as a whole. As a result of attending mobile schools and acquiring education via the mobile schools, boys in mobile schools stated that (a) cattle rustling (crime) has reduced in the area, (b) they now value human life and (c) are able to communicate to people outside their communities. Relatedly, girls stated that mobile schools have protected them from early marriages. Women (their mothers) corroborated these accounts by adding that the schools have improved the behaviour of their girls since they no longer idle around after herding their livestock.

- The Samburu case revealed that other SDGs (e.g. Gender) are also being achieved through this initiative. The MSs are attended by both girls and boys, while other actors are involved in the management of the MS, thus promoting inclusivity and achieving the SDGs
- Transformative innovation is made successful by inputs and contributions from a wide range of actors. These include: Christian churches representing civil society; government agencies at various levels, and the community which provide for example, food, financial support to mobile school teachers and security, writing materials, and paraffin used for lighting.

Senegal

The following are major insights from the transformative innovation based on the Virtual University in Senegal (Cissé et al., 2019a).

- It can be argued that the successful establishment of Virtual University of Senegal (UVS) was the result of strong political commitment from Senegal's national government and local authorities – demonstrating a strong focus on societal goals and directionality, two core criteria for transformative change.
- Moreover, a strong local champion in the form of leadership from the Minister of Higher Education, Research and Innovation (MESRI) has been a critical factor in the success of the conceptualisation, design, and implementation of the UVS.
- The establishment of the UVS had provided a functional multi-stakeholder exchange framework, which enabled a crucial participatory process in various stages of implementation. For example, stakeholders' consultations at national and international levels led to informed and relevant decisions that were vital to the success of the UVS.
- The use of local expertise in the design of the UVS fostered its harmonious integration into the social fabric of the country, thus emphasising the importance of inclusion and participatory approach to transformative innovation.
- The UVS also, had robust monitoring and evaluation system put in place which was essential to making the necessary revisions to the project goals in ways that encouraged adaptability and robustness.
- The sustainability of the UVS, however, requires the combination of different policies designed to address the human, financial and organizational challenges necessary for achieving societal goals.

Summary of key insights and lessons from country TILHs

Ghana's TILH, revealed that some actors dominate the policy space, at the expense of less powerful groups (e.g. beneficiaries) who are prevalent within the Africa TIP policy ecosystem. This disconnect – among strong actors, weaker actors, and beneficiaries – could potentially have a detrimental impact once initiatives are implemented, because of a lack of “buy-in” (Quaye et al., 2019d).

Kenya's TILH on the other hand points to a strong recognition that for transformative change to be successful, it is essential that existing cultures and lifestyles among the local communities are preserved in the formulation, implementation, evaluation and governance of innovation (but also, public) policies. Therefore, mobile schools complement the nomadic lifestyle by providing flexibility,

job opportunities for the pastoralists, and a break from the traditional way of learning (Ayisi et al., 2019b; Ndakala et al., 2019). TIP Policies recognise the importance of local communities and grassroots innovation, thereby promoting inclusion.

Senegal's TILH, by focusing on students and individuals in general as local agents for change, places a strong emphasis on community-driven learning for example, as a major factor in the success of innovation for transformative change programmes. In recognising this key element for transformation, the ENO model facilitates a regional approach to education, and thus mitigates youth migration to the cities, and other social and environmental challenges including urbanisation, exclusion and marginalisation of women and girls in STEM, inequality and digital divide (Cissé et al., 2019a).

4.3 Research Insights Brief summary

The Research Insights Briefs are linked to the two transnational working sessions (workshops) during which participants used the time and space to engage in mutual / second-order learning, and reflexivity – key TIPC concepts and principles. The research briefs were co-created by the three local research teams (using insights from the three TILH's), with inputs from the SPRU research team.

4.4 Blogs

In line with the objectives of the research each country produced blogs based on the transnational insights learning sessions (workshops) and TILH (case studies). The blogs helped the country teams to express what they have learned about prospects for transformative innovation policy in their context, and possible options for future work. The blog was also an avenue for documenting the process, promoting mutual learning and enhancing reflexivity. Citations for the blogs are provided below, and in the References section. For Ghana's blogs, see for example, Quaye et al. (2019a) and Quaye et al. (2019e); while for Senegal's blogs, see for example, Cissé et al. (2019c) and Diallo et al. (2019)

4.5 Insights working session training materials

As stated in Section 4.4 above each country produced blogs based on the transnational insights learning sessions (workshops) held in 2019: 4th and 5th February, South Africa; and 18th and 19th July, Senegal. References to the country specific blogs have been provided in Section 4.4 above. In addition to the country specific blogs and outputs, below are related materials that help capture some of the learning and insights from the two insights working sessions.

- a. TIP Africa Hub: Second Transnational workshop takes place in Senegal, July 24, 2019, <http://www.tipconsortium.net/news/tip-africa-hub-second-transnational-workshop-takes-place-in-senegal/>
- b. Transformative Innovation Policy in Ghana: Lessons from the South Africa workshop, March 10, 2019, <http://www.tipconsortium.net/transformative-innovation-policy-in-ghana-lessons-from-the-south-africa-workshop/>

- c. TIP Africa Hub advances understanding of transformative change as case studies chosen, February 7, 2019, <http://www.tipconsortium.net/news/tip-africa-hub-advances-understanding-of-transformational-change-as-regional-case-studies-chosen/>
- d. Africa Hub Meets in February to Review First Stage, January 14, 2019, <http://www.tipconsortium.net/headline/africa-hub-meets-in-february-to-review-first-stage/>

4.6 Final TIPC project conference

The four project countries – Ghana, Kenya, Senegal and South Africa – attended the Final TIPC project conference, which took place on 4-5 November 2019, Valencia, Spain. The three pilot countries, Ghana, Kenya and Senegal, presented their projects and participated in the poster sessions. The conference report and outputs are available at: <http://www.tipconsortium.net/tip-conference-report-2019/>; while for the posters, visit: <http://www.tipconsortium.net/poster> and links to the TIP Africa Hub case countries⁵.

4.7 Academic journal papers

4.7.1 Academic journal papers based on individual country case studies

The academic journal papers in this group, co-written by country teams and PI, are based on the country case studies. Participating countries researchers lead the production of the papers, which are based on the TIP work, ideas, and project findings. The PI, SPRU and TIPC teams provide support. As of the time of this report, the papers are still in development. The current status are as follows:

- a. Ghana: paper is currently undergoing peer review
- b. Kenya: in progress, draft completed, undergoing internal peer reviews
- c. Senegal: in progress, second draft completed, revisions and production of third draft

4.7.2 Academic journal paper incorporating the three country cases

Similar to 4.7.1 above, this academic journal paper, is based on the pilot. However, in this case the paper is led by the PI and builds on the three country country-specific papers. Status: in progress.

4.8 Policy brief

A TIPC policy brief was published, which outlined key lesson and insights relevant for policy makers (Daniels and Ting, 2019). The Policy brief summarises the main findings and provide overarching recommendations. The consolidated key messages and recommendations are presented in Table 7 below.

⁵ **Ghana's** poster on "[Transformative Innovation Policy Research on e-Waste Management in Ghana](#)"; **Kenya's** poster on "[Nomadic Education in Kenya: A Case Study of Mobile Schools in Samburu County as a Transformative Innovation Policy](#)"; and **Senegal's** poster on "[Transformative Innovation Learning History – ICTs and higher education: the case of the Université Virtuelle du Sénégal](#)".

