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Greening the implementation of the African Continental Free Trade Area Agreement

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Highlights

- While the AfCFTA negotiations have not yet dealt in depth with climate change and green transition issues, the establishment of a national carbon market is now on the agenda of many African countries.
- According to simulations with the MIRAGE-Power model implementing the AfCFTA Agreement without adopting any climate policies in Africa would increase the continent's emissions in 2045 by 0.3%.
- The adoption of climate policies in line with African countries' NDCs, in addition to implementing the AfCFTA Agreement, would enable a 25% decrease in GHG emissions by 2045, assuming a common carbon price in line with the IMF's ICPF proposal for low-income countries.
- Differentiated but coordinated efforts between African countries to reduce emissions through carbon pricing could bring the cost of abatement to US$ 19.00 per ton of carbon.

Abstract

The African Continental Free Trade Area (AfCFTA) Agreement aims to create a single market for goods and services, increase intra-Africa trade and promote sustainable socioeconomic development in Africa. African countries need to balance efforts to address these goals with the urgency of climate change. As of the 27th session of the Conference of Parties of the United Nations Framework Convention on Climate Change in 2022, most African countries had submitted their Nationally Determined Contributions (NDCs) to mitigate the impact of climate change. Establishing a carbon market is now on the policy agenda. This paper uses a dynamic general equilibrium model with different sources of energy (including renewable energy) and an in-depth presentation of greenhouse gas emissions to assess the economic and environmental impacts of implementing the AfCFTA Agreement and adopting various climate policies in Africa, including those NDCs and the International Monetary Fund's proposal of carbon price floors. It shows that implementing the agreement and achieving Africa's climate objectives are compatible. Continental coordination of emissions reduction among African countries proves most efficient for climate action.

Keywords

International Trade, Climate Change, AfCFTA.

JEL

F13, F17, F18, Q56.

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RESEARCH AND EXPERTISE
ON THE WORLD ECONOMY

Greening the Implementation of the African Continental Free Trade Area Agreement[1]

Lionel Fontagné, Stephen Karingi, Simon Mevel, Cristina Mitaritonna and Yu Zheng[2]

1 Introduction

The African Continental Free Trade Area (AfCFTA) Agreement entered into force on 30 May 2019, creating the largest free trade area in the world by number of participating countries. Phase I of the negotiations towards a liberalized market, which is almost completed, has focused on trade in goods, trade in services and dispute settlement.[3] Phase II focuses on investment, intellectual property rights, competition policy, digital trade, and women and youth in trade.

While AfCFTA Agreement negotiations so far have not extensively considered climate change and green transition matters,[4] establishing a national carbon market is now on many African

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[2] Lionel Fontagné is scientific advisor at CEPII and Bank of France, Stephen Karingi and Simon Mevel are economists at ECA, Cristina Mitaritonna and Yu Zheng are economists at CEPII.
[3] Outstanding issues include rules of origin in textiles and apparel and in the automotive industry, as well as the final schedules of tariff commitments on trade in goods and lists of services commitments by all State Parties.
[4] These issues have not been completely overlooked, either. For instance, Article 26 of the AfCFTA Protocol on Investment is dedicated to climate change.

countries' agenda. Indeed, Africa accounts for a small share (around 7% in 2020) of global greenhouse gas (GHG) emissions[5] and has the lowest emissions per capita of any region (IEA 2022a; De Melo & Solleder 2023). However, with a higher average temperature than other regions, it is highly vulnerable to climate change, as coping with climate change is more difficult for developing economies than for developed countries (Arreyndip 2021; Tol 2009). Climate issues will move to the fore in the coming decades as Africa's projected economic growth and anticipated trade expansion translate into additional GHG emissions.

In this context, a major concern for Africa is how to achieve sustainable economic development while retaining a lower carbon footprint and accomplishing a green transition. As of the 27th session of the Conference of Parties (COP27) of the United Nations Framework Convention on Climate Change (UNFCCC), many African countries had updated their Nationally Determined Contributions (NDCs) with more ambitious commitments.[6] Several countries have NDCs with only unconditional commitments, but most countries' NDCs include both unconditional and conditional commitments.[7] As such, along with full trade integration of the continent, is to assess the options for introducing market instruments to reduce emissions.

Few studies address the potential environmental effects of the AfCFTA Agreement. Bengoa, Mathur, Narayanan and Norberg (2021), using the standard static Global Trade Analysis Project (GTAP) model, show that the agreement increases carbon dioxide (CO_2) emissions marginally and non-CO2 GHG emissions significantly.[8] Janssens, Havlík, Boere, Palazzo,

[5] Africa also accounts for around 3.7% of carbon dioxide emissions. Authors' computation based on the baseline emissions in the model. These figures are in line with those in other data sources. For instance, according to IEA (2022a), Africa accounted for 3% of carbon dioxide emissions in 2020; according to the Emissions Database for Global Atmospheric Research's Community GHG Database, Africa accounted for 6.5% of total GHG emissions in the same year (Crippa, Guizzardi, Solazzo, Muntean, Schaaf, Monforti-Ferrario, Banja, Olivier, Grassi, Rossi et al. 2023).

[6] NDCs are pledges to reduce GHG emissions as part of the global effort to limit global warming to 2 degrees Celsius. See the NDC Registry on the UNFCCC website (https://unfccc.int/NDCREG) for the latest publicly available NDCs.

[7] Unconditional NDCs are contributions that can be implemented with domestic resources; conditional NDCs are contributions that can be implemented if international support is provided.

[8] According to their simulations, the AfCFTA Agreement would increase African countries' CO_2 emissions by 0.3% and non-CO_2 emissions by 21.5%.

Mosnier, Leclère, Balkovič and Maertens (2022), using the Global Biosphere Management Model, show that the agreement has a small impact on total GHG emissions from agriculture, despite a large increase in intra-Africa agricultural trade. African Development Bank (2022) argues that developing and trading in electricity markets across the continent may also alleviate environmental constraints.

This paper explores how to make the industrial transformation and economic development in Africa brought about by the trade reforms under the AfCFTA Agreement consistent with climate ambition. It provides detailed results on:

- The impact on trade—particularly intra-Africa trade—from implementing the agreement.
- The impact on GHG emissions from implementing the agreement without adopting climate policies in Africa.
- The impact on GHG emissions and economic outcomes from implementing the agreement and adopting climate policies in Africa under different scenarios (including under existing NDCs and different designs of carbon markets).
- The implicit carbon price required to meet the targets set in African countries' most recent NDCs.
- The change in the electricity generation mix and the growing share of renewables under all the options considered.

Section 2 provides the policy background. Section 3 discusses the model, the data used and the scenarios. Section 4 presents the economic and environmental results. And section 5 concludes.

2 Background

2.1 The AfCFTA Agreement

The Agreement establishing the AfCFTA was signed at the 10th extraordinary summit of the African Union Assembly on 21 March 2018 in Kigali, Rwanda. The agreement was set to come into force 30 days after being ratified by 22 of the signatory states. On 29 April 2019, the Sahrawi Republic made the 22nd deposit of ratification instruments. The agreement went into force on 30 May 2019 and entered its operational phase following a summit on 7 July 2019. As of 18 October 2023, 54 of the 55 African Union member states have signed the agreement, and 47 have ratified it.

Trading under the AfCFTA Agreement officially commenced on 1 January 2021 but began in practice in October 2022, following the AfCFTA Secretariat's launch of the Guided Trade Initiative in eight pilot countries (Cameroon, Egypt, Ghana, Kenya, Mauritius, Rwanda, United Republic of Tanzania and Tunisia). The initiative, which expanded the number of participating countries and products traded over its first year of operation, was designed to test and facilitate implementation of the agreement in participating countries.

The AfCFTA Agreement created the largest free trade area in the world by number of participating countries. Its objectives are to create a single market, deepen the continent's economic integration, resolve countries' multiple and overlapping memberships in regional economic communities and lay the groundwork for a continental customs union and ultimately an African economic community. Its scope is large, covering issues beyond those in traditional free trade agreements. Phase I of the negotiations towards the AfCFTA's liberalized market have focused on standard trade areas (trade in goods, including non-tariff barriers, and trade in services) and dispute settlement. Phase II focuses on investment, intellectual property rights, competition policy, digital trade, and women and youth in trade.

While AfCFTA Agreement negotiations so far have not extensively considered climate change and green transition matters, these issues are gaining importance across the world—and Africa is no exception.

2.2 NDCs and carbon markets in Africa

To date, all African countries but Libya have submitted their NDCs.[9] However, African countries continue to face challenges in financing and implementing them. As such, most of these NDCs are constructed with both unconditional commitments, expected to be fulfilled through domestic resources, and conditional commitments that rely on the availability of international funds.

Countries can use a variety of methods—market-based instruments, subsidies, tax credits or regulations—to fulfil the commitments in their NDCs. However, given scarce national budgetary resources, fragile tax systems and low income per capita, carbon markets provide a promising avenue, as long as prices are in line with income levels. Multiple initiatives, along with national efforts, promote developing a carbon market in Africa—for example, the African Development Bank's Africa Climate Change Fund and the Africa Carbon Markets Initiative (ACMI), launched at COP27. With 13 African leaders, chief executive officers and carbon credit experts as steering committee members, ACMI's objective is to support the generation of carbon credits and create jobs in Africa. In this context, the United Nations Economic Commission for Africa and the African Export-Import Bank, in cooperation with the African Union Commission, the Congo Basin Climate Commission, the Climate Commission for the Sahel Region, the African Islands Climate Commission, the African Development Bank and the ACMI, convened the 2023 Africa Business Forum on 20 February, with the theme "Making

[9] See the NDC Registry on the UNFCCC website (https://unfccc.int/NDCREG).

carbon markets work for Africa." The forum offered a platform to move the conversation on carbon markets forward among governments, private sector and investors.

The challenge for African countries is to identify carbon prices that can help achieve emissions reduction targets without undermining economic development. The IMF has promoted differentiated carbon price floors through the International Carbon Price Floor (ICPF) proposal, with a floor of US$ 25 for low-income countries, US$ 50 for middle-income countries and US$ 75 for high-income countries (Parry, Black & Roaf 2021). In practice, these prices do not necessarily allow for an economically optimal sharing of the burden of emissions reduction. The next section shows that the same reduction in emissions from African countries can be achieved at a lower economic cost by differentiating but still coordinating carbon prices across African countries.

3 The model and the scenarios

3.1 MIRAGE-Power: a general equilibrium model

Simulations in this paper rely on MIRAGE-Power, a multiregional, multisector, dynamic computable general equilibrium model, featuring a detailed representation of energy use. This recently enhanced version of the MIRAGE[10] computable general equilibrium model is an extension of MIRAGE-e (Fontagné, Fouré & Ramos 2013) that incorporates electricity generation using data recently released by the Global Trade Analysis Project (GTAP). In MIRAGE-Power, electricity is generated from multiple sources, including renewables (hydro, solar, wind and others), nuclear reactions, coal, oil and gas. The regional or national electricity producer provides aggregate electricity for intermediate consumption and households.

[10] MIRAGE stands for Modelling International Relationships in Applied General Equilibrium.

Electricity can also be traded, and because renewables are large sources of electricity generation in Africa, this feature is of particular interest to the African electricity market.

Beyond electricity generation, several features of MIRAGE-Power help in analysing trade policy in more detail, with a focus on energy. First, it is an energy-oriented model: energy is not considered an intermediate consumption but is directly substituted with capital in the production function. Second, the model incorporates GHG emissions from both production and household consumption. Firms emit CO_2 during the intermediate use of fossil fuels (coal, refined oil and gas). Emissions of non-CO_2 gases (methane, nitrous oxide and fluorinated gases) are also associated with the production process and are thus modelled as production factors. Households emit CO_2 and non-CO_2 gases based on their consumption. Figure A2 in the appendix shows the detailed structure of the production function for the manufacturing and services sectors in the MIRAGE-Power model.

The model incorporates climate policies in Africa through two mechanisms: a cap-and-trade system and, for the part of the economy not covered by such mechanism, a carbon tax. The carbon tax is implemented in the model as an implicit carbon price, which includes not only the tax but also the costs associated with meeting regulations and standards.[11] The model also accounts for trade policies, based on highly disaggregated databases of bilateral applied tariffs and the equivalents of non-tariff barriers for goods and services.

The model relies on the GTAP-Power 10.1 Data Base as a global social accounting matrix and is accordingly calibrated on the 2014 base year. The database includes disaggregated data on electricity transmission and generation activities that are consistent with the full GTAP 10.1 Data Base. It covers the world economy, with data disaggregated across 76 sectors and 147 geographic regions. For this paper, the data were aggregated into 37 sectors and 29 regions or countries (see tables A1 and A2 in the appendix). The GTAP 10.1 Satellite Non-

[11] The European Union Emissions Trading System is the only cap-and-trade market represented in this version of the model.

CO_2 GHG Emissions Data Base was used to calibrate the representation of GHG in MIRAGE-Power. Trade elasticities are from Fontagné, Guimbard and Orefice (2022), based on the dataset in the GTAP classification from October 2020.

3.2 The dynamic baseline

Because climate policy is a long-term agenda, a business as usual (BAU) economic scenario was constructed to reflect economic growth until 2045 in the absence of the AfCFTA Agreement, which should be fully implemented by 2035 in the relevant scenarios.[12]

The BAU economic scenario used long-term macroeconomic projections—for gross domestic product (GDP), the labour participation rate and skills, the current account, investment and saving rates and energy efficiency—from Fontagné, Perego and Santoni's (2022) up-to-date estimates based on the Macroeconometrics of the Global Economy model (Fouré, Bénassy-Quéré & Fontagné 2013). Both models use two exogenous series: population projections, from the UN central scenario, and oil price projections, from the U.S. Energy Information Administration (EIA) database. MIRAGE-Power also incorporates coal and gas price projections from the EIA database. Total factor productivity is considered endogenous to reconcile the two models. Thus, MIRAGE-Power projects a reference trajectory for the world economy that is consistent with the Macroeconometrics of the Global Economy model.

The BAU scenario also included trade policy and climate policy baselines, while keeping total factor productivity exogenous. Consequently, GDP, investment and energy prices are endogenous. The trade policy baseline included the evolution of key trade policy variables between 2014 and 2019, including the latest information on current free trade agreements, based on the 2014 and 2019 versions of the Market Access Map HS6 dataset (Guimbard, Jean, Mimouni & Pichot 2012). In particular, the Economic Partnership Agreements between

[12] Although the reform on tariff liberalization is scheduled to be fully considered in 2033, the model conservatively assumes that the modalities on non-tariff measures will not be settled until 2035.

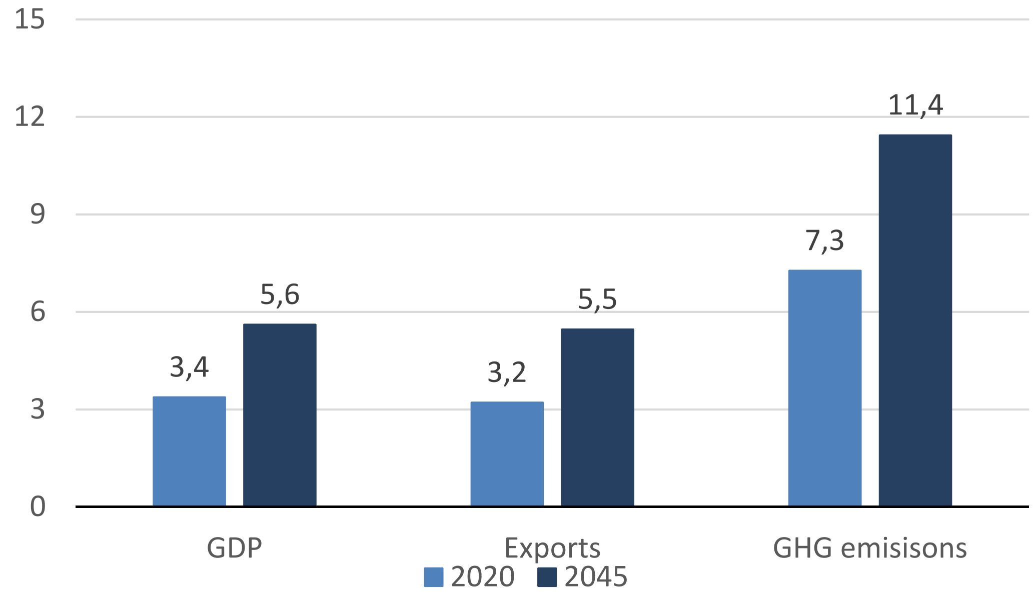
the European Union and African countries (Cameroon, Côte d'Ivoire, Comoros, Madagascar, Mauritius, Seychelles and Zimbabwe, as well as the Southern African Development Community) and between the European Union and Caribbean and Pacific countries through 2019 are accounted for. In addition, changes in the European Generalised Scheme of Preferences (GSP) and GSP+ for other developing countries are included. Changes in the Chinese most-favoured-nation treatment and in the common external tariff set in 2015 for the Economic Community of West African States are included. Non-tariff measures in services were estimated using the standard gravity approach (Fontagné, Mitaritonna & Signoret 2016), based on the GTAP 10.1 database. Non-tariff measures for goods were based on World Bank estimates (Nicita & Olarreaga 2007). There is no change in the non-tariff measures in the baseline.

The climate policy baseline is based on updated NDCs from COP27.[13] Following Bellora and Fontagné (2023), the baseline includes the fulfilling of unconditional commitments only for countries with a national carbon market in place by 2021.[14] It is assumed that these countries will fulfil their commitments from the Paris Agreement by 2030 and that the emissions of these policy regions will then be capped at their 2030 levels until 2045.

Africa's share of world GHG emissions is expected to increase quickly under the BAU scenario (figure 1). While its share of world GDP would rise from 3.4% in 2020 to 5.6% in 2045, its share of world GHG emissions, notwithstanding expected gains in energy efficiency, would jump from 7.3% in 2020 to 11.4% in 2045, an increase of 4.1 percentage points (or 56%).[15]

[13] See the NDC Registry on the UNFCCC website (https://unfccc.int/NDCREG).
[14] Those countries are Argentina, Canada, China, Colombia, Japan, Kazakhstan, the Republic of Korea, Mexico, New Zealand, Ukraine and the United Kingdom, as well as the 4 members of the European Free Trade Association and the 27 members of the European Union. South Africa is excluded from the baseline, despite having a national carbon market, because the conditionality of its NDC is ambiguous.
[15] Africa's share of world CO_2 emissions would grow from 3.7% in 2020 to 4.5% in 2045.

Figure 1. Africa's shares of world gross domestic product (GDP), exports and greenhouse gas (GHG) emissions in 2020 and 2045 under the business as usual scenario (%)



Note: The business as usual scenario assumes no implementation of the African Continental Free Trade Area Agreement or adoption of climate policies in Africa but includes projected energy efficiency gains that endogenously reduce the carbon content of GDP.

Source: Authors' simulations using the MIRAGE-Power model.

3.3 The scenarios

All simulations reflect implementation of the AfCFTA Agreement. Five scenarios also considered adoption of different climate policies in Africa. The results refer to deviations from the BAU scenario. The trade reforms under the agreement reflect, within African only, progressive liberalization (97% of tariff lines) of trade in goods, in line with agreed AfCFTA modalities, starting in 2021 and spread over 10 years for developing countries and 13 years for the Least Developed Countries;[16] a 50% reduction in actionable restrictions to trade in the

[16] Each African Union State Party of the AfCFTA Agreement is required to put forward a tariff offer with three types of tariff lines: non-sensitive (90% of tariff lines, representing at least 10% of imports from the rest of Africa), sensitive (7% of tariff lines) and excluded (3% of tariff lines). Developing countries have 5 years to

five AfCFTA priority services sectors (communication, tourism, transport, financial services and business services), as well as health and education services; and a 50% cut in actionable non-tariff measures.

In scenario 0 (**AfCFTA**), included for comparison only, the AfCFTA Agreement is implemented without adoption of any climate policies in Africa.

Three scenarios assume that African countries fulfil their NDC commitments through national carbon markets in Africa. The model includes an endogenous carbon tax that reflects the combined shadow price of all measures—explicit carbon price, the cost of meeting regulations, and subsidies—needed to reach emissions reduction targets. Moreover, the commitments fulfilled in 2030 remain in place until 2045.[17] In ascending order of ambition, the scenarios are:

- **Scenario 1: AfCFTA + 100% Unconditional NDCs (AfCFTA + 100U NDC):** all African countries that have submitted NDCs fulfil all their unconditional commitments in 2030.
- **Scenario 2: AfCFTA + 100% Unconditional & 25% Conditional NDCs (AfCFTA + 100U25C NDC):** all African countries that have submitted NDCs fulfil all their unconditional commitments and 25% of any conditional commitments by 2030.
- **Scenario 3: AfCFTA + 100% Unconditional & 50% Conditional NDCs (AfCFTA + 100U50C NDC):** all African countries that have submitted NDCs fulfil all their unconditional commitments and 50% of any conditional commitments by 2030.

A fourth scenario includes an exogenous uniform carbon price in African countries, set at US$ 25 per ton of carbon (per the IMF's ICPF proposal), for the sake of illustration:

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eliminate tariffs on non-sensitive tariff lines and 10 years to eliminate tariffs on sensitive tariff lines. The Least Developed Countries have 10 years to eliminate tariffs on non-sensitive tariff lines and 13 years to eliminate tariffs on sensitive tariff lines. Excluded tariff lines are not subject to tariff liberalization.

[17] Achieving 100% of conditional NDCs is not considered because it is unclear whether the required international support could be mobilized.

- **Scenario 4: AfCFTA + uniform US$ 25 carbon price (AfCFTA + US$25 CP):** an exogenous and uniform carbon price of US$ 25 per ton of carbon is assumed for all African countries. The price is linearly reached by 2030 and remains unchanged until 2045.

This scenario, with a uniform carbon price, is contrasted with a fifth scenario that distributes decarbonization efforts among African countries to achieve the same overall reduction as under the IMF's ICPF proposal in proportion to each country's GHG emissions in 2045 under the baseline scenario:

- **Scenario 5: AfCFTA + proportional abatement coordination (AfCFTA + coordination):** the model determines for each country the implicit carbon price associated with the abatement target in 2045, provided that the emissions reduction is implemented linearly from 2022 onwards. Countries engage in differentiated but coordinated efforts to reduce their emissions in proportion to their contribution to Africa's total emissions in 2045 under the baseline scenario.

In scenario 5, a country that generates 10% of Africa's GHG emissions in 2045 in the baseline scenario would account for 10% of the targeted reduction in GHG emissions, here again with a national carbon price. The motivation for this scenario is twofold. First, the results can be compared with those from scenario 4 to verify the extent to which the common carbon price of US$ 25 per ton is linked to actual national contributions to Africa's total emissions. Second, the induced carbon price can be compared with the price associated with each African country's NDC, which helps seize the ambition of NDCs.

4 Results

4.1 Impact on trade from implementing the AfCFTA Agreement without adopting climate policies in Africa

Scenario 0, implementing the AfCFTA Agreement without adopting any climate policies in Africa, an unrealistic scenario, serves as a point of comparison for the different ways in which African countries could fulfil their climate commitments.

Fully implementing the AfCFTA Agreement would increase Africa's total exports in 2045 by 5.8% and imports by 5.5%, compared with the baseline scenario where the agreement is not implemented. These differences are modest because about 85% of Africa's current formal trade is with non-African partners that are not involved in the AfCFTA. Intra-Africa formal trade in 2045 would increase by 34.6% with the agreement, compared with the baseline scenario without it. Intra-Africa trade would increase by 53.6% in agrifood, 37.6% in services, 36.3% in industry and 19.3% in energy and mining.

4.2 Impact on GHG emissions from implementing the AfCFTA Agreement without adopting climate policies in Africa

Implementing the AfCFTA Agreement without adopting any climate policies in Africa would increase the continent's emissions in 2045 by 0.3%, compared with not implementing the agreement. CO_2 emissions alone would increase by 0.6%, whereas non-CO_2 emissions would increase by 0.1%, with methane emissions increasing by 0.2%, fluorinated gas emissions by 1.5% and nitrous oxide gas emissions unchanged. The larger increase for fluorinated gas emissions, which come mostly from industry, is in line with expectations and the large increase in intra-Africa trade in industrial sectors (accounting for nearly two-thirds of the absolute intra-Africa trade gains) following implementation of the AfCFTA Agreement. Methane and nitrous oxide emissions come mostly from agriculture, land use and waste.

The modest (0.3%) increase in Africa's GHG emissions from implementing the AfCFTA Agreement is expected. At least four reasons can explain the outcome.

First, Africa accounts for a small share of world GHG emissions, and the considerable percentage growth in intra-Africa trade from implementing the AfCFTA Agreement would be from a small base. Therefore, the agreement as designed would not be expected to have a major effect on GHG emissions. Indeed, the model indicates that intra-Africa trade as a share of Africa's total trade would grow from around 15% in 2020 to around 24% in 2045 with full implementation of the agreement but would still reach about 19% under the baseline scenario without the agreement. The relatively small difference of 5 percentage points in trade growth therefore suggests a modest impact of the AfCFTA Agreement's implementation on GHG emissions.

Second, while intra-Africa trade would increase considerably, it would come at the expense of Africa's trade with the rest of the world, which would decrease slightly. The net change in Africa's total trade would be limited, so the change in emissions would be as well.

Third, because over 95% of GHG emissions come from the production process,[18] implementing the AfCFTA Agreement reduces GHG emissions in two emissions-intensive sectors: livestock (0.16% lower) and coal (1.01% lower) (see figure A1 in the appendix). Because the two sectors account for non-negligeable shares of Africa's total GHG emissions (around 20% for livestock and 5% for coal), the reduction in emissions from these two sectors also limits the increase in Africa's total GHG emissions.

Fourth, as much as 60% of the increase in Africa's total GHG emissions in 2045 from implementing the AfCFTA Agreement comes from higher CO_2 emissions. The increase is from a small base: without the agreement, CO_2 would account for around 25% of Africa's total GHG

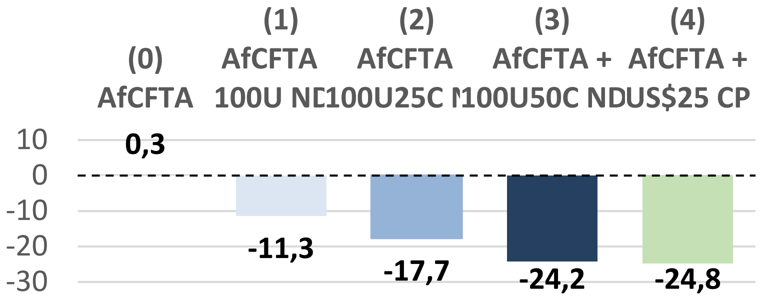
[18] Transportation, including domestic and international transportation, is modelled as a sector that performs production activities.

emissions in 2045 and non-CO_2 emissions for the rest. Africa's baseline GHG emissions are driven largely by agriculture, land use and waste, which mostly involve non-CO_2 emissions.

4.3 Impact on GHG emissions and economic outcomes from implementing the AfCFTA Agreement and adopting climate policies in Africa

Adopting climate policies in line with African countries' NDCs in addition to implementing the AfCFTA Agreement leads to a 11.3%–24.8% decrease in GHG emissions from Africa in 2045, depending on the policies' level of ambition (figure 2). Scenario 4, the most ambitious scenario, assumes a common carbon price in line with the IMF's ICPF proposal for low-income countries and would reduce emissions by 24.8%. To reach a comparable reduction in GHG emissions through their NDCs, African countries would have to fulfil 100% of their unconditional commitments and 50% of their conditional commitments (scenario 3), which would reduce emissions by 24.2%.

Figure 2. Change in greenhouse gas emissions in 2045 from implementing the African Continental Free Trade Area Agreement and adopting climate policies in Africa, relative to the business as usual scenario (%)



Note: The business as usual scenario assumes no implementation of the African Continental Free Trade Area Agreement or adoption of climate policies in Africa. Scenario 0, included for comparison only, reflects implementation of the agreement without any climate policies in Africa. Scenario 1 reflects implementation of the agreement and fulfilment of all unconditional commitments for emissions reduction. Scenario 2 reflects implementation of the agreement and fulfilment of all unconditional commitments and 25% of conditional commitments for emissions reduction. Scenario 3 reflects implementation of the agreement and fulfilment of all unconditional commitments and 50% of conditional commitments for emissions reduction. Scenario 4 reflects implementation of the agreement and an exogenous uniform carbon price in African countries of US$ 25 (in 2014 dollars) per ton of carbon (per the International Monetary Fund's International Carbon Price Floor proposal). Scenario 5 is not included here because it is designed to have the same overall emissions reduction in Africa as scenario 4 through differentiated but coordinated efforts among African countries.

Source: Authors' simulations using the MIRAGE-Power model.

Implementing the AfCFTA Agreement would increase Africa's overall GDP in 2045 by 0.9%, compared with not implementing the agreement, but adopting climate policies in Africa in addition to implementing the agreement would reduce this figure by redirecting resources towards decarbonization (table 1).

The MIRAGE-Power model, because of its computable general equilibrium structure, departs from an integrated assessment model that would incorporate a damage function associated with temperature elevation. Hence, there is no positive feedback on GDP from lower emissions. Absent this feedback, the analysis underestimates the economic benefits of climate policies. Within this modelling framework, the important question is whether "greening the AfCFTA" through parallel adoption of climate policies that reduce GHG emissions could still deliver a positive outcome in economic terms while reducing emissions.

More ambitious climate policies in Africa reduce the expected macroeconomic impacts on GDP and trade from the AfCFTA Agreement. This is true particularly as the ambition to fulfil conditional commitments increases (thereby highlighting that a much larger share of African countries' commitments are conditional). Indeed, if countries fulfilled 100% of their unconditional commitments and 50% of their conditional ones in addition to implementing the agreement (scenario 3), Africa's GDP would be lower than without the agreement or climate policies, and the increase in intra-African trade would be nearly 3.4 percentage points smaller than with the agreement implemented but without any climate policies (scenario 0) (see table 1). The differences in macroeconomic impacts between the scenario with only the agreement and the other scenarios with both the agreement and climate policies are smaller.

Table 1. Change in economic outcomes in 2045 from implementing the African Continental Free Trade Area (AfCFTA) Agreement and adopting climate policies, relative to the business as usual scenario (%)

	Scenario					
	(0)	(1)	(2)	(3)	(4)	(5)
Outcome	**AfCFTA**	**AfCFTA + 100U NDC**	**AfCFTA + 100U25C NDC**	**AfCFTA + 100U50C NDC**	**AfCFTA + US$25 CP**	**AfCFTA + coordination**
GDP volume	0.9	0.7	0.4	–0.2	0.3	0.5
Exports	5.8	4.5	3.5	2.0	3.5	3.4
Intra-Africa trade	34.6	34.7	33.4	31.2	33.6	33.4

Note: The business as usual scenario assumes no implementation of the African Continental Free Trade Area Agreement or adoption of climate policies in Africa. Scenario 0, included for comparison only, reflects implementation of the agreement without any climate policies in Africa. Scenario 1 reflects implementation of the agreement and fulfilment of all unconditional commitments for emissions reduction. Scenario 2 reflects implementation of the agreement and fulfilment of all unconditional commitments and 25% of conditional commitments for emissions reduction. Scenario 3 reflects implementation of the agreement and fulfilment of all unconditional commitments and 50% of conditional commitments for emissions reduction. Scenario 4 reflects implementation of the agreement and an exogenous uniform carbon price in African countries of US$ 25 (in 2014 dollars) per ton of carbon (per the International Monetary Fund's International Carbon Price Floor proposal). Scenario 5 reflects proportional emissions reductions by each country that yield the same overall emissions reduction in Africa as scenario 4 and is expected to be more economically efficient because countries with higher emissions will have to curb their emissions more.

Source: Authors' simulations using the MIRAGE-Power model.

In sum, greening the AfCFTA Agreement would not substantially undermine the increase in intra-Africa trade that the agreement will bring about. The scenario with the adoption of differentiated but coordinated efforts to reduce emissions through carbon pricing (scenario 5) appears to be the most economically efficient. So, regional cooperation on climate policies, combined with regional trade integration, is likely a promising avenue for economic and environmental progress in Africa.

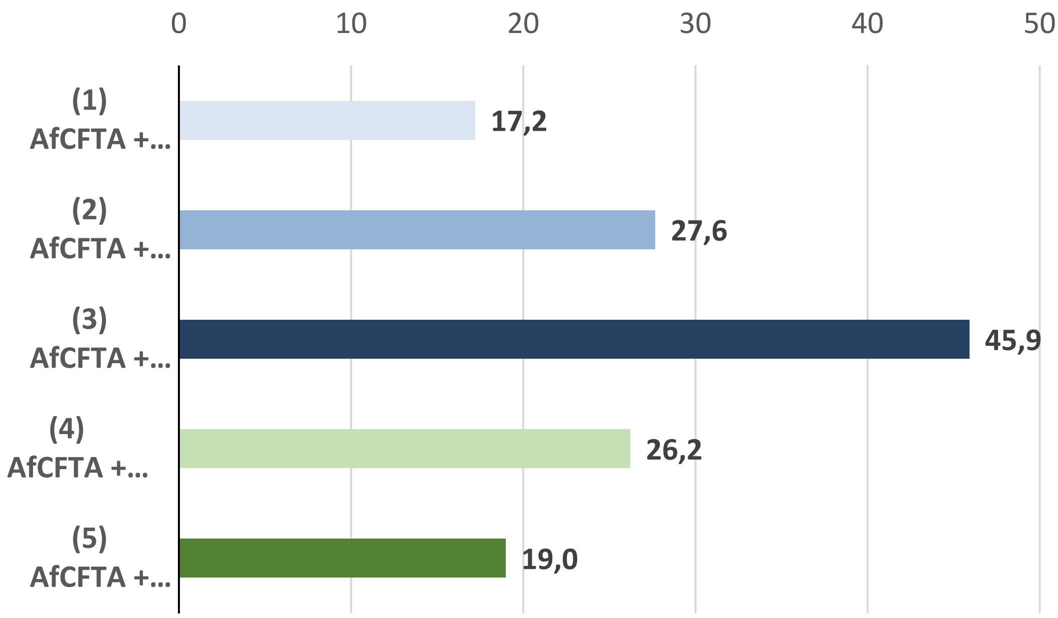
4.4 Abatement cost of climate policies in Africa

The ultimate criterion for assessing the efficiency of climate policies is the cost of one ton of carbon avoided. It is computed here as the loss in GDP per ton of avoided GHG emissions after the AfCFTA Agreement has been implemented.

Implementing the AfCFTA Agreement and fulfilling all unconditional commitments (scenario 1) would reduce GHG emissions at a cost of US$ 17.20 to avoid one ton of carbon (figure 3), in line with the limited ambition of these NDCs. In contrast, implementing the agreement and fulfilling all unconditional commitments and 25% of conditional commitments (scenario 4) would cost US$ 27.60 per ton of carbon avoided—close to the cost envisaged under the IMF's ICPF proposal for low-income countries. Enhanced ambition in fulfilling conditional commitments—implementing the agreement and fulfilling all unconditional commitments and 50% of conditional commitments (scenario 3)—would raise the abatement cost substantially, to US$ 45.90 per ton of carbon avoided.

Most importantly in terms of African integration, differentiated but coordinated efforts among African countries to reduce emissions through carbon pricing (scenario 5) reduces the abatement cost to US$ 19.00 per ton of carbon (see figure 3). This scenario is disconnected from the bottom-up approach of the Paris Agreement: the abatement cost of efficient cooperative carbon pricing in Africa is computed from a determined reduction in emissions, based on harmonized carbon pricing across Africa, as suggested by the IMF's ICPF proposal. Nonetheless, it is worth exploring how this option compares with the NDCs (with both unconditional and conditional commitments) set by African countries under the Paris Agreement (see the next subsection).

Figure 3. Abatement cost of climate policies in Africa (US$ per ton of carbon avoided)



Note: Scenario 1 reflects implementation of the AfCFTA and fulfilment of all unconditional commitments for emissions reduction. Scenario 2 reflects implementation of the agreement and fulfilment of all unconditional commitments and 25% of conditional commitments for emissions reduction. Scenario 3 reflects implementation of the agreement and fulfilment of all unconditional commitments and 50% of conditional commitments for emissions reduction. Scenario 4 reflects implementation of the agreement and an exogenous uniform carbon price in African countries of US$ 25 (in 2014 dollars) per ton of carbon (per the International Monetary Fund's International Carbon Price Floor proposal). Scenario 5 reflects proportional emissions reductions by each country that yield the same overall emissions reduction in Africa as scenario 4.

Source: Authors' simulations using the MIRAGE-Power model.

4.5 African countries' NDCs in perspective

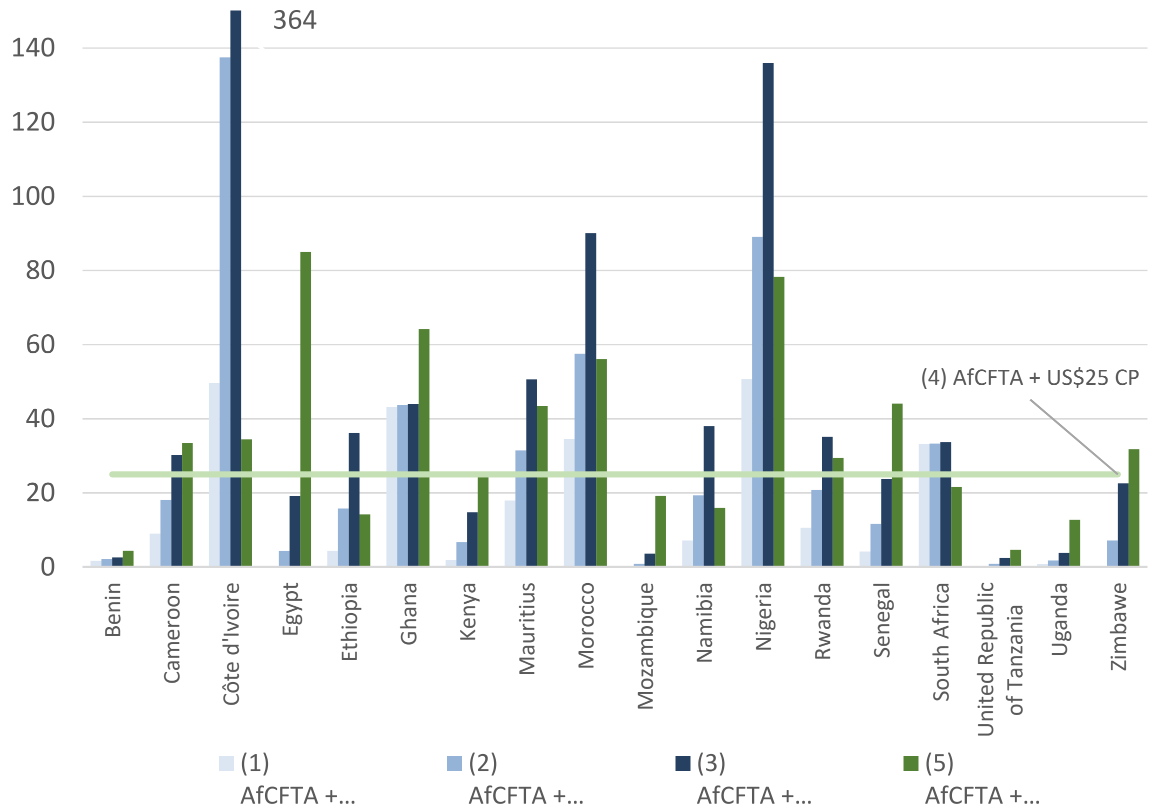
Adopting homogenous carbon pricing across Africa in addition to implementing the AfCFTA Agreement would reduce Africa's GHG emissions in 2045 by 25%, compared with not implementing the agreement or adopting climate policies, but that reduction could be attained more efficiently (that is, with a lower overall abatement cost) through differentiated and coordinated efforts among African countries (see figure 3). However, this solution would have to be backed by differentiated national policies, wherein countries with higher emissions adopt more aggressive abatement policies. In other words, the implicit carbon price—the equivalent carbon price of abatement policies—for countries with higher emissions would be above the average for Africa. This outcome does not differ from the induced variability in implicit carbon prices across the continent that would be needed to fulfil national NDCs.

This subsection compares the implicit carbon prices that each scenario induces, by country.

The climate policy ambition of NDCs in Africa differs considerably across countries. Under scenario 1, where the AfCFTA Agreement is implemented and all unconditional commitments are fulfilled, only 4 of 18 African countries with data[19] (Côte d'Ivoire, Ghana, Morocco and Nigeria) have commitments that correspond to ambitious climate policies: their commitments translate to implicit carbon prices well above the benchmark of US$ 25 per ton of carbon used in the analysis (in line with the IMF's ICPF proposal for low-income countries) (figure 4). South Africa's implicit carbon price would be closer to this benchmark. Egypt, Mozambique, the United Republic of Tanzania and Zimbabwe would have null implicit carbon prices because they have no unconditional commitments. All the remaining African countries in the simulations would have implicit carbon prices far below the US$ 25 benchmark.

[19] Data for other African countries are included in aggregates for African country groupings (see table A2 in the appendix).

Figure 4. Implicit carbon prices in 2045 resulting from Nationally Determined Contributions and cooperative burden sharing, after the African Continental Free Trade Area Agreement is implemented (US$ per ton of carbon)



Note: The figure does not include aggregates for African country groupings (see table A2 in the appendix). Scenario 1 reflects implementation of the AfCFTA and fulfilment of all unconditional commitments for emissions reduction. Scenario 2 reflects implementation of the agreement and fulfilment of all unconditional commitments and 25% of conditional commitments for emissions reduction. Scenario 3 reflects implementation of the agreement and fulfilment of all unconditional commitments and 50% of conditional commitments for emissions reduction. Scenario 4 reflects implementation of the agreement and an exogenous uniform carbon price in African countries of US$ 25 (in 2014 dollars) per ton of carbon (per the International Monetary Fund's International Carbon Price Floor proposal). Scenario 5 reflects proportional emissions reductions by each country that yield the same overall emissions reduction in Africa as scenario 4.

Source: Authors' simulations using the MIRAGE-Power model.

Under scenario 3, where the AfCFTA Agreement is implemented and all unconditional commitments and 50% of conditional commitments are fulfilled, 10 African countries would have implicit carbon prices above the benchmark of US$ 25 per ton of carbon, and 2 others would have implicit carbon prices above US$ 20 (see figure 4).

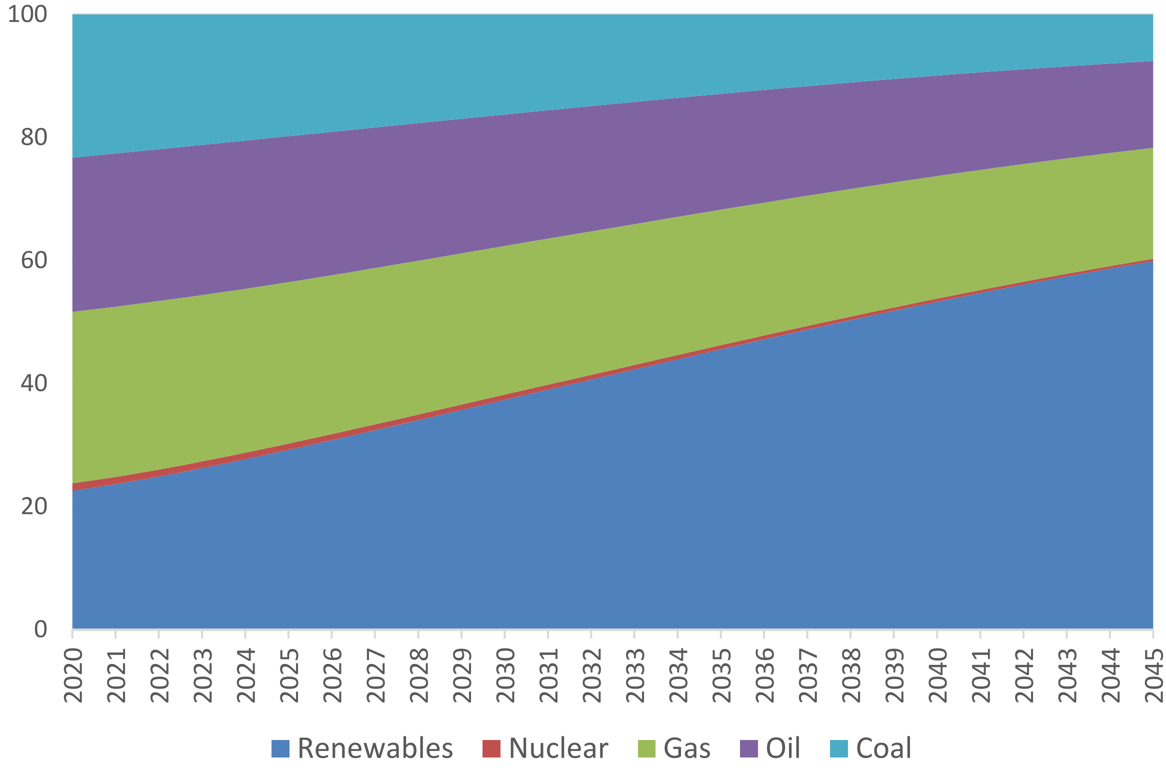
The large differences in implicit carbon prices associated with African countries' NDCs are totally disconnected from the implicit carbon prices of scenario 5—with differentiated but coordinated efforts to reduce emissions through carbon pricing, whereby countries with higher emissions would reduce their GHG emissions more—because the abatement cost is lower. This sheds light on the issues raised by the bottom-up approach endorsed in the Paris Agreement. Indeed, though the implicit carbon prices in scenarios 3 and 5 are comparable in Benin, Cameroon, Mauritius, Rwanda and the United Republic of Tanzania, they differ greatly in other African countries. Côte d'Ivoire, Morocco and Nigeria would have prohibitively high implicit carbon prices under the most ambitious NDC scenario (scenario 3), and therefore their reduction in GHG emissions would be much larger under a carbon price scenario based on differentiated but coordinated efforts (scenario 5).

To meet their climate objectives, most African countries will require external financial support and technology transfer. Continental coordination to establish carbon markets in Africa shows promise for reducing Africa's GHG emissions in the context of the AfCFTA Agreement.

4.6 Impact of climate policies in Africa on the electricity generation mix

According to the BAU scenario, even in the absence of climate policies in Africa, the continent is already on the path to a green transition, with an increasing share of renewables expected in the electricity generation mix. Indeed, the share of renewables in Africa's electricity generation mix is expected to rise from 23% in 2020 to 37% in 2030 and 60% in 2045 (figure 5). This dynamic evolution is in accordance with the projections in IEA (2022b).

Figure 5. Projected evolution of Africa's electricity generation mix for 2020–2045 under the business as usual scenario, by main source (%)

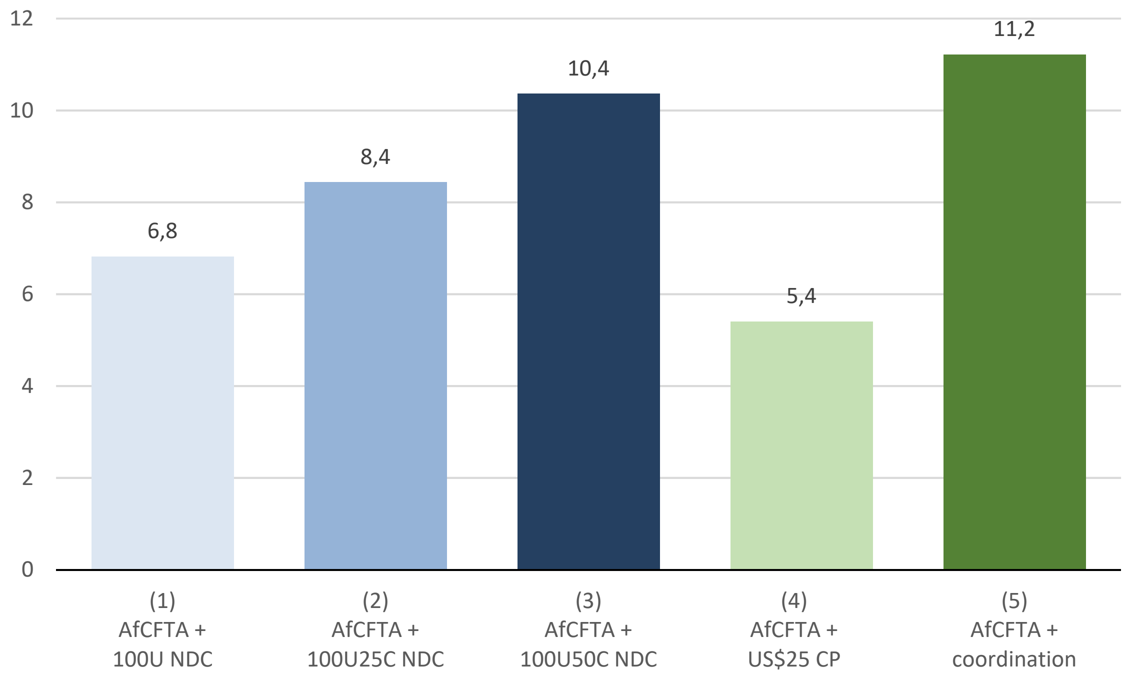


Note: The business as usual scenario assumes no implementation of the African Continental Free Trade Area Agreement or adoption of climate policies in Africa.

Source: Authors' simulations using the MIRAGE-Power model.

Adopting climate policies in Africa in addition to implementing the AfCFTA Agreement would accelerate the continent's green transition, with the share of renewables in Africa's electricity generation mix growing further under all scenarios considered (figure 6). The largest increase would again be under the coordinated approach scenario, reinforcing support for regional coordination to achieve climate policy action in Africa. The much higher implicit carbon prices required in a few high-emissions African countries (for example, Côte d'Ivoire, Morocco and Nigeria) (see figure 4) under various scenarios compared with the uniform US$ 25 per ton explain the smaller increase in these countries.

Figure 6. Change in the share of renewables in Africa's electricity generation mix in 2045 under various climate policy options, relative to the business as usual scenario (%)



Note: The business as usual scenario assumes no implementation of the African Continental Free Trade Area Agreement or adoption of climate policies in Africa.

Source: Authors' simulations using the MIRAGE-Power model.

5 Conclusion

Implementing the AfCFTA Agreement will promote intra-Africa trade without substantially worsening climate change. This contrasts with the expected increase in Africa's emissions due to the economic growth, even without a regional trade agreement. The agreement could also renew regional political perspectives and add climate policies to the agenda, as suggested by emerging discussions on carbon pricing.

Even if adopting climate policies in line with Africa's climate objectives in addition to implementing the AfCFTA Agreement would somewhat undermine anticipated economic gains from the agreement, intra-Africa trade would still grow considerably. Two carbon pricing scenarios (either a uniform price across Africa or differentiated implicit national prices determined through continental coordination) would lead to substantially lower GHG emissions (24.8% lower) relative to no agreement or climate policies, while preserving intra-Africa trade increases induced by the agreement (33.4% under a coordinated climate policy approach, compared with 34.6% with the agreement alone).

Combining implementation of the AfCFTA Agreement with differentiated national carbon prices determined through continental coordination, which guarantees a reduction in Africa's emissions similar to that from the uniform carbon price of US$ 25, not only shows the greatest reduction in GHG emissions (24.8%) but also a low abatement cost (US$ 19.00 per ton of carbon).

Based on implicit carbon prices relative to the proposed US$ 25 uniform carbon price for low-income countries from the IMF's ICPF, the climate policy ambition of African countries' NDCs differs greatly, including their often smaller shares of unconditional commitments. Under the least ambitious scenario, with only unconditional commitments fulfilled, just a handful of African countries (Côte d'Ivoire, Ghana, Morocco, Nigeria and South Africa) would have implicit carbon prices above the US$ 25 benchmark. However, under a more ambitious scenario, with all unconditional commitments and 50% of conditional commitments fulfilled, most African countries would have implicit carbon prices above the benchmark. Also, those prices would be extremely variable across countries, with gaps totally disconnected from the differences in implicit carbon prices under the scenario with differentiated but coordinated efforts.

Furthermore, Africa's climate objectives can accelerate transition to renewables, with a coordinated approach across the continent offering the best outcome.

In sum, pricing carbon in Africa seems to be an effective mechanism to help African countries meet the climate objectives defined in their NDCs, and continental coordination shows the most promising results. While coordination may be difficult to achieve, the AfCFTA Agreement promotes regional economic integration, offering an unprecedented opportunity for regional climate policy cooperation. Both a uniform price of US$ 25 per ton of carbon across Africa and differentiated national prices set through continental coordination that yield a similar overall reduction in Africa's GHG emissions seem to be viable benchmarks. More could certainly be achieved, but as carbon prices increase, the trade-off between environmental and economic ambitions comes into play.

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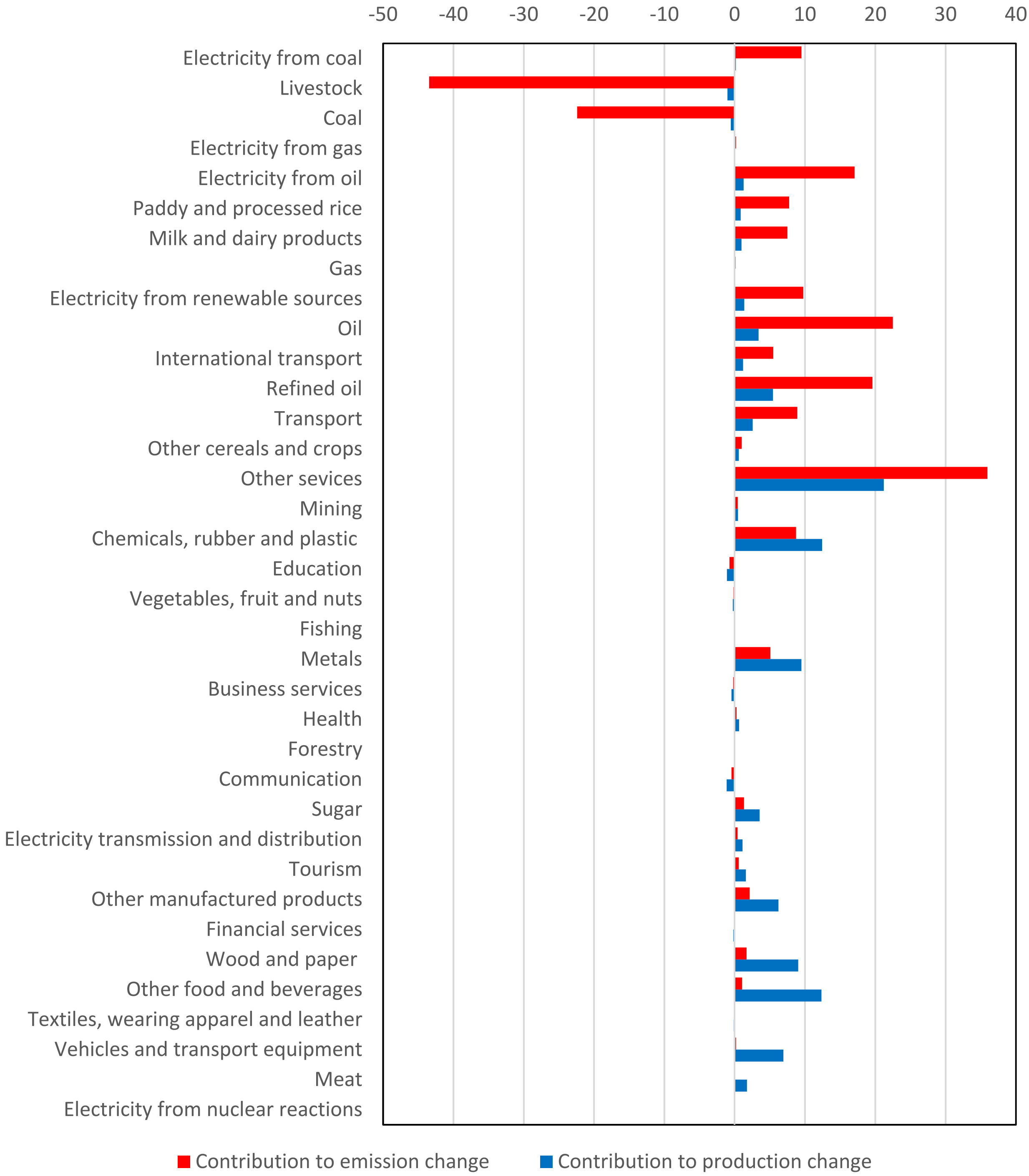
Appendix

Figure A1. Sectoral contribution to emissions intensity and production change with implementation of the African Continental Free Trade Area Agreement (%)



Note: Sectors are listed from the most to least emissions intensive sector.

Source: Authors' simulations using the MIRAGE-Power model.

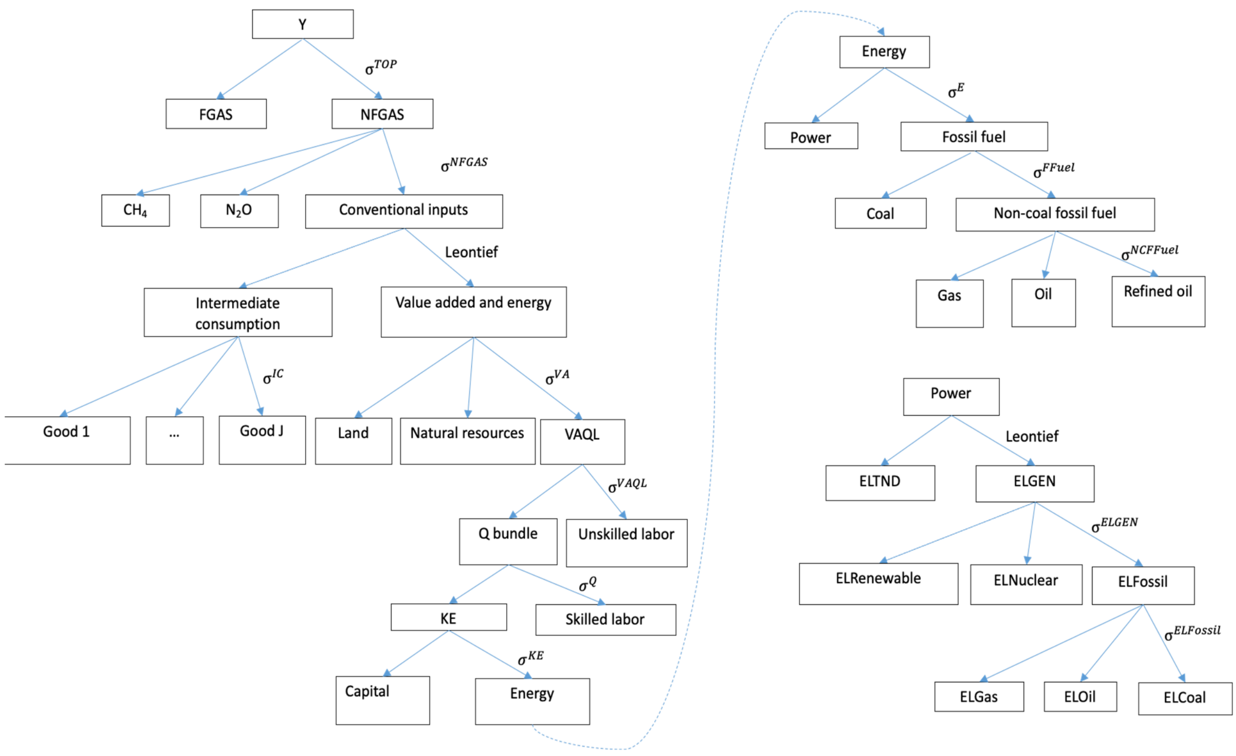
Table A1. Sectoral aggregation

MIRAGE sector	Aggregated sector code	Global Trade Analysis Project sector code
Business services	bus	obs
Other cereals and crops	cec	wht, gro, osd, pfb, ocr
Chemical, rubber, plastic, pharma	chp	chm, bph, rpp
Coal	coal	coa
Communication	com	cmn
Milk and dairy products	dpd	rmk, mil
Education	edu	edu
Electricity from coal	ElCoal	CoalBL
Electricity from gas	ElGas	GasBL, GasP
Electricity from nuclear reactions	ElNuclear	NuclearBL
Electricity from oil	ElOil	OilBL, OilP
Electricity from renewable sources	ElRen	WindBL, HydroBL, OtherBL, HydroP, SolarP
Mining	ext	oxt, nmm
Financial services	fin	ofi
Forestry	frs	frs
Fishing	fsh	fsh
Gas	gas	gas, gdt
Health	hea	hht
International transport	inttrp	wtp, atp
Livestock	lvs	ctl, oap, wol
Meat	meat	cmt, omt
Metals	met	i_s, nfm, fmp
Other food and beverages	ofdb	vol, ofd, b_t
Oil	oil	oil
Other manufactured products	oma	ele, eeq, ome, omf
Other services	ose	wtr, cns, trd, whs, ins, rsa, ros, osg, dwe
Power	power	ely
Refined oil	refinedoil	P_c
Paddy and processed rice	ric	pdr, pcr
Sugar	sug	c_b, sgr
Textiles, wearing apparel and leather	tal	tex, wap, lea
Electricity transmission and distribution	tnd	tnd
Tourism	trm	afs
Transport	trp	otp
Vegetables, fruit and nuts	vfn	v_f
Vehicles and transport equipment	vtp	mvh, otn
Wood, paper, plastic and chemicals	wop	lum, pp

Table A2. Regional aggregation

MIRAGE region	Aggregated region code	Global Trade Analysis Project region code
Benin	Benin	BEN
Cameroon	Cameroon	CMR
China	China	CHN
Côte d'Ivoire	CoteIv	CIV
Egypt	Egypt	EGY
Ethiopia	Ethiopia	ETH
EU27_UK	EUUK	AUT, BEL, CYP, CZE, DNK, EST, FIN, FRA, DEU, GRC, HUN, IRL, ITA, LVA, LTU, LUX, MLT, NLD, POL, PRT, SVK, SVN, ESP, SWE, GBR, BGR, HRV, ROU
Ghana	Ghana	GHA
Kenya	Kenya	KEN
Mauritius	Mauritius	MUS
Morocco	Morocