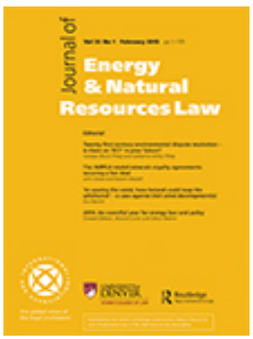

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From technology transfer to technology absorption: addressing climate technology gaps in Africa

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Despite many years of technology transfer to Africa under various mechanisms and programmes of the United Nations Framework Convention on Climate Change (UNFCCC), Africa remains the continent with the lowest level of technology required for climate change mitigation and adaptation. Several studies on how to fix Africa's climate technology needs, including policy prescriptions by African leaders, tend to focus primarily on the need for more technology transfer to the African continent. In contrast, this article emphasises how African countries can proactively address current technology gaps by strengthening their domestic capacities to absorb, assimilate and deploy imported climate technologies. This article examines the importance of climate technology absorption as a critical component of a holistic climate technology diffusion plan for Africa. It discusses inadequate access to information about imported climate technologies, weak legal protection for imported technologies, lack of domestic capacities to deploy and maintain imported technologies, the weak regulatory environment to stimulate clean technology entrepreneurship, and the absence or inadequacy of climate change laws, as barriers that must be addressed in order to effectively bridge current climate technology gaps in Africa.

Keywords: climate technology; absorption capacity; entrepreneurship; innovation; Africa

1. Introduction

Climate change poses complex and multifaceted threats to the survival, livelihood and health of the African continent, more so than to, arguably, any other region in the world.[1] Apart from the many mainland African states with unique geographical vulnerabilities, which contribute to their low adaptive capacity, the African continent is home to low-lying Sahelian countries, such as Cape Verde, Comoros, Equatorial Guinea, Madagascar and Mauritius.[2] Even without climate change, many of these low-lying African states are already subjected to tough arid conditions and severe water shortages,

1 See D Olawuyi, 'Proposal for a Climate Compensation Mechanism for Small Island States: Response to Maxine Burkett' (2015) 13 Santa Clara J Int'l L 133; also, A Ben Mohamed, N van Duivenbooden and S Abdoussallam, 'Impact of Climate Change on Agricultural Production in the Sahel – Part 1. Methodological Approach and Case Study for Millet in Niger' (2002) 54 Climatic Change 327.

2 The Sahel region covers nine countries: Burkina Faso, Chad, Cape Verde, Guinea-Bissau, Mali, Mauritania, Niger, Senegal and The Gambia. These countries have dual vulnerability to climate change, both as arid countries in the Sahel region and as impoverished small island states. See A Chappell and C Agnew, 'Modelling Climate Change in West African Sahel Rainfall (1931–90) as an Artifact of Changing Station Locations' (2004) 24 Int'l J Climatology 547.

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which typically make farming and agriculture difficult or near impossible.[3] Climate change would only escalate these pre-existing social, economic and environmental conditions, and could intensify the cycle of food shortage, desertification, water scarcity, depleting fish stocks and the spread of diseases in Africa.[4] Despite the grim reality of climate change, Africa remains one of the world's most vulnerable and least prepared regions facing it.[5]

One key factor that continues to stifle the capabilities of African countries to effectively combat climate change is the lack of advanced climate technologies; that is, 'technologies that can be applied in the process of minimising greenhouse gas (GHG) emissions and adapting to climatic variability and climate change'.[6] Although the extent of technological gaps on the continent varies from one country to another, advanced climate technologies are simply not available in several African states.[7] Consequently, technology transfer – that is, 'the flows of know-how, experience, and equipment for mitigating, and adapting to, climate change'[8] – has been, and continues to be,

3 Water is a scarce resource in all Sahel countries. Besides erratic rainfall patterns, poor soils and unfavourable socio-economic conditions are key constraints to agricultural development in Sahelian states. See A Dietz, R Ruben and Jan Verhagen, 'The Impact of Climate Change on Drylands with a Focus on West Africa' (2001) 39 Env't & Pol'y 465.

4 See I Ajibade and D Olawuyi, 'Climate Change Impacts on Housing and Property Rights in Nigeria and Panama: Toward a Rights-Based Approach to Adaptation and Mitigation' in D Stucker and E Lopez-Gunn (eds), *Adaptation to Climate Change through Water Resources Management: Capacity, Equity and Sustainability* (Routledge 2014) 264–84.

5 African Development Bank, 'Solutions for a Changing Climate: African Development Bank's Response to Impacts in Africa' (African Development Bank 2012) 2; also, United Nations Framework Convention on Climate Change (UNFCCC), 'Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries' (UNFCCC Secretariat 2007) https://unfccc.int/resource/docs/publications/impacts.pdf accessed 10 May 2017.

6 United Nations Development Programme, 'Handbook for Conducting Technology Needs Assessment for Climate Change' (United Nations Development Programme, 2010) ix. Achieving climate change mitigation and adaptation goals will only be possible through large-scale deployment of climate technologies. See, for example, the 2007 Report of the Intergovernmental Panel on Climate Change (IPCC), which concluded that GHG stabilisation levels could be achieved by the deployment of a 'portfolio of technologies that are currently available and those that are expected to be commercialised in coming decades': IPCC, *Climate Change 2007: Mitigation of Climate Change, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers* (Cambridge University Press 2008) 16; also, the Stern Review of 2007 noted that, 'the development and deployment of a wide range of low-carbon technologies is essential in achieving the deep cuts in emissions that are needed'. N Stern, *The Economics of Climate Change: The Stern Review* (Cambridge University Press 2007) xix.

7 Some African countries – for example, Malawi, Rwanda, Tanzania and Uganda – have already made progress in promoting the use of 'soft' climate technologies, such as locally made fuel-efficient cooking stoves, as a way of reducing the deforestation and GHG emission effects of burning wood for cooking. As well, the African Development Bank, alongside regional and national governments across the continent, has increased efforts aimed at promoting climate-resilient infrastructure development. However, despite these efforts, the development and deployment of advanced climate technologies remain very low in Africa. See African Development Bank, 'Poor Technological Capability Undermining Africa's Growth Potential' (11 January 2014) www.afdb.org/en/news-and-events/article/poor-technological-capability-undermining-africas-growth-potential-13684 accessed 19 May 2017; African Development Bank, 'Solutions for a Changing Climate' (n 5) 29; United Nations Economic Commission for Africa (UNECA), 'Innovation and Technology Transfer for Enhanced Productivity and Competitiveness in Africa' (Background Paper, 2014) at paras 1–2.

8 See IPCC, *Methodological and Technological Issues in Technology Transfer: Summary for Policymakers* (Special Report of Working Group III Intergovernmental Panel on Climate Change, Cambridge University Press 2000) 3; also, P Speser, *The Art and Science of Technology Transfer* (Wiley 2006)

the primary means (and perhaps the only realistic means) through which the African continent can accelerate its response to climate change.[9]

In recognition of this reality, the 2016 Marrakech Action Proclamation for Our Climate and Sustainable Development calls for an increase in access to, and the volume and flow of, finance for climate technology from developed to developing countries.[10] Similarly, Article 10 of the Paris Agreement on Climate Change encourages developed countries to provide technology development and transfer support to developing countries, in order to improve resilience to climate change and reduce GHG emissions.[11] Notably, these global commitments to increase the flow of clean technologies to developing countries are not new, and have been enshrined in the international climate change regime as far back as 1992, when the United Nations Framework Convention on Climate Change (UNFCCC) was adopted.[12]

However, despite several proclamations and declarations on the need to promote the transfer and deployment of climate technologies to African countries, Africa remains the continent with the lowest level of climate technology deployment.[13] Several studies on Africa's climate technology needs, including policy prescriptions by African leaders, tend to focus primarily on the need for more technology transfer to the African continent as a primary way of boosting Africa's technological capacity to combat climate change.[14] For example, the Technology Mechanism, a mechanism established at the 16th session of the Conference of the Parties to the UNFCCC in Cancun (COP 16) to enhance climate technology development and transfer to developing countries, has focused attention mainly on technology transfer as the key to bridging the technology gap in developing countries.[15] This one-track approach has

xxii–xxiii; B Biagini and others, 'Technology Transfer for Adaptation' (2014) 4 Nature Climate Change 828.

9 See B Oyelaran-Oyeyinka and P Gehl Sampath, *Latecomer Development: Innovation and Knowledge for Economic Growth* (Routledge 2010) 1–15; also, V Ruttan, *Technology, Growth and Development: An Induced Innovation Perspective* (Oxford University Press 2001).

10 See UNFCCC, Marrakech Action Proclamation for Our Climate and Sustainable Development https://unfccc.int/files/meetings/marrakech_nov_2016/application/pdf/marrakech_action_proclamation.pdf accessed 13 June 2017.

11 See Adoption of the Paris Agreement, UNFCCC Conference of the Parties, 21st Session, UN Doc FCCC/CP/2015/10/Add.1 (12 December 2015) at 9 http://unfccc.int/files/home/application/pdf/paris_agreement.pdf accessed 12 May 2017.

12 Article 4(5) of the UNFCCC provides that developed countries 'shall promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how' needed by developing country parties to meet the targets of emission reductions. United Nations Framework Convention on Climate Change (Adopted by the United Nations General Assembly, 20 January 1994, A/RES/48/189).

13 See UNFCCC, 'Capacity Building for Technology Transfer in the African Context: Priorities and Strategies' 1–5 https://unfccc.int/files/documentation/workshops_documentation/application/pdf/maya.pdf accessed 13 June 2017, rightly noting that, although it sounds crude, the reality is that climate technology internalisation is yet to be fully ingrained in the thought process at governance levels in Africa. See also African Development Bank, 'Poor Technological Capability Undermining Africa's Growth Potential' (n 7).

14 See, for example, UNECA (n 7); also J Boldt and others, *Overcoming Barriers to the Transfer and Diffusion of Climate Technologies* (UNEP Risø Centre 2012) 130; N Agola, *Technology Transfer and Economic Growth in Sub-Sahara African Countries: Lessons from East Asia* (Springer Nature 2016) 7–21; F Castellacci, 'Closing the Technology Gap?' (2011) 15 Review of Development Economics 180.

15 The key focus area of the Technology Mechanism is to facilitate the implementation of enhanced action on technology development and transfer. By focusing exclusively on technology development and transfer, the Technology Mechanism has done little, so far, in addressing barriers to the

failed to fully analyse and address the complicity of African countries in exacerbating current technological gaps, and/or their failure to proactively put in place adequate law and governance frameworks needed to enhance the absorption of climate technologies. Focusing alone on transfer of climate technologies to Africa, without addressing the domestic abilities of African countries to adequately absorb, deploy and maintain transferred climate technologies, and to develop endogenous climate technology solutions, will not holistically address Africa's climate technology gaps.

The basic premise of this article, therefore, is that the problematisation of the lack of climate technology in Africa must move beyond current prevailing discourses on the need for increased technology transfer to Africa. The key barrier to climate technology diffusion across Africa is arguably not the lack of technology inflow to Africa; rather, it is the perennial inability of African states to absorb and assimilate transferred technology. This article examines how African countries can proactively address the continent's technology gaps by removing legal, institutional and governance barriers to the smooth assimilation and deployment of climate technologies.

The article is organised into five sections. Section 2 discusses the importance of technology absorption as a fundamental, yet less considered, component of an effective climate technology diffusion process. Section 3 develops an analytical profile of the legal, governance and institutional barriers to technology absorption in Africa. It discusses inadequate access to information about imported climate technologies, weak legal protection for imported technologies, lack of domestic capacities to deploy and maintain imported technologies, the weak environment to accommodate and promote clean technology entrepreneurship, and the absence or inadequacy of climate change laws, as barriers that must be addressed in order to effectively bridge current climate technology gaps in Africa. Section 4 discusses practical approaches for integrating climate absorption as part of a holistic framework for addressing Africa's climate technology gaps. The article concludes with Section 5.

2. Technology absorption: a crucial element of a holistic climate technology diffusion process

Most of the existing literature and policy prescriptions on how to address climate technology gaps focus on technology development and transfer, leaving out technology absorption, a third and highly important component of a holistic technology diffusion process. This section discusses why technology absorption remains a critical element of a coherent climate technology action plan that needs to be better accentuated in international, regional and national plans on climate technology acceleration, especially in African countries.

According to the Intergovernmental Panel on Climate Change (IPCC), technology diffusion encompasses three important processes: first, technology acquisition, that is, development and exchange of climate technologies and technology cooperation across and within countries; second, technology transfer, that is, actions accompanying the

absorption and deployment of climate technologies in technology-importing countries. See UNFCCC, 'Technology Mechanism' http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TEM/0e7cc25f3f9843ccb98399df4d47e219/174ad939936746b6bfad76e30a324e78.pdf accessed 12 May 2017.

integration of environmentally sound technologies into nations where those specific technologies had not before existed;[16] and, third, technology absorption, that is, the process of learning to understand, utilise and replicate technology, including the capacity to choose it and adapt it to local conditions and to integrate it with indigenous technologies.[17] Simply, technology absorption encompasses the ability of the technology-importing country to understand, utilise, manage and learn from the acquired technology so that it can develop its own domestic capabilities.[18]

Although the importance of technology absorption has been generally well theorised in business, technology and economics literature, its practical implications have not been exhaustively discussed in the climate change context. As far back as the 1980s, scholars have considered the effective assimilation, deployment and absorption of technological knowledge and capability from an external source as a final and most important step in holistic technology diffusion plans.[19] Since then, a number of empirical studies have reinforced the idea that effective technology acquisition requires a clear and detailed effort to expand the absorption capacity of technology-importing entities.[20] However, while these studies help us understand the concept of absorption capacity, especially in business and management contexts, they have not sufficiently put forward a strong case on why technology-importing countries, like firms and organisations, also need to put in place strong technology absorption plans to ensure that imported technologies fit into, and are effectively absorbed by, their new location. Further, although some studies have identified the importance of climate technology absorption as part of an overall climate technology diffusion strategy, they do not fully elaborate what an improved technology absorption capacity will mean in the climate technology context.[21] Additionally, existing studies do not adequately analyse law, governance and institutional frameworks for enhancing climate technology diffusion and absorption in Africa. These gaps mean that many technology impoverished countries, especially African countries, continue to clamour for the transfer of

16 UNFCCC, 'Benefits of the Clean Development Mechanism' (2011) https://cdm.unfccc.int/about/dev_ben/ABC_2011.pdf accessed 4 October 2017.

17 IPCC, *Methodological and Technological Issues in Technology Transfer: Summary for Policymakers* (Special Report of Working Group III, IPCC 2000).

18 See UNECA, 'A Technological Resurgence? Africa in the Global Flows of Technology' (Paper for the UNECA Series on Technology Transfer for Africa's Development, UNECA/ICT, Science and Technology Division 2010) http://repository.uneca.org/handle/10855/459 accessed 20 June 2017; also UNFCCC, 'Capacity Building for Technology Transfer in the African Context' (n 13) at 4–5.

19 See Patricia Succar, 'International Technology Transfer: A Model of Endogenous Technological Assimilation' (1987) 26 Journal of Development Economics 375; W Cohen and DA Levinthal, 'Innovation and Learning: The Two Faces of R&D' (1989) 99(397) The Economic Journal 569; W Cohen and DA Levinthal, 'Absorptive Capacity: A New Perspective of Learning and Innovation' (1990) 35 Administrative Science Quarterly 128; G Dosi, 'The Nature of Innovative Process' in G Dosi and others (eds), *Technical Change and Economic Theory* (Pinter 2001); G Stock, N Greis and WA Fischer, 'Absorptive Capacity and New Product Development' (2001) 12 Journal of High Technology Management Research 77.

20 M Nieto and P Quevedo, 'Absorptive Capacity, Technological Opportunity, Knowledge Spillovers, and Innovative Effort' (2005) 25 Technovation 1141; A Arbussa and G Coenders, 'Innovation Activities, Use of Appropriation Instruments and Absorptive Capacity: Evidence from Spanish Firms' (2007) 36 Research Policy 1545; F Castellacci and M Natera, 'The Dynamics of National Innovation Systems: A Panel Cointegration Analysis of the Coevolution Between Innovative Capability and Absorptive Capacity' (2013) 42 Research Policy 579.

21 See B Xu, 'Multinational Enterprises, Technology Diffusion, and Host Country Productivity Growth' (2000) 62 Journal of Development Economics 477.

more climate technologies as ways of bridging climate technology gaps, without considering why, and how, domestic capacities to enhance the absorption of transferred climate technologies could be improved to accelerate and enhance climate action.

The escalating rise in the transfer of technology to Africa, without a corresponding rise in the eventual deployment of the received technology, indicates that there is a lacuna in the climate diffusion process in Africa. For example, over the last two decades, climate technologies have been transferred at varying scales to several African countries in one form or another. According to a UN study, overall inflow of technology to Africa through foreign direct investments soared by over 800 per cent between 2000 and 2008.[22] This percentage has further increased since the progressive adoption and implementation of Clean Development Mechanism (CDM) projects across Africa, under which African countries have increasingly received climate technologies.[23] Despite evidence of rapid growth in the rate of Africa's climate technology acquisition, a lack of climate technology remains one of the key threats to climate change action in Africa.[24] Owing to cultural, governance and legal barriers in several African countries, the full-scale adoption, diffusion and assimilation of climate technologies and innovation have remained complex endeavours across the continent.[25] African countries must do much more to address the continent's current technology gaps by removing legal, institutional and governance barriers to the smooth absorption of climate technologies. Climate technology transfer to Africa will only achieve maximum results when African countries develop enabling law and policy frameworks that address barriers to the effective absorption of climate technologies.

2.1. *Importance of an effective climate technology absorption framework*

The importance of climate technology absorption, as a key element of a holistic climate technology diffusion plan, is fourfold.

First, being in a position to deploy new technological innovations depends to a great extent on the accumulation of relevant knowledge from the source of the technology.[26] For example, most entities or countries that rely on climate technology transfer do so

22 UNECA, 'A Technological Resurgence?' (n 18).

23 See UNFCCC, 'Compilation and Synthesis of Technology Transfer Activities Reported in the Fifth National Communications' (2011) http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/IMS_BLS/a70e62d7861e4f1c9a6fb250af63d1c2/56314f26379d4df4aa8dd1285d438036.pdf accessed 10 June 2017; also K Das, 'Technology Transfer under the Clean Development Mechanism: An Empirical Study of 1000 CDM Projects' (2011) The Governance of Clean Development, Working Paper Series No 14, Economic and Social Research Council and University of East Anglia; A Dechezleprêtre and others, 'The Clean Development Mechanism and the International Diffusion of Technologies' (2008) 36 Energy Policy 1273; N Kreibich and others, 'An Update on the Clean Development Mechanism in Africa in Times of Market Crisis' (2017) 9 Climate and Development 178.

24 United Nations Environment Programme (UNEP), *Report on Climate Change* (African Regional Implementation Review for the 14th Session of the Commission on Sustainable Development (CSD-14) Report on Climate Change) 2–3, highlighting lack of access to technology and cultural practices as key barriers to reducing Africa's climate change vulnerability.

25 *Ibid*.

26 See United Nations Conference on Trade and Development (UNCTAD), *Transfer of Technology and Knowledge Sharing for Development: Science, Technology and Innovation Issues for Developing Countries* (UNCTAD Current Series on Science, Technology and Innovation, Vol 8, 2014) 5–14; S Zahra and G George, 'Absorptive Capacity: A Review, Reconceptualization and Extension' (2002) 27 Academy of Management Review 185; Arbussa and Coenders (n 20).

because required technologies are either scarce or unavailable domestically, or when available, they could be too expensive to acquire at home. This unavailability often also means that the skill set and experience necessary to deploy such technologies are not readily available internally. A lot will therefore depend on how much knowledge is acquired from the source of the technologies. Importation or availability of new technologies is not enough; without the required human capacity, such facilities may deteriorate due to limited use or may be sub-optimally deployed.[27] For example, in the 2013 climate technology needs assessment report of the UNFCCC, all the 11 participating African countries – Cote d'Ivoire, Ethiopia, Ghana, Kenya, Mali, Mauritius, Morocco, Rwanda, Senegal, Sudan, Zambia – identified the lack of in-country capacity to deploy climate technology as a key barrier to effective climate action.[28] Ghana, for example, reported that inadequately skilled personnel, at community and local (district) levels, to keep transferred water technologies functional is a key reason for ineffective deployment of climate technologies in the country's water and agricultural sector.[29] Furthermore, climate technologies that have been transferred to Ghana as part of the effort to promote sustainable water and agricultural management practices have been sub-optimally deployed due to lack of capacity to utilise and manage the technologies.[30] The lack of capacity to deploy and maintain clean technologies has also been identified as a technical barrier to climate action in the energy and aviation sectors in Ethiopia, Kenya, Nigeria and South Africa.[31]

Similarly, with respect to deploying clean technology for sustainable aviation, the dearth of skilled personnel in African countries has been identified as one of the barriers to low carbon aviation on the continent.[32] According to the International Civil Aviation Organization (ICAO), a considerable number of institutions in Africa that have been training pilots, air traffic controllers and mechanics for decades do not possess the critical mass of resources needed to meet the growing capacity development demands of

27 See UNECA, 'Innovation and Technology Transfer for Enhanced Productivity and Competitiveness in Africa' (n 7) at para 42 stating that making the best of transferred technology, adapting it to the local conditions and culture, usually requires active learning, which is not costless.

28 See Subsidiary Body for Scientific and Technological Advice, UNFCCC, *Third Synthesis Report on Technology Needs Identified by Parties Not Included in Annex I to the Convention* (2013) http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf accessed 3 June 2017. Reports for the respective countries are available at http://unfccc.int/ttclear/tna/reports.html accessed 21 May 2017.

29 George O. Essegbey, Barnabas Amisigo, Delali Nutsukpo, KY Oppong-Boadi and Daniel Benefo, *Ghana: Technology Needs Assessment: Report on Barrier Analysis and Enabling Framework for Diffusion of Prioritized Adaptation Technologies in the Water and Agriculture Sectors* (Technology Needs Assessment Team, 2013) ix–xi.

30 See *ibid* at 15–17.

31 See Abebe Tadege, *Climate Change Technology Needs Assessment Report of Ethiopia* (Federal Ministry of Water Resources, 2007); also L Le Grange and AJ Buys, 'The Management of Maintenance Technology Transfer in the South African Aviation Industry' (2002) 13(2) South African Journal of Industrial Engineering 131; 'The Need and Challenges of Harmonizing CAA Trainings in Africa' (ICAO, Aviation Panel 3); D Olawuyi, 'Sustainable Aviation and the Transfer of Environmentally Sound Technologies to Africa: Paradoxes, Barriers and Prospects' (McGill Occasional Paper Series: No 13, Sustainable International Civil Aviation, 2016) 17–19.

32 For a discussion of the several practical and logistical constraints facing aviation training in Africa, according to the Africa Civil Aviation Commission. 'Efforts and Commitment Towards the Provision of Sustainable Aviation Training in Africa' (ICAO) www.icao.int/safety/afiplan/documents/aato%20assembly,%20abuja,%20nigeria,%20april%202013/presentations/presentation%20by%20afcac.pdf accessed 12 May 2017.

transitioning to low carbon aviation systems.[33] Furthermore, efforts to deploy solar home systems in Kenya have been stifled by a lack of required capacity and expertise.[34] These examples show that technology transfer alone, without a sufficient pool of skilled and trained officers to deploy and maintain climate technologies, cannot effectively address Africa's climate technology needs. A holistic technology diffusion plan for Africa must incorporate skill transfer and knowledge assimilation as its core component.

Second, a technology absorption framework provides an opportunity for a technology-importing country to consider the local context and requirements for deploying the technology. Just as the body could reject an incompatibly transplanted kidney, a society could reject technologies that are not compatible with local practices and customs. For example, while solar photovoltaic technology is an important technology that has been well developed and deployed across Europe to generate cleaner and low carbon energy from sunshine, local communities have rejected attempts to leverage solar technologies in Rwanda and Zambia as culturally inappropriate.[35] Similarly, social and cultural resistance has hampered the adoption of biogas technologies in Kenya.[36] Local communities often resist large climate change technologies when the immediate and long-term benefits from the use and installation of such technologies are not understood.[37] For example, small-scale farmers in Kenya, who have strong cultural and religious attachments to farmlands, viewed bio-digesters and biogas technologies as long-term threats to good farm harvests and health and therefore resisted its uptake.[38]

Local resistance has also been identified as a barrier to the deployment of water and agricultural technologies in Ghana, Kenya, Rwanda, South Africa and Zambia.[39] Such resistance arises mainly due to inadequate public information on the short- and long-term impact of a technology, failure to consult widely before selecting a location for the technology, or unaddressed concerns about the human rights impacts of the technology or project.[40] In Zambia, for example, efforts to deploy boreholes and tube wells adaptation technology, to reduce water shortage, have been largely unsuccessful

33 *Ibid*.

34 See Republic of Kenya, *Barrier Analysis Framework for Technologies Mitigation* (National Environment Management Authority-Kenya, 2013) stating that lack of skilled personnel to deploy and maintain low carbon emission technology is a critical barrier to the adoption of solar home systems technology in Kenya.

35 See Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (Federal Ministry of Lands, Natural Resources and Environmental Protection, 2012) 19–20; see also Government of Zambia, *Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation* (Ministry of Lands, Natural Resources and Environmental Protection, 2013) 23–24. Also for detailed discussions of these, see D Olawuyi, *The Human Rights Based Approach to Carbon Finance* (Cambridge University Press 2016) 1–15.

36 See Republic of Kenya, *Barrier Analysis Framework for Technologies Mitigation* (n 34).

37 Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (n 35) 19–20.

38 See (n 34).

39 UNFCCC, *Ghana: Technology Needs Assessment* (n 29) at x; see also Government of South Africa, *South Africa's Climate Change Technology Needs Assessment* (2007) 40; Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (n 35) 19–20.

40 *Ibid*. See also N Roht-Arriaza, 'Human Rights in the Climate Change Regime' (2010) 1(2) J Human Rights & Env, in which the author identifies areas where current climate change regimes may cause human rights violations in local communities. These include some projects under the Clean Development Mechanism, large hydropower and biomass projects, use of biofuels, choices on energy and adaptation, and REDD+ projects 211.

mainly because industrial locations selected for the project were unsuitable for this type of technology.[41] Because of resulting groundwater contamination of the boreholes from nearby industrial effluents, there has been increased pressure from local communities for the technology to be removed.[42]

Concerns about the impacts of climate technology on the local community are exacerbated by the failure of national authorities to provide adequate information to local communities on the nature and importance of climate technologies and projects.[43] For example, if information about the Zambian water climate technology had been gathered and shared in a timely and transparent manner, through a comprehensive impact assessment process, project proponents and national authorities could have obtained adequate feedback that could have helped in modifying the technology, or in selecting a more suitable project location, to make it appropriate or suitable for the local community. Similarly, in Nigeria, despite the huge clean technology potential of the Kwale CDM project in Nigeria, a project designed to capture and recover associated gas that would otherwise be flared at the Kwale Oil-Gas Processing Plant, local communities have heavily resisted this project.[44] Local groups in Nigeria raised concerns ranging from the cultural implications of the project for traditional lands and forests, lack of adequate information on the long-term benefits of the gas recovery technology, to failure of the Nigerian government and project proponents to adequately consult with local communities or demonstrate the cultural appropriateness or benefits of the project to stakeholders.[45] Lack of adequate information on climate technologies and projects, especially on the long-term health and cultural implications of a technology or project, is a fundamental concern that must be addressed if African countries are to generate local support required for the absorption and deployment of climate technologies.

Third, a technology absorption plan is required to provide adequate infrastructure support for climate change technology. New climate technologies are often transferred to update or replace extant systems. Effectively deploying new climate technologies would often require modernising or aligning existing infrastructure or governance systems, to combine the new technology with existing systems and to achieve a coherent technology structure.[46] For example, while importing biofuel jets into a country to

41 See Republic of Zambia, *Technology Needs Assessment for Climate Change Adaptation: Barrier Analysis and Enabling Framework Report (Water and, Agriculture & Food Security Sectors, 2013)* 14–15.

42 *Ibid*.

43 *Ibid*.

44 See F Onojiribholo, 'Kwale Chief Laments Plight of Communities' *Daily Independent* (16 August 2011); also K Adeyemo, 'Nigerians Oppose Climate Development Projects' *Tribune* (Ibadan, 12 September 2010); F Allen and others, 'Niger Delta Niger Delta Oil Flares, Broken Laws, Pollution and Oppression' in *Why the Carbon Trading Gamble and the Clean Development Mechanism Won't Save the Planet from Climate Change and How African Civil Society Is Resisting* (Report by the University of KwaZulu-Natal, Centre for Civil Society and Dartmouth College, Climate Justice Research Project, April 2012); N Bassey, 'Foreword' in *Mired in a Fossil Trap: The Nigerian CDM Report* (Envtl Rights Action/Friends of the Earth, May 2011); D Olawuyi, 'Fostering Accountability in Large Scale Environmental Projects: Lessons from CDM and REDD+ Projects' in J Wouters and others (eds), *Improving Delivery in Development: The Role of Voice, Social Contract, and Accountability* (The World Bank Legal Review, World Bank 2015) 127–47.

45 Onojiribholo, 'Kwale Chief Laments Plight of Communities' (n 44).

46 See P Speser, *The Art and Science of Technology Transfer* (Wiley 2006) 282–84; also UNFCCC, 'Capacity Building for Technology Transfer in the African Context' (n 13) at 13–15.

replace fossil fuel jets is increasingly considered as a good way of promoting sustainable aviation and reducing GHG emissions from aviation, there is a need to examine whether current aviation infrastructure, such as fuelling stations, information systems and flight gadgets are put in place by transforming current infrastructure and establishing new ones when required.[47] In addition to infrastructure modernisation, human capacity development, operational improvements, fiscal incentives, research development and investigation, compensation and reward programmes may also be required to accelerate the wide-scale acceptance of such new technologies at local levels. Furthermore, in many countries, achieving such transformation could require new or updated legal frameworks that would allow the deployment of such technologies.[48] A system transformation component of a technology absorption plan allows a technology-importing country to pave the way for an accelerated and wide-scale deployment of imported technologies.

Fourth, and perhaps most important, a technology-importing country must put in place a strategy to take ownership of the long-term maintenance and/or modernisation or improvement of the imported technology over long periods. Without a long-term maintenance culture or plan, imported technologies could make a short-term impact, and then become non-functional after a while due to lack of maintenance or failure to regularly update the technology. Lack of a holistic technology maintenance culture or plan is one of the key reasons for the huge technology deficits across Africa.[49] For a country to sustain the benefits of climate technologies over a long period, there is need for a holistic strategy aimed at developing local capacities to maintain imported technologies, modify or repair it when necessary and, in the long run, to develop its own domestic capabilities to produce required technologies. For example, by developing policies to support clean technology entrepreneurship and the startup innovation ventures, a country can empower a new generation of climate technology entrepreneurs that can both develop innovative solutions for maintaining imported technologies and unearth endogenous climate technology solutions.

Unless a clear and coherent legal and regulatory framework is put in place to encourage knowledge acquisition, assimilation, systems transformation and long-term innovation components of technology absorption, the current paradox of more technology transfer, and less effective climate technology deployment, may continue to hinder climate action in Africa. An appropriate starting point is for African countries to remove legal, governance and institutional barriers that hinder the smooth assimilation and absorption of climate technologies. The next section develops a profile of some of the key law, governance and institutional barriers to technology absorption in Africa.

47 See Luís Augusto Barbosa Cortez et al 'Flightpath to Aviation Biofuels in Brazil: Action Plan' (June 2013) www.fapesp.br/publicacoes/flightpath-to-aviation-biofuels-in-brazil-action-plan.pdf accessed 20 June 2017.

48 Olawuyi, 'Sustainable Aviation and the Transfer of Environmentally Sound Technologies to Africa' (n 31) at 12–24.

49 *Infrastructure in Sub-Saharan Africa* (World Bank 2008), stating that closing Africa's infrastructure gaps, including technology gaps, must include improving the efficiency with which existing resources are used. It identifies lack of timely maintenance activities, inefficient distribution networks, weak revenue collection performance, underpricing of services, and low capital budget execution as key reasons for infrastructure deficits in Africa. See also UNFCCC, 'Capacity Building for Technology Transfer in the African Context' (n 13) at 10–15.

3. Law, governance and institutional barriers to climate technology absorption in Africa

3.1. *Methodology*

This section develops a profile of law, governance and institutional barriers to climate technology absorption in Africa. The methodology approach adopted is based on a comparative review and survey of the scope and status of climate technology absorption across Africa. This survey relies primarily on published reports of countries with publicly available data and information on climate technology needs (Côte d'Ivoire, Ethiopia, Egypt, Kenya, Ghana, Mali, Morocco, Mauritius, Nigeria, Rwanda, Senegal, South Africa, Sudan and Zambia).[50] This has allowed conclusions to be drawn on key legal, institutional and governance barriers that stifle climate technology diffusion in African countries. Furthermore, an analytical review of published literature is adopted because existing research in the field has satisfactorily compiled the scope and status of technology absorption in Africa.[51] However, a detailed examination of the legal, governance and institutional barriers to climate technology absorption in Africa has remained absent. This article moves the discussion forward by examining how legal, governance and institutional barriers to climate technology absorption can be addressed to accelerate climate technology deployment and absorption in Africa.

Owing to the scope of the study and the nature of the methodological approach, the survey can, by no means, be regarded as representative. However, since this survey is combined with the review of the literature, this section provides an analytical profile of, and insights on, the salient law, governance and institutional barriers that must be addressed to enhance climate technology absorption in Africa.

3.2. *Results and analysis*

In order to accelerate climate change mitigation and adaptation, African countries must address five key law, institutional and governance barriers across the technology transfer chain. Generally, the problem starts from the point of reception, during which several cultural barriers make it difficult for technologies to fit into the African context, followed by legal questions on intellectual property rights, concerns on technical capacity to effectively deploy and assimilate the technologies, weak investment environment, and then the absence of comprehensive and overarching climate change legislation that addresses these concerns. Each of these barriers is briefly examined below.

3.2.1. Inadequate public information on imported technologies

As noted earlier, one key governance challenge facing technology absorption in all of the surveyed African countries is the perennial local and cultural resistance to

50 Reports for the respective countries are available at http://unfccc.int/ttclear/tna/reports.html accessed 21 May 2017. For a synthesis report, see Subsidiary Body for Scientific and Technological Advice, UNFCCC, *Third Synthesis Report on Technology Needs Identified by Parties Not Included in Annex I to the Convention* (n 28).

51 *Ibid*; see also UNEP, *Report on Climate Change* (n 24).

transferred climate technology. Local communities have rejected climate technologies for cultural, religious or human rights reasons.[52] Nearly all cases of conflict over new technologies in the surveyed countries arose from projects executed without proper consultations with local communities, inappropriate site selection or lack of adequate information on the impact of imported technologies on local communities.[53] For example, while hydroelectric or geothermal technology may enhance climate action, failure by national authorities or project proponents to provide clear and transparent information on the short- and long-term impacts of such technology on migratory birds, animals and human health could result in misalignment between the climate technology deployment goals, and the desire by local communities to protect their land, forests, homes and cultural practices from negative impacts.[54]

Concerns relating to information disclosure can be addressed through clear and transparent gathering and disclosure of information on climate technologies at early stages of deployment. Early disclosure of project information will provide opportunities for local communities to identify any aspect of the technology or implementation plan that could be problematic or culturally inappropriate. Enforcing corporate reporting and proactive self-disclosure obligations by project proponents and national authorities, as a precondition for the deployment of climate technologies, is therefore important to provide adequate avenues for the public to access project information.[55]

It is also important for African countries to establish clear and transparent freedom of information (FOI) legislation, in order to provide a robust legal basis for local communities to seek and obtain information on climate technologies that could have a negative impact on their culture and life. While adopting FOI laws may not solve all of the problems relating to non-disclosure and lack of transparency with respect to the long-term impacts of climate technologies, adopting such laws could be a helpful starting point for African countries to embrace a culture of openness in the design, approval, financing and implementation of climate projects. In all of the surveyed African countries, governments are yet to implement robust legal safeguards that recognise and protect the rights of the public to seek and obtain information about climate technologies and projects. Ghana and Zambia, for example, have no FOI legislation in place.[56] Similarly, although FOI legislation has been enacted in

52 See Subsidiary Body for Scientific and Technological Advice, UNFCCC, *Third Synthesis Report on Technology Needs Identified by Parties Not Included in Annex I to the Convention* (n 28); also Government of Ghana, *Ghana: Technology Needs Assessment: Report on Barrier Analysis and Enabling Framework for Diffusion of Prioritized Adaptation Technologies in the Water and Agriculture Sectors* (2013) (n 29); see also Government of South Africa, *South Africa's Climate Change Technology Needs Assessment* (2007) 40; Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (n 35) at 19–20.

53 D Olawuyi, 'Climate Justice and Corporate Responsibility: Taking Human Rights Seriously in Climate Actions and Projects' (2016) 34 Journal of Energy & Natural Resources Law 27, 33–35.

54 See Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (n 35) 19–20; also F Onojiribholo, 'Kwale Chief Laments Plight of Communities' (n 44); D Olawuyi, 'Fostering Accountability in Large Scale Environmental Projects: Lessons from CDM and REDD+ Projects' in J Wouters and others (eds), *Improving Delivery in Development: The Role of Voice, Social Contract, and Accountability* (The World Bank Legal Review, World Bank 2015) 127–47.

55 Olawuyi, 'Climate Justice and Corporate Responsibility' (n 53) at 33–35.

56 While draft FOI bills have been proposed in these countries over the years, they have not been passed into law, making them legally enforceable. For example, the Draft Access to Information Bill in Zambia has remained unpassed since 2002. See 'Zambia Moves Forward with Access to Information Bill'

Côte d'Ivoire, Kenya, Nigeria, Rwanda, South Africa and Zimbabwe, the extent to which such laws are respected, and information requests complied with, varies.[57] Failure to guarantee and protect information rights often means that climate projects are approved and registered without adequate information to the public on the short- and long-term impacts of such projects.[58] One of the end results is the perennial resistance or rejection of such projects by local communities during implementation stages.

African countries can do more to clear the path for the absorption and deployment of climate technologies by ensuring that robust information on technologies and projects is publicly and proactively disclosed in a clear and transparent manner. As recognised in international law, the core elements of access to information (ATI) include maximum disclosure of project information, obligation to publish and disclose new information, establishing processes to facilitate timely access to information at a reasonable cost and increased public education and awareness.[59] African countries must ensure that these elements of ATI are mainstreamed into FOI laws and implemented.

3.2.2. Weak legal protection for imported technologies

Another key obstacle to technology absorption and assimilation in Africa is the weak legal protection for intellectual property rights (IPRs) in many African countries.[60]

(15 February 2017) www.ifex.org/zambia/2017/02/15/ati_bill accessed 20 June 2017; see also Government of Ghana, 'Parliament Begins Consideration of RTI Bill' (12 February 2015) www.ghana.gov.gh/index.php/media-center/news/2565-parliament-begins-consideration-of-rti-bill accessed 20 June 2017.

57 For example, although Ethiopia, Nigeria, Rwanda, South Africa and Zimbabwe all have Freedom of Information Acts, concerns relating to lack of adequate disclosure of information on climate technologies and projects have been raised. See n 51. In Nigeria, for example, the FOI Act has been criticised as defective, while the Nigerian government has been frequently criticised for failing to comply with public disclosure requests. See 'Nigeria's Access to Information Law Is Not Working' (4 December 2012) http://icirnigeria.org/nigerias-access-to-information-law-is-not-working accessed 26 June 2017; see also 'Nigeria: Reality of the Freedom of Information Act' *Daily Trust* (Lagos, 17 September 2012). For a catalogue of FOI laws in Africa, see Freedom of Information in Africa, 'African Platform on Access to Information' www.africanplatform.org/resources/national-ati-laws accessed 20 June 2017.

58 Olawuyi, 'Climate Justice and Corporate Responsibility' (n 53) at 33–35.

59 Several reports have been released by the Special Rapporteur on the Right to Freedom of Opinion and Expression that recognise access to information (ATI) as part of the right to freedom of expression. Though not binding, these reports provide normative interpretations of the right to information as one of the most essential elements of freedom of speech and expression. According to the Special Rapporteur, 'The right to seek, receive and impart information imposes a positive obligation on States to ensure access to information, particularly with regard to information held by Government in all types of storage and retrieval systems … '. See Report of the Special Rapporteur, 'Promotion and Protection of the Right to Freedom of Opinion and Expression' (28 January 1998) UN Doc E/CN.4/1998/40, para 1. See also Report of the Special Rapporteur, 'Promotion and Protection of the Right to Freedom of Opinion and Expression' (4 February 1997) UN Doc E/CN.4/1997/31; Report of the Special Rapporteur, 'Promotion and Protection of the Right to Freedom of Opinion and Expression' (14 December 1995) UN Doc E/CN.4/1995/31, para 35; Joint Declaration of the UN Special Rapporteur on Freedom of Opinion and Expression, the OSCE Representative on Freedom of the Media and the OAS Special Rapporteur on Freedom of Expression of 26 November 1999 www.article19.org/pdfs/igo-documents/three-mandatesdec-1999.pdf accessed 12 May 2017. See also Joint Declaration of the UN Special Rapporteur on Freedom of Opinion and Expression, the OSCE Representative on Freedom of the Media and the OAS Special Rapporteur on Freedom of Expression of 6 December 2004; and the Joint Declaration of the UN Special Rapporteur on Freedom of Opinion and Expression, the OSCE Representative on Freedom of the Media and the OAS Special Rapporteur on Freedom of Expression of 19 December 2006 www.article19.org/pdfs/standards/four-mandates-dec-2006.pdf accessed 12 May 2017.

This long-standing concern has exacerbated the difficulty in retaining and assimilating climate technologies in Africa.[61] Innovators want to be sure that their innovations will not be abused, or deployed without adequate permission or protection under national regimes of the country to which the technology is transferred.[62] Strong IPR laws can serve as an incentive to technology transfer and domestic innovation, especially in countries that pose a strong threat to technology imitation.[63] As a UN study rightly identified, lack of high quality patent and IPR systems to protect innovation is a major barrier to technology deployment and absorption in Africa.[64] Although many African countries are parties to the Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement, which emphasises the importance of domestic IPR protection regimes for inventions, legal and policy frameworks have not been effectively implemented across the African continent to strengthen IPR protection.[65]

Concerns over inadequate protection of IPR in Africa manifest themselves in two broad ways. One is the wide exclusion of certain technologies from patentability. Patent laws in many African states still maintain and apply rigid and exclusionary definitions of patents and inventions, which exclude certain technologies from patentability.[66] The Nigerian Patents and Designs Act, for example, grants several arbitrary powers to Nigerian authorities to exclude some innovations from patentability.[67]

60 IPR relates to legal protection on inventions through patents, utility models, design rights, trademarks, domain names and copyrights.

61 See J De Beer and others, 'Innovation, Intellectual Property and Development Narratives in Africa' in J De Beer and others, *Innovation & Intellectual Property Collaborative Dynamics in Africa* (University of Cape Town Press 2014) 2–5, discussing how administrative bottlenecks, systemic inefficiencies and overzealous IP protection regimes raise the costs of future innovations in Africa and may, therefore, discourage potential innovators and creators who cannot afford high up-front investments; also C Correa, 'Intellectual Property in LDCs: Strategies for Enhancing Technology Transfer and Dissemination' (UNCTAD, The Least Developed Countries Report 2007 Background Paper) 7–10.

62 L Branstetter and others, 'Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-level Data' (2005) NBER Working Paper 11516, 2–5, stating that innovators will be hesitant to transfer technology to countries known to be hesitant to enforce IPR law; also D Ockwell, *Intellectual Property Rights and Low Carbon Technology Transfer to Developing Countries – A Review of the Evidence to Date* (Sussex Energy Group, TERI, Institute of Development Studies 2008) 1–5.

63 See Y Qian, 'Do National Patent Laws Stimulate Domestic Innovation in a Global Patenting Environment? A Cross-country Analysis of Pharmaceutical Patent Protection, 1978-2002' (2007) 89 Review of Economics and Statistics 436; J Barton, 'Intellectual Property and Access to Clean Energy Technologies in Developing Countries: An Analysis of Solar Photovoltaic, Biofuels and Wind Technologies' (ICTSD Trade and Sustainable Energy Series, Issue Paper No 2, 2007); C Tébar Less, 'Achieving the Successful Transfer of Environmentally Sound Technologies: Trade-Related Aspects' (2005) OECD Trade and Environment Working Paper No 2005-02; W Park and D Lippoldt, 'Technology Transfer and the Economic Implications of the Strengthening of Intellectual Property Rights in Developing Countries' (2008) OECD Trade Policy Working Paper No 62.

64 United Nations Environment Programme, *Patents and Clean Energy Technologies in Africa* (United Nations Environment Programme, Division of Environmental Law and Conventions 2013) 7–8; also A Abdel-Latif, 'Intellectual Property Rights and the Transfer of Climate Change Technologies: Issues, Challenges, and Way Forward' (2015) 15 Climate Policy 103.

65 D Foray, 'Technology Transfer in the TRIPS Age: The Need for New Types of Partnerships between the Least Developed and Most Advanced Economies' (International Centre for Trade and Sustainable Development, Issue Paper No 23, 2009) 1–3.

66 Article 7 of the TRIPS Agreement provides that the objective of the protection and enforcement of intellectual property should be to 'contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare'. www.wto.org/english/docs_e/legal_e/27-trips.pdf accessed 12 May 2017.

It also fails to clarify whether climate change technologies and inventions can be patented.[68] Concerns about legal barriers to biofuel patenting have also been raised in Egypt, Mozambique and Tanzania.[69]

A second paradox in IPR protection laws is the application of expanded compulsory licence provisions that allow the use of a patented product or process without authorisation or compensation to the patent rights holder.[70] Article 31 of the TRIPS agreement, for example, provides some safeguards against the use of a patented product or process without authorisation or compensation to the patent rights holder, including the requirements that the proposed user should have made good-faith efforts to obtain authorisation from the patent holder, that the use will be for domestic supply only, that the patent holder shall be granted adequate remuneration and that there be an established review process for considering the application for compulsory licences. In many of the surveyed African regimes, however, several of the procedural safeguards under TRIPS are not replicated.[71] In Nigeria, not only does the Patents and Designs Act not codify these safeguards, it in fact provides that, once a compulsory licence has been granted, the licensee is insulated from making any payment to the patentee in the form of royalty or any other manner described. Similarly, the Nigerian law authorises federal and state authorities to utilise or obtain a patented product for the service of the government agency in Nigeria for public interests. This excessive power to leverage

67 For example, under s 1(4)(a) and (b) Nigerian Patents and Designs Act Cap P2 Laws of the Federation of Nigeria 2004, patents cannot be granted or obtained for inventions relating to plant, animal or biological processes. This raises questions on whether, and how, inventions relating to the biofuel industries are patentable under Nigerian law. Also s 1(4)(a) and (b) exclude inventions that are deemed to be contrary to public order or morality. The Act does not define what constitutes public order or morality and how such terms could be measured for the purposes of application in terms of patents. The unclarified power of the patent office to refuse to grant patent on moral grounds raises significant questions especially in a multi-ethnic, multi-cultural and multi-religious country such as Nigeria where the definition of a technology that is morally acceptable could vary from one ethnic or religious group to another. See Templars Law Firm, 'Patentability under the Nigerian Patents and Designs Act (PDA): An Introductory Analysis' www.templars-law.com/wp-content/uploads/2015/05/Patentability-Under-the-Nigerian-Patent-Act.pdf accessed 21 September 2017; also FO Babafemi, *Intellectual Property: The Law and Practice of Copyrights, Trade Marks, Patents and Industrial Designs in Nigeria* (Justinian Books Limited, 2006) 342.

68 The Nigerian law does not define the term 'invention' for the purposes of obtaining or granting a patent. It is, therefore, unclear which technologies or inventions can be patented in Nigeria. Furthermore, s 1 of the Act, which stipulates the circumstances under which an invention could be considered patentable, states that, for an invention to be patentable, it must be one that is 'new, results from inventive activity and is capable of industrial application'. This raises questions as to whether small-scale climate technologies such as cooking stoves, household solar panels or smaller-scale wind turbines come under the category of industrial and patentable technologies in Nigeria. See T Akande, 'NOTAPA and Technology Transfer in Nigeria' (Nigerian Institute of Social and Economic Research, NISER Joint ICTSD/FES, 2 December 2002) at 2, also I Mgeboji, 'African Patent Offices Not Fit for Purpose' in J De Beer and others, *Innovation & Intellectual Property Collaborative Dynamics in Africa* (University of Cape Town Press 2014) 234.

69 For example, Fernando dos Santos and Simão Pelembe state that, despite the clear articulation of biofuel policies in Mozambique's National Policy and Strategy on Biofuels of 2009, patenting and IPR protection are not adequately addressed in Mozambique's biofuel strategy. See F dos Santos and S Pelembe, 'The State of Biofuel Innovation in Mozambique' in J de Beer and others, *Innovation & Intellectual Property Collaborative Dynamics in Africa* (University of Cape Town Press 2014) 248–66, 248.

70 See United Nations Environment Programme, *Patents and Clean Energy Technologies in Africa* (n 64).

71 See, for example, ss 55 and 56 of South Africa's Patents Act No 57 of 1978. See also J de Beer and others, *Innovation & Intellectual Property Collaborative Dynamics in Africa* (University of Cape Town Press 2014).

innovations for 'public interest' again raises concerns as to the adequacy of legal protection available, in practical terms, to IPRs in Africa. In a continent in dire need of climate technologies, overzealous legal provisions and policies that narrow or weaken IPR protection must be addressed by either removing them or fundamentally rethinking them. In addition to strengthening the level of protection accorded to IPR, African countries must also modernise intellectual property (IP) institutions and regulatory structures to give confidence to inventors that transferred technology will be protected from arbitrary confiscation or abuse.[72]

3.2.3. Lack of technical and institutional capacity

As noted earlier, a key institutional barrier to climate technology absorption in Africa is the lack of technical capacity to adequately deploy and maintain transferred technologies. As the African Development Bank rightly noted, poor technological capability remains one of the major constraints to Africa's efforts to achieve sustainable development.[73] In Ethiopia, for example, a lack of technical capacity has been cited as a key reason why imported technologies have not been put to effective and consistent use across diverse sectors.[74] This challenge has also hindered the progressive adoption of climate technologies in Ghana, Kenya, Nigeria, South Africa, Zambia and Zimbabwe.[75] As the World Bank estimates, Africa's stock of graduates remain skewed toward the humanities and social sciences, while the share of students enrolling in science, technology, engineering and mathematics averages less than 25 per cent.[76]

In addition to inadequate technological capacity, a lack of skilled personnel in institutions and ministries responsible for coordinating climate change mitigation and adaptation, particularly lack of capacity to formulate policy and analyse legal frameworks required for supporting effective technology deployment, has also been rightly identified as a key institutional barrier to climate technology absorption in Africa.[77] In all of the surveyed African countries, lack of skilled personnel, inadequate staffing of climate and environment ministries, and lack of up-to-date training on climate technology deployment and absorption were identified as institutional barriers to climate technology absorption.[78] To effectively absorb and assimilate climate technologies, current institutional gaps with respect to deploying, utilising and maintaining imported technologies, and developing appropriate policy frameworks to support climate technology, must be comprehensively bridged at all government levels. Governments must, as a matter of priority, identify the training needs of regulators,

72 United Nations Environment Programme, *Patents and Clean Energy Technologies in Africa* (n 64) at 10–12.

73 African Development Bank, 'Poor Technological Capability Undermining Africa's Growth Potential' (n 7).

74 *Climate Change Technology Needs Assessment Report of Ethiopia* (n 31) at 2–3, 35–37.

75 See n 52.

76 See M Diop, 'Powering Science and Technology for Africa's Economic Transformation' (World Bank, 20 May 2014) www.worldbank.org/en/news/opinion/2014/05/20/op-ed-powering-science-and-technology-for-africas-economic-transformation accessed 18 July 2017.

77 See UNFCCC, 'Capacity Building for Technology Transfer in the African Context: Priorities and Strategies' (n 13) 1–5.

78 See Subsidiary Body for Scientific and Technological Advice, UNFCCC, *Third Synthesis Report on Technology Needs Identified by Parties Not Included in Annex I to the Convention* (n 28).

environment ministries, climate change institutions and private sector agencies, across policy and technological levels, and then provide adequate and updated knowledge for them in essential areas.

3.2.4. Weak investment environment for clean technology entrepreneurship

The most complex barrier to climate technology diffusion in Africa is the dearth of local firms that could absorb climate technologies and develop endogenous climate technology solutions. This problem has been attributed to the lack of a favourable regulatory and policy environment to support climate technology entrepreneurship across Africa.[79] High import duties, heavy tax burdens, excessive technology assemblage costs, inconsistent treatment of technologies at airports, and lack of government subsidies or fiscal incentives for new climate technology startup firms have been identified as regulatory hurdles that have served as disincentives to start up climate technology companies and have stifled the diffusion of climate technologies across West Africa.[80] Lack of economic incentives and supportive government policy on clean technology innovation and entrepreneurship has also been identified as a key barrier to the effective deployment of transferred technology in East African countries such as Kenya, Rwanda and Zambia.[81]

Similarly, in a survey released in 2014 by the World Wide Fund for Nature on countries where entrepreneurial clean technology companies are most likely to emerge from over the next ten years, South Africa is the only African country on the list.[82] This aside, a more recent survey suggests that even South Africa's progress in clean technology innovation has declined mainly due to lack of a favourable ecosystem for clean technology innovation, absence of a streamlined innovation pipeline and lack of a good entrepreneurial culture.[83] These studies reveal an urgent need for African countries to address hurdles that prevent and discourage climate technology entrepreneurship and innovation. In a continent with an urgent need for climate technologies, African countries must create a fiscal, regulatory and policy environment that could support and make clean technology innovation and entrepreneurship attractive to the private sector.

For Africa to move beyond its dependence on technology transfer, it must create the right policy and regulatory environment to encourage entrepreneurial activity and

79 See Clean Energy Group, *Accelerating Climate Technologies: Innovative Market Strategies to Overcome Barriers to Scale* (2010) 27 www.cleanegroup.org/wp-content/uploads/Accelerating-Climate-Technologies.pdf accessed 18 July 2017. See also Subsidiary Body for Scientific and Technological Advice, UNFCCC, *Third Synthesis Report on Technology Needs Identified by Parties Not Included in Annex I to the Convention* (n 28).

80 See Clean Energy Group, *Accelerating Climate Technologies* (n 79).

81 See Republic of Kenya, *Barrier Analysis Framework for Technologies Mitigation* (n 34) 14–15, Republic of Rwanda, *Barrier Analysis and Enabling Framework for Technology Transfer and Diffusion* (n 35) 19–20; Government of Zambia, *Technology Needs Assessment and Technology Action Plans for Climate Change Mitigation* (n 35) 23–24.

82 World Wide Fund for Nature and Cleantech Group, *The Global Cleantech Innovation Index 2014: Nurturing Tomorrow's Transformative Entrepreneurs* (2014) https://wwf.fi/mediabank/6751.pdf accessed 4 October 2017).

83 See World Wide Fund for Nature and Cleantech Group, *The Global Cleantech Innovation Index 2017: Nurturing Tomorrow's Transformative Entrepreneurs* (2017) 14, 38–40 https://wwf.fi/mediabank/9906.pdf accessed 4 October 2017.

incentivise startups to deploy, commercialise and develop climate technology. Failure to create the right innovation environment not only weakens the abilities of African countries to continually attract sustained inflow of clean technology, but it also hinders the rise of clean technology companies that can spearhead large-scale deployment of climate technologies. Climate technology innovators generally want to transfer technologies to, or settle in, countries where they can readily market their technologies at an early stage of development.[84] Thus, African countries can also promote climate technology absorption by providing favourable fiscal and policy incentives for climate technology entrepreneurs to assemble and maintain imported technologies, or to spearhead home-grown technological solutions.

The advantage of actively promoting clean technology entrepreneurship is exemplified by the Province of Ontario, Canada, which has maintained its reputation as having the fastest-growing clean technology sector in Canada, and one of the largest in North America. The Province of Ontario actively provides capital for clean technology firms under its Clean Tech Venture Capital Fund – a $55m fund designed to help clean technology firms acquire the capital they need to grow their business.[85] Some countries – such as China, India and Malaysia – have also committed significant resources to supporting clean technology, and have over the years been rewarded with a geometric rise of startup clean technology companies and increased technology inflow. This can be seen in China, which saw a 60 per cent rise in clean technology investment in 2016.[86]

A mix of fiscal incentives, such as tax discounts or subsidy mechanisms for innovators, access to clean technology financing, and streamlined and more affordable incorporation or permitting processes, can encourage clean technology startup companies.[87] Governments can also introduce local content or product mandating standards that will encourage or mandate government entities or investors to source for, and acquire, a percentage of their technologies from local manufacturers. Local content policies have been adopted across Africa, especially in the oil and gas sector, with a measure of success to provide a level playing field for local manufacturers to compete with foreign firms in the provision of goods and services.[88] Local content policies can also be mainstreamed into investment policies and legislation, to incentivise or mandate government agencies and private sector entities to source for, and acquire, locally-made clean technologies.

84 See Clean Energy Group, *Accelerating Climate Technologies* (n 79) 12–15.

85 See Government of Ontario, 'Helping Clean Tech Companies Grow and Compete Globally' (17 January 2017) https://news.ontario.ca/mris/en/2017/01/helping-clean-tech-companies-grow-and-compete-globally.html accessed 19 June 2017.

86 C Middlehurst, 'China Dominates Top 200 Clean Tech Companies List' (*Chinadialogue*, 22 February 2017) www.chinadialogue.net/blog/9626-China-dominates-top-2-clean-tech-companies-list/en accessed 18 June 2017.

87 Clean Energy Group, *Accelerating Climate Technologies* (n 79) at 27–28.

88 See S Tordo and others, *Local Content Policies in the Oil and Gas Sector* (World Bank 2013); Groupo Faro Acode, 'Local Content Frameworks in Latin American and African Oil and Gas Sector' (ELLA Research Design and Methods Papers 2015); also T Muller and M Schitzer, 'Technology Transfer and Spillovers in International Joint Ventures' (Discussion Paper No 2003–22, 2003); D Coe, E Helpman and AW Hoffmaister, 'International R&D Spillovers and Institutions' (2008) IMF Working Paper No WP/08/104; A Glass and K Saggi, 'The Role of Foreign Direct Investment in International Technology Transfer' in A Dutt and J Ros, *International Handbook of Development Economics* (Edward Elgar Publishing 2008).

3.2.5. Lack or inadequacy of climate change laws

Another key barrier to climate technology absorption in Africa is the lack, or inadequacy, of domestic climate change laws. Indeed, several African countries, including Ethiopia, Ghana, Namibia, Nigeria, Rwanda and Zimbabwe, where climate technology deployment projects have been controversial, have no climate change laws.[89] In Nigeria, there is currently no direct legislation on climate change at the federal, state or municipal levels. Since 2010, when the Nigerian National Climate Change Commission Bill was adopted by the Nigerian federal parliament, it has not received presidential assent.[90] The result is that there is currently no legislative framework that addresses direct and indirect impacts of climate change on local and vulnerable communities in Nigeria.[91] Other African countries, such as Algeria, Angola, Botswana, Cameroon, Democratic Republic of Congo, Egypt, Gabon, Libya, Morocco, Senegal, South Africa and Uganda, also have no climate change laws.[92]

The importance of domestic framework legislation, as opposed to mere strategy or policy documents, in promoting climate action in African countries cannot be overemphasised.[93] Guideline-type instruments and policy frameworks on climate change that have been widely adopted across Africa have limited enforceability in law.[94] Without an overarching legal framework that defines a country's climate change strategy, including technology transfer and absorption plans, or the basis for implementing and approving climate projects, many of the key issues of lack of information, lack of protection for cultural rights, limited protection for intellectual property rights for climate technologies, lack of capacity and limited incentives to stimulate climate innovation are left either unaddressed or unimplemented by national authorities. A clear, comprehensive and transparent legal framework could place legally enforceable obligations on the government to fast track the importation and deployment of climate change technologies that will prevent catastrophic climate change. A legal framework on climate change could also establish procedural and rights-based mechanisms to increase awareness, foster participation, build capacity and initiate public information disclosure programmes. Such a legal framework could also provide a proper mechanism for local communities to

89 See 'The 2015 Global Climate Legislation Study A Review of Climate Change Legislation in 99 Countries: Summary for Policy-makers' www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/05/Global_climate_legislation_study_20151.pdf accessed 9 May 2016.

90 Information on the status of climate legislation in Nigeria is available at Federal Ministry of Environment, Climate Change Unit http://climatechange.gov.ng.

91 A Climate Change and Global Greenhouse Emission Reduction Bill 2015 is currently undergoing debates in Nigeria's parliament. If passed, this Bill will provide a comprehensive legal framework for combating climate change in Nigeria. See 'Nigeria: Climate Change Bill Scales Second Reading in Senate' *Vanguard Newspaper* (5 May 2016).

92 See 'The 2015 Global Climate Legislation Study' (n 89) at 42–45.

93 See 'The Global Climate Legislation Study: Summary of Key Trends 2016 COP22, Marrakesh, November 2016' www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/11/The-Global-Climate-Legislation-Study_2016-update.pdf, noting that framework legislation has been shown to encourage a strategic approach to climate policy and generate further policy action; also United Nations Environment Programme (UNEP), *Guidelines for the Development of National Legislation on Access to Information, Public Participation and Access to Justice in Environmental Matters* (Adopted by the Governing Council of the United Nations Environment Programme in decision SS.XI/5, part A of 26 February 2010).

94 For the distinction between formal and informal norms in law, see S Toope, 'Formality and Informality' in Daniel Bodansky, Jutta Brunnée and Ellen Hey (eds), *Oxford Handbook of International Environmental Law* (Oxford University Press 2007) 107.

demand enforcement and action by national authorities for lack of action on climate change, or for the implementation of climate actions that increase local vulnerabilities.

Climate change laws can also be very helpful in addressing overlaps and limitations in other domestic laws that could hinder the successful implementation of climate technology absorption programmes.[95] For example, where existing technology transfer or foreign investment laws contain restrictive provisions on technology absorption or where foreign direct investment laws provide little or no fiscal incentive for climate technology innovation or entrepreneurship, adopting a climate change law could provide an opportunity for a country to address those gaps. Adopting clear and specific provisions on technology importation and absorption could provide opportunities for a country to harmonise its climate change agenda with existing laws to avoid overlap and fast track climate technology absorption.

Most importantly, a country's climate legislation could provide a basis for establishing a designated institution or focal point as a one-stop-shop for climate change programmes, including climate technology transfer and absorption. As can be learned from countries such as Australia and the United Kingdom, countries that have empowered focal climate change committees or authorities to directly oversee policies and targets on climate change, a focal agency on climate change can enhance greater coordination in climate change mitigation and adaptation efforts.[96] Currently, due to the lack of overarching climate change legislation, climate change institutions in all of the surveyed African countries are ensconced within the environment ministry.[97] This governance approach has not fostered the required level of coordination to streamline and implement climate technology absorption programmes.

Establishing a focal institution responsible for climate technology transfer and absorption could help simplify the processes and procedures for seeking and obtaining regulatory permits and approvals; it would also serve as a rallying point that could foster intergovernmental coordination and linkages among the many institutions that currently play important roles in the delivery of climate change technology transfer programmes. For example, apart from the environment ministry or department, the education ministry has a role in assessing and monitoring local capacity and training programmes, technology departments and ministries have roles to play in facilitating the transfer and deployment of petroleum technologies, while labour ministries and departments have roles in measuring how new technologies are leveraged for productivity across various sectors of the economy. The multiple range of stakeholders underscores the importance of coordination. A focal agency on climate change can bring together and coordinate climate technology absorption across all relevant sectors of the economy. With robust intergovernmental coordination, granting and

95 C Nwapi, 'Defining the "Local" in Local Content Requirements in the Oil and Gas and Mining Sectors in Developing Countries' (2015) 8 Law & Development Review 187; also J Ovadia, *The Role of Local Content Policies in Natural Resource-based Development* (Österreichische Entwicklungspolitik Rohstoffe und Entwicklung, 2015) 37–38.

96 See Australia's Climate Change Authority Act 2011, which established the Climate Change Authority to oversee Australia's climate change policies and action, including issues relating to climate technologies. See also the UK's Climate Change Act 2008, which establishes an independent Committee on Climate Change to provide advice to the UK Government on these targets and related policies.

97 For a comprehensive list of all environment ministries in Africa, see The World Bank, Africa Environmental Agencies http://web.worldbank.org/archive/website01004/WEB/0__CO-75.HTM accessed 18 July 2017.

getting climate technology related approvals and permits could be less cumbersome and more straightforward for inventors and other stakeholders in the technology absorption chain. Developing a coordinated implementation approach could also simplify the process of passing information between government ministries, thereby removing inefficiencies and bureaucracies.

The aforementioned gaps and barriers to climate technology absorption in African countries can be addressed through holistic law and governance systems that enhance domestic absorptive capacity for climate technology. The next section discusses the guiding principles of a holistic law and governance reform process through which African countries can accelerate climate technology absorption and integration.

4. Improving law and governance frameworks on climate technology absorption in Africa

Africa's capabilities to effectively contribute to the Paris Agreement's global agenda of reducing the threats of climate change depend mainly on how quickly and efficiently the continent can absorb and leverage the technological competencies needed to sustain climate change mitigation and adaptation. The following action points should be considered for bridging existing legal and governance gaps with respect to climate technology absorption.

4.1. *Establish clear and comprehensive climate change legislation*

To enhance absorptive capacities for climate change technologies, the starting point is for national authorities across Africa to establish a clear and comprehensive legislative framework on climate change. That framework should clarify national climate change targets and priorities, including technology transfer and absorption policies, and establish robust procedural rights safeguards on access to information and stakeholder participation in technology deployment and project approval processes.[98] Thus, while several of the human rights and land use puzzles associated with climate technology deployment cut across broad sectors, and are not restricted to climate change projects, a comprehensive climate change law will provide an opportunity to address the specific manifestations of these challenges in the climate change context. Given the urgent need for African countries to leverage climate technologies to fast track climate change mitigation and adaptation, comprehensive legislation on climate change could identify and address barriers and disincentives to the smooth deployment of climate change technologies across all sectors.

In addition to eliminating rules and procedures that act as barriers and disincentives to climate technology entrepreneurship, comprehensive climate change legislation could also clarify questions relating to permitting, licensing, site selection, impact assessment and establish fiscal incentives for technology entrepreneurs. African countries could reduce uncertainties relating to the transfer and adoption of climate technologies and increase investor confidence in their countries as favourable locations

98 For example, s 1 of the UK's Climate Change Act 2008 expressly codifies the country's national target on climate change mitigation, while ss 56–60 address national priorities on climate change adaptation.

for deploying and marketing advanced climate change technologies through an overarching legal framework on climate change.

4.2. *Update and reform patent and intellectual property protection laws*

In addition to adopting an overarching legislative framework on climate change, it is pertinent for African countries to review and reform extant patent and IP laws to provide more robust protection for IPRs. A robust patent and IP regime should contain clear and comprehensive provisions to protect climate technologies and inventions from illegitimate appropriations, or use without authorisation or compensation. Such a law should also establish judicial mechanisms that protect IPRs whenever these are violated. Studies have shown a correlative increase in the level of technology innovation when IPR laws are introduced and enforced.[99] Robust IPR legislation, backed by clear and transparent judicial mechanisms for redress, could increase technology transfer and innovation activity in African countries.[100]

Restrictive and ambiguous provisions that limit the scope of technologies that could be patented must be updated to fast track the absorption and deployment of priority climate technologies, especially in key sectors such as water, food, energy and transportation. For example, excluding small-scale climate change technologies from patenting could serve as a disincentive for small-scale climate technology producers and could stifle climate technology entrepreneurship. Given the urgent need to accelerate climate change technology absorption in Africa, national authorities must review IP laws that could result in policy mismatch or serve as disincentive for climate technology inventors.

As well as strengthening the level of protection accorded to IPRs, African countries must also revitalise IP institutions and regulatory structures to make patenting applications and processes more streamlined and accessible. As important stakeholders in the climate absorption process, patent offices should be equipped with human and technical resources required to provide transparent and effective patent registration processes. Similarly, fast track and one-stop centres for climate technology patenting and licensing can be established to facilitate easier and faster processing for priority technologies.

4.3. *Improve legal framework on information disclosure*

As discussed earlier, local and cultural resistance to climate technologies is often propelled, or exacerbated, by systemic failures by project proponents and national authorities to provide clear and transparent information on the nature, benefits and impacts of climate technologies on local communities. Similarly, inappropriate site selection, or deliberate targeting of low income communities as site locations for climate technology deployment without adequate consultation, have fuelled waves of local protests about and resistance to the uptake of climate technologies and projects across Africa.[101] There is a need to address these problems by promoting greater

99 L Branstetter and others, 'Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-level Data' (2005) NBER Working Paper 11516, 2–5; Copenhagen Economics, *Are IPR a Barrier to the Transfer of Climate Change Technology* (January 2009) 26–28.

100 Branstetter and others (n 99).

101 See P Cullet, 'Rethinking the Legal Regime for Climate Change: The Human Rights and Equity Imperative' in Steffen Böhm and Siddhartha Dabhi (eds), *Upsetting the Offset: The Political*

transparency in the design, approval, planning and implementation of climate technology deployment projects.

African countries can address the problem of local resistance, first by removing legal or procedural requirements that impede public access to information about climate technologies. In countries such as Ghana and Zambia, where FOI legislation has not been passed, a good starting point will be to adopt clear and comprehensive FOI laws that provide an adequate legal basis for the public to seek and obtain information about climate technologies and other climate change mitigation and adaptation projects. Effective FOI legislation must establish processes to facilitate timely access to information about climate technologies at a reasonable cost. For example, the process of obtaining information should not be too tedious and complex; neither should it be designed to frustrate and discourage individuals from seeking publicly held information. Similarly, in countries with existing FOI laws, it is imperative to address procedural barriers that may impede or discourage the public from accessing public information about climate technologies. For example, the cost of accessing information should be affordable so as not to deter information requests, while the process of seeking and obtaining information from public bodies should be streamlined to ensure information can be accessed without stress or delay.

Second, public disclosure of information must go beyond acceding to requests for information. National authorities can do much more by proactively and publicly disclosing information that could alleviate the concerns of the public about a climate technology or project. For example, governments can *suo motu* conduct community awareness programmes on project site selection, environmental impact assessments that have been conducted, how a new climate technology could affect the local community, and steps that have been taken to mitigate such impacts. Disclosing project information on an ongoing basis can help local communities understand the risks, impacts and opportunities of a climate technology, thereby reducing the likelihood of public protest or resistance. Proactive public disclosure could also be achieved by keeping a public database or by releasing periodic documents on governmental affairs. The aim is to reduce the culture of secrecy, to ensure that information disclosure about climate technologies is not only reactive, but also proactive.

Furthermore, information disclosure should not end at the planning stages. As projects move from one stage of development to another, information is most likely to change with new facts emerging and some previous project information becoming outdated. There is, therefore, a need for project proponents and national authorities to publish, on a regular basis, all information related to the technology, even when the public do not specifically request such information. Examples of project information that should be constantly released through public disclosure programmes include operational information, budgeting and costs, information on how the public can raise complaints, procedures for public input and details of decisions taken regarding issues affecting the public.[102] This can be done by publishing project updates on dedicated websites, sending periodic newsletters and communication to members of the public,

Economy of Carbon Markets (MayFly Books 2009) 292–306; also Olawuyi, *The Human Rights Based Approach to Carbon Finance* (n 35) at 1–25.

102 See Article 19, 'The Public's Right to Know: Principles on Freedom of Information Legislation' (1999) www.article19.org/pdfs/standards/righttoknow.pdf accessed 12 May 2017.

and promoting public awareness through radio, television documentaries and photos. The aim should be to deliver project information in the language and format understood by local communities and in such a way that information reaches the most remote and rural communities.

Establishing cost effective disclosure programmes will provide the public with a clear path to understanding the nature and implications of a new climate technology on their communities and lives. It could also help national authorities to obtain important feedback that could enhance the application and deployment of mitigation and adaptation technologies in rural contexts.

5. Conclusion

While increased transfer of climate technologies from the North to South, especially to Africa, reflects global commitment to accelerate the Paris Climate Agreement goals, the barriers to rapid diffusion of new climate technologies in Africa are complex, heterogeneous and cannot be resolved by increased technology transfer activity alone. Law, governance and institutional barriers that stifle the implementation of a coherent technology absorption framework must be addressed in order to accelerate wide-scale and sustained deployment of climate technologies across the continent.

As noted in this article, the international climate change regime, especially the Technology Mechanism, can do more to better reflect and accentuate the importance of climate technology absorption as a third and important component of the international climate technology diffusion process.[103] Rather than concentrate on technology transfer alone, international development agencies and organisations can support African countries to develop coherent technology absorption plans, which will include training and capacity development, infrastructure modernisation, systems transformation and long-term innovation components, as strategic components of technology transfer programmes.

Regional sharing of expertise, knowledge and best practices on climate technology absorption could also provide an effective platform for African countries to jointly identify common challenges relating to training and capacity development, infrastructure modernisation, systems transformation and long-term climate technology entrepreneurship on the continent. With regard to emerging opportunities and challenges for developing a coordinated regional framework or approach for enhancing the absorptive capacities for climate technologies in Africa, future research will be necessary to develop a better understanding of the role of the African Union, the African Development Bank and the UN Economic Commission for Africa in coordinating and presenting a common position to the international climate change regime on how to accelerate climate technology deployment and absorption in Africa.

103 See (n. 15) above.