Table 7: Key Messages from the TIP Africa case studies TIPC Policy Brief

| | |
|--|--|
| <p>Key message 1 Top down approaches to policymaking continue to dominate the African innovation policy ecosystem. This results in disconnects among policy actors, with potentially detrimental impacts on the implementation of policy initiatives, due to a lack of buy.</p> | <p>Recommendation 1 Encourage policy learning, and policy experimentation in ways that combine top-down and bottom-up approaches in policymaking.</p> |
| <p>Key message 2 Transformative innovation must recognise and address the concerns of existing local cultures, practices and lifestyle; particularly those that enhance and/or help to address social, environmental, inclusion and sustainability.</p> | <p>Recommendation 2 Consider the use of new policy instruments (that target inclusion and sustainability, i.e. SDGs) in existing and future policy mixes.</p> |
| <p>Key message 3 Co-creation of knowledge, agenda/priority setting and community driven learning, are essential to the success of transformative innovation. Individuals and communities are essential local agents for change, transformation and achieving the SDGs.</p> | <p>Recommendation 3 In formulating, implementing, evaluating or governing transformative innovation policies, policymakers must place strong emphasis on grassroots innovations and actors. In addition, innovation for transformative change must incorporate innovations from the informal economy, alongside a focus on innovation for inclusive development</p> |

Source: Daniels and Ting, 2019

4.9 Webpage and Video

A video on “An Introduction to the TIP Africa Hub”, which provides a summary of the entire project is available at the dedicated page for the research project: http://www.tipconsortium.net/regional_hub/tip-africa-hub/. The video can also be accessed at: https://www.youtube.com/watch?time_continue=4&v=TVf5gjiU45rA&feature=emb_logo

4.10 Research outputs and outcomes

In this section, I present a summary of the main outputs and outcomes from the research project.

4.10.1 Summary of outputs

The list of outputs from the TIP Africa Exploratory Hub research project include: research briefs, blogs, grey literature, training materials and academic journal publications (in progress). The majority of the outputs are published online on the TIP Africa webpage, available here: http://www.tipconsortium.net/regional_hub/tip-africa-hub/.

1. **Country STI Policy Ecosystem Mapping** reports based on the TIP lens:
 - a. Ghana: Quaye et al., 2019b
 - b. Kenya: Ayisi et al., 2019a
 - c. Senegal: Cissé et al., 2019b
2. **Country Case Studies** referred to as Transformative Innovation Learning History (TILH) in TIPC terminology:
 - a. Ghana: Quaye et al., 2019c
 - b. Kenya: Ayisi et al., 2019b
 - c. Senegal: Cissé et al., 2019a
3. **Research Insights Briefs** linked to the TILHs and two transnational working sessions.
4. Country specific **blogs** based on the insights from the transnational working sessions (workshops) and TILHs. Examples are provided below. The full list can be found online at www.tipconsortium.net
 - [The E-waste Mgt. system in Ghana through the Transformative Innovation Policy Lens](#)
 - [Pathway forged towards Transformation in South Africa with STI Experimentation](#)
 - [Transformative Innovation Policy in Ghana: Lessons from the South Africa workshop](#)
 - [TIP Africa Hub: Second Transnational workshop takes place in Senegal](#)
 - [TIP Africa Hub advances understanding of transformative change](#)
5. Insights Working Session **Co-creation and Learning Journey Materials**
 - a. Insights Working Session Co-creation Material, South Africa, Annex 1
 - b. Insights Working Session Communications Material, South Africa, Annex 2
 - c. Insights Working Session Co-creation Material, Senegal; Annex 3
 - d. Insights Working Session Communications Material, Senegal; Annex 4
6. **Final TIPC project conference** attendance and presentation of project: 4-5 November 2019, Valencia, Spain. Conference materials and more info available at: <http://www.tipconsortium.net/tip-conference-report-2019/>

7. **Academic journal papers**
 - a. **Academic papers** based on country case studies, co-written by country teams and PI:
 - i. Ghana: the paper applies the TIP learning in the management of e-waste
 - ii. Kenya: in progress, first draft completed
 - iii. Senegal: in progress, second draft completed
 - b. **Academic journal paper**, led by PI (in progress, builds on the three country cases)
8. **Policy brief** that summarises the main findings and provides overarching recommendations.
9. **Webpage and Video** on “An Introduction to the TIP Africa Hub” available at: http://www.tipconsortium.net/regional_hub/tip-africa-hub/. The video is located on a webpage dedicated to the research project.
10. Final **technical report**, refers to this report.

4.10.2 Summary of outcomes

In terms of outcomes, below is a summary of a selection. The following were achieved:

1. Capacity building on TIP with a group of SSA countries involved in the SGCI. Three countries that took part in a deeper analysis of the prospects for TIP through a country review and TILH, conducted in a co-creation process, between national researchers and policymakers on one hand, and SPRU and TIPC teams on the other hand.
2. Senegal has committed to joining TIPC as full member, and in addition have demonstrated an interest in establishing and hosting a West Africa Regional TIP Africa Hub. The hub, is being designed to serve other countries in the region, such as Burkina Faso, Cote d’Ivoire, Ghana, and Nigeria. Discussions in setting up the Hub are underway. The Hub will provide a platform for interactive learning and building the capacity of SSA countries in TIP work.
3. Alongside South Africa (a founding TIPC member), Ghana, Kenya and Senegal are now knowledgeable in the TIP concepts, theories, research methodology and literature; understand the TIP approach to innovation policies, and are equipped with skills to carry out further research and policy analyses using the TIP approach.
4. This research has led to more explicit linkages between the work of SGCI and TIPC in SSA countries. It has, therefore, created a good platform for further collaborations in innovation, development and public policy.
5. As the outputs presented above show, by applying the TIP approach in the SGCI and national contexts, the research has produced empirical evidence and useful lessons that can inform future policy research on the role of innovation in transformative change.
6. Through TIP Africa pilot research, the University of Sussex have been able to develop a deeper tri-lateral relationship between SPRU, NRF and IDRC on TIP and other strategic partnerships.
7. The three countries are exploring opportunities for collaborating among themselves in proposal development, joint application of calls and project delivery.
8. The project has enhanced research collaboration and mutual learning among the countries, who hitherto, did not have active research engagements. Furthermore, nor have the actors previously collaborated together. This fosters integration at national and regional levels.

9. Moreover, further collaboration between the participant countries and other partners - NRF, IDRC, SPRU and TIPC – are being sought to provide opportunities for new strategic partnerships.
10. Lastly, the TIP Africa Hub exploratory research, and TIPC work, has contributed to the success in securing on a five-year Tri-lateral Research Chair that involves the University of Sussex, University Johannesburg, South Africa and Jaramogi Oginga Odinga University of Science and Technology (JOUST), Kenya^{vi}. This five-year research project will involve eight fully-funded doctoral researchers, recruitment of additional faculty, and has the possibility of renewal.

5. Challenges experienced in the course of the project

The research did experience some difficulties, of which some were relatively easy to navigate, whilst others required more time, resources, planning and management. Below is a summary.

- Governance and coordination issues: each of the countries had their own unique research cultures and practices, with some working more hierarchically, while others had flat, open structures. These diverse ways of working needed to be appreciated, recognised and carefully coordinated in order to ensure project success.
- Quality of national project teams and time availability: the research project from the start, tried to include a high calibre of researchers and strategic policymakers to work with, which proved difficult. Researchers in the project had their academic qualification and relevant experiences scrutinised, to ensure suitability and success. Moreover, it was imperative that researchers and policymakers, worked in a co-creation process, so that outputs and outcomes were derived from each of the countries. However, in majority of the cases, the project did suffer from optimal dedication and commitment, considering that this project was, for example, the second, third or even lower in the priority list of researchers' workload.
- Data collection: the field work in Kenya, required travel across long distances, and in remote areas. In this instance, more time should be allocated to account for local needs such as nomadic tribes. Moreover, the research project achieved three field case studies, and three trans-national workshops, across Africa, in less than one year. Travelling in these countries required time, visa considerations, and flexibility throughout the research.
- In-country management and funding processes: in a few instances, the admin, management and governance processes were significantly slower and not adequately coordinated in the respective countries. This meant that, for example, funds were not approved in time for country teams to attend the transnational working sessions and the final conference. Visas were late, and some countries missed out on key engagement events. Institutions handled funding allocation and travel approvals differently. Therefore, clear expectations and good funding management are essential to success.
- Language challenges: working in multiple languages presented some challenges, with the resources and materials e.g. academic papers and training materials requiring translations, and session facilitators only able to function effectively in one language, English. The language challenge and the need to work in two languages (English and French) required more resources (bilingual teams and session facilitators, translation of written materials, interpretations during workshops, and field work). Multiple countries with various languages should be encouraged, in order to provide diversity in research findings. However, future projects of this nature should take into consideration resource, communication and cost implications.
- Research project duration: the duration of the project was considerably short relative to the objectives, expected outputs and outcomes. This is particularly important because the participating teams from Ghana, Kenya and Senegal especially, had very little or no prior knowledge of the core TIP concepts such as 'socio-technical transitions' and 'directionality'.

6. Overall Assessment, Next steps on TIP Africa Hub, and Future Research

6.1 Overall Assessment

The project was a success, considering that it was a one-year exploratory research project with limited resources, in terms of funding and human resources. In addition, the countries were starting from a point where they did not have relevant capabilities or prior experience of dealing with the key concepts, theories and methodologies utilised in the research. As the outputs and outcomes, outlined in the section above show, the achievements were significant within the short duration and the limitations imposed by funding, capabilities, access to personnel and policy processes. The results show that there are many opportunities to build on these early achievements. I articulate some of the opportunities below.

6.2 Next steps on TIP Africa Hub

The priority next step is for TIPC and IDRC to continue engagements with the three countries on TIP work, building on the capabilities in STI and the policy developed. One of the major outcomes of this project is the commitment from Senegal to become a full TIPC member, and host the West Africa TIPC Regional Hub. Details are still being worked out. However, with Senegal as a TIPC member, other countries in the region, interested in the TIP approach, for example, Ghana, Nigeria, Burkina Faso, and Cote D'Ivoire^{vii}, will have a place to continue with TIP Africa work. The Hub, when in place, will provide a platform for countries to engage with TIPC ideas, experiment with the approach, and gain deeper insights into the theories and concepts. Furthermore, Ghana and Kenya could possibly join TIPC as full individual members in the future. Discussions are on-going with the respective actors. TIPC is also working on setting up a Southern Africa (SADC) Hub, to be led by South Africa. This Hub is expected to achieve many objectives, two of which are: (a) ensure connection between the Senegal-led hub (West Africa TIP work) and SADC hub, making it possible to ensure mutual learning at the continent level; (b) provide a platform for other SADC countries, interested in TIP work, to engage and benefit from the initiative.

Currently, the TIPC and SPRU teams are working on improving the linkage between the work taking place in TIP Africa Hub and the existing Trilateral Research Chair, which was initiated last year. The Trilateral chair entitled "Transformative Innovation, the 4th Industrial Revolution, and Sustainable Development", includes faculty, researchers, and doctoral students from SPRU, University of Sussex; JOUST in Kenya, and the University of Johannesburg, South Africa.^{viii} The establishment of TIP Africa Hubs and the Trilateral Chair research programme, will provide many opportunities to extend TIP work in Africa to other countries, such as those aligned to the SGCs, including Burkina Faso and Cote d'Ivoire in West Africa, and Botswana, Malawi and Zambia in SADC.

6.3 Future Research

Future research is essential to help pilot countries move on to the next stage of TIPC work, focusing on policy experimentation and evaluation; and to make it possible for new countries to start the pilot phase. With more countries exposed to TIP research and the approach to policy, there is a potential for a radical transformation in policy formulation, implementation, evaluation and governance that is best suited to the African context and to the increased prospects of achieving the SDGs.

References

- ACBF (2017). *Africa Capacity Report 2017, Building Capacity in STI for Africa's Transformation*.
- AfDB (African Development Bank), 2020. African Economic Outlook 2020, Developing Africa's Workforce for the Future. African Development Bank, [https://au.int/sites/default/files/documents/38116-doc-african_economic_outlook_2020 .pdf](https://au.int/sites/default/files/documents/38116-doc-african_economic_outlook_2020.pdf)
- AMANKWAH-AMOAH, J. 2016. The evolution of science, technology and innovation policies: A review of the Ghanaian experience. *Technological Forecasting and Social Change*, 110, 134-142.
- AMOYAW-OSEI, Y., AGYEKUM, O. O., PWAMANG, J. A., MUELLER, E. & FASKO, M. 2011. Ghana e-Waste country assessment.
- AOSTI (African Observatory of Science, Technology and Innovation) (2013). Science, Technology and Innovation Policy-making in Africa: An Assessment of Capacity Needs and Priorities, AOSTI, Working Papers No. 2.
- ATIEMO, S., FAABELUON, L., MANHART, A., NYAABA, L. & SCHLEICHER, T. 2016. Baseline assessment on e-waste in Ghana Accra, Ghana: Sustainable Recycling Industries (SRI)
- AUC (2015). Agenda 2063, The Africa We Want, Popular Version. Addis Ababa: AUC
- AUC (African Union Commission) (2014). *AU Strategy for Science, Technology and Innovation for Africa 2024, STISA-2024*, Addis Ababa: African Union.
- AUDA-NEPAD (African Union Development Agency), (2019) African Innovation Outlook III. AUDA-NEPAD: Johannesburg, <https://au.int/en/documents/20200213/african-innovation-outlook-iii>
- AYISI, J., NDAKALA, F., NYANGA, R., DANIELS, C., OWUOR, R., TING, M. B. & WANYAMA, B. 2019a. Assessing the Potential for Transformative Innovation Policy in Kenya National Commission for Science and Technology (Nacosti) and Transformative Innovation Policy Consortium (TIPC) [*Kenya's STI Ecosystem Mapping, "five-pager"*]
- AYISI, J., NDAKALA, F., OWUOR, R., NYANGA, R., DANIELS, C., BONIFACE, W. & TING, M. B. 2019b. Nomadic Education in Kenya: A case study of mobile scholls in Samburu County, as a transformative innovation policy *TILH report, TIP Africa*.
- BALDÉ, C. P., R. KUEHR, BLUMENTHAL, R. K., GILL, S. F., HUISMAN, J., KERN, M., MICHELI, P. & MAGPANTAY, E. 2015. E-Waste Statistics: Guidelines on Classifications, Reporting and Indicators. Bonn, Germany.
- CHATAWAY, J. & DANIELS, C. 2020. The Republic of Science meets the Republics of Somewhere: Embedding scientific excellence in sub-Saharan Africa. . *In: KRAEMER-MBULA, E., TIJSSEN, R., WALLACE, M. L. & R. MCLEAN, R. (eds.) Transforming Research Excellence: New Ideas from the Global South*. Cape Town, South Africa: African Minds.
- CHATAWAY J, DOBSON C, DANIELS C, BYRNE R, TIGABU A & HANLIN R (2019) Science Granting Councils in Sub-Saharan Africa: Trends and tensions. *Science and Public Policy* 46 (4): 620–631
- CISSÉ, F., DIÉMÉ, J. S., ASSION, L., SY, M., DANIELS, C. & TING, M. B. 2019a. ICT in Higher Education in Africa: Example of the Virtual University in Senegal. *TILH Report, TIP Africa*.
- CISSÉ, F., DIÉMÉ, J. S., SY, M., DANIELS, C., DIALLO, M. & TING, M. B. 2019b. Developing a Transformative Innovation Policy Approach: the case of Senegal University Cheikh Anta Diop (UCAD) and Transformative Innovation Policy Consortium (TIPC)

- CISSÉ, F., SY, M., DIÉMÉ, J. S., DANIELS, C. & TING, M. B. 2019c. Implementation of Open Digital Spaces and the Virtual University in Senegal: a Journey through Transformative Innovation. <http://www.tipconsortium.net/7088-2/> [Online].
- DANIELS, C (2017) Science, Technology and Innovation in Africa: Conceptualisations, relevance and policy directions. In C Mavhunga (ed.) *What Do Science, Technology and Innovation Mean from Africa?* Chicago, USA: MIT Press
- DANIELS, C. & TING, M. B. 2019. Transforming Science, Technology and Innovation Policies in Africa: Insights from Ghana, Kenya, Senegal and South Africa. *TIPC Policy Brief*. University of Sussex: Transformative Innovation Policy Consortium (TIPC), available at: <http://www.tipconsortium.net/publication/tipc-policy-brief-transforming-science-technology-and-innovation-policies-in-africa-insights-from-ghana-senegal-and-south-africa/> (accessed 25 May 2020).
- DANIELS, C. U., USTYUZHANTSEVA, O., & YAO, W. (2017). Innovation for inclusive development, public policy support and triple helix: perspectives from BRICS. *African Journal of Science, Technology, Innovation and Development*, 9(5), 513–527. <https://doi.org/10.1080/20421338.2017.1327923>
- DANIELS, C., MAWOKO, & P. KONTE, A. (2018). Evaluating Public Policies in Africa: insights from the Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024). Policy brief. Policy@Sussex. December.
- DANIELS, C., SCHOT, J., CHATAWAY, J., RAMIREZ, M., STEINMUELLER, E. & KANGER, L. 2020. Transformative Innovation Policy: Insights from Colombia, Finland, Norway, South Africa, and Sweden. In: Cele, M. B. G., Luescher, T. M. & Fadji, A. W. (eds.) *Innovation policy at the intersection: Global debates and local experiences*. Cape Town: HSRC Press.
- DIALLO, M., DASYLVA, J., CISSÉ, F., SY, M., TING, M. B., DANIELS, C. & DIÉMÉ, J. S. 2019. Senegal’s Virtual University, a Case Study on Transformative Innovation Policy. <http://www.tipconsortium.net/senegals-virtual-university-a-case-study-on-transformative-innovation-policy/> [Online].
- DOUTHWAITE, B. & ASHBY, J. 2005. Innovation histories: A method from learning from experience. *Brief 5 p. 4*. Institute of Learning and Change (ILAC).
- FREEMAN, C. 1995. The “National System of Innovation” in historical perspective’,. *Cambridge Journal of Economics*, 19, 5-24.
- GHANA 2019. Ghana beyond aid, charter and strategy document President of the Republic, Nana Addo Dankwa Akufo-Addo.
- HARGREAVES, T. 2012. Carbon Conversations: an innovation history.
- KENYA 2007. Kenya Vision 2030. Nairobi, Kenya
- KENYA 2008. First Medium Term Plan, 2008-2012: A globally competitive and prosperous Kenya. In: Office of the Prime Minister & Ministry of State for Planning (eds.). Nairobi, Kenya.
- KENYA 2010. The Constitution of Kenya
- KENYA 2013a. The Science, Technology and Innovation Act. Nairobi, Kenya. : Kenya Gazette Supplement, No 43 (Acts No 28).
- KENYA 2013b. Second Medium Term Plan, 2013-2017: Transforming Kenya, pathway to devolution, socio-economic development, equity and national unity In: THE PRESIDENCY & MINISTRY OF DEVOLUTION AND PLANNING (eds.). Nairobi, Kenya. .
- KENYA 2018. Third Medium Term Plan, 2018 – 2022, Transforming lives: Advancing socio-economic development through the Big Four. In: THE NATIONAL TREASURY AN PLANNING (ed.).

- KRAEMER-MBULA, E., R TIJSSSEN, M L WALLACE & R McLEAN (Eds), 2020. Transforming Research Excellence: New Ideas from the Global South. Cape Town, South Africa: African Minds. <http://doi.org/10.5281/zenodo.3607326>.
- LUNDEVALL, B.-A. 1992. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, London, U.K., Pinter.
- MESTI 2017. Draft National Science, Technology Innovation Policy (2017-2020). In: Ministry of Environment, S., Technology and Innovation (ed.).
- NDAKALA, F., NYANGA, R., AYISI, J., OWUOR, R., WANYAMA, B., TING, M. B. & DANIELS, C. 2019. Analysis of Transformative Components of Mobile Schools for the Nomads in Kenya. *TIP Africa Research Brief*
- QUAYE, W., AKON-YAMGA, G., ASANTE, A. & DANIELS, C. 2019a. The E-waste management system in Ghana through the Transformative Innovation Policy Lens. <http://www.tipconsortium.net/the-e-waste-management-system-in-ghana-through-the-transformative-innovation-policy-lens/> [Online].
- QUAYE, W., AKON-YAMGA, G., DANIELS, C., TING, M. B. & ASANTE, A. 2019b. Mapping of Science, Technology and Innovation Policy Development in Ghana Using the Transformative Change Lens Science and Technology Policy Research Institute (CSIR-Stepri) and Transformative Innovation Policy Consortium (TIPC). <http://www.tipconsortium.net/resource/mapping-of-science-technology-and-innovation-policy-development-in-ghana-using-the-transformative-change-lens/>
- QUAYE, W., AKON-YAMGA, G., DANIELS, C., TING, M. B. & ASANTE, A. 2019c. Transformation Innovation Learning History of Ghana's E-Waste Management System *TILH Report, TIP Africa*.
- QUAYE, W., AKON-YAMGA, G., DANIELS, C., TING, M. B., ASANTE, A. & ANTWI, D. O. 2019d. RESEARCH BRIEF ON TRANSFORMATIVE INNOVATION POLICIES: LESSONS FROM GHANA'S E-WASTE MANAGEMENT SYSTEM. *TIP Africa Research Brief*
- QUAYE, W., ASANTE, A. & DANIELS, C. 2019e. Transformative Innovation Policy in Ghana: Lessons from the South Africa workshop. <http://www.tipconsortium.net/transformative-innovation-policy-in-ghana-lessons-from-the-south-africa-workshop/> [Online].
- SCHOT J., DANIELS C, TORRENS J, and BLOOMFIELD G. (2017). Developing a Shared Understanding of Transformative Innovation Policy TIPC Research Brief 2017-01
- SCHOT, J. & STEINMUELLER, W. E. 2018. Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change. *Research Policy* 47, 1554-1567.
- UNESCO 2015. UNESCO Science report, Towards 2030. Paris, France.

Annex

The annexes below are uploaded online as PDF files

- Annex 1: Insights Working Session Co-creation and Learning Journey Material, South Africa
- Annex 2: Insights Working Session Communications Material, South Africa
- Annex 3: Insights Working Session Co-creation and Learning Journey Material, Senegal
- Annex 4: Insights Working Session Communications Material, Senegal

Notes

ⁱ For more on the SGCI, visit: <https://sgciafrica.org/en-za>

ⁱⁱ <http://www.sussex.ac.uk/spru/newsandevents/2016/talks/africaew>

ⁱⁱⁱ With seven SSA countries (Botswana, Ghana, Kenya, Namibia, Nigeria, Tanzania, and South Africa) in addition to UNCTAD and IDRC in attendance - <https://tipconsortium.net/tipc-aims-outlined-in-pan-africa-workshop/>

^{iv} For more on this, visit: <http://www.tipconsortium.net/headline/ghana-hosts-exploratory-workshop-with-tipc/>

^v TIPC TO BEGIN WORK WITH GHANA, KENYA AND SENEGAL, 6 November 2018 - <http://www.tipconsortium.net/headline/tipc-in-partnership-with-idrc-to-begin-work-in-ghana-kenya-and-senegal/>

^{vi} For more on this see, “Transformative Innovation, the 4th Industrial Revolution and Sustainable Development Trilateral Research Chair”, available at: <http://www.tipconsortium.net/poster/transformative-innovation-the-4-th-industrial-revolution-and-sustainable-development-trilateral-research-chair/>. For recruitment of the doctoral students, see: <https://www.africalics.org/trilateral-chair-phds-scholarships/>; <https://www.sussex.ac.uk/study/fees-funding/phd-funding/view/1157-PGR-Studentship-in-Transformative-Innovation,-the-4th-Industrial-Revolution-and-Sustainable-Development>

^{vii} Preliminary discussions are on-going with these four countries, with initial agreements by the countries to join Senegal and be part of the West Africa Regional TIP Hub

^{viii} <http://www.tipconsortium.net/poster/transformative-innovation-the-4-th-industrial-revolution-and-sustainable-development-trilateral-research-chair/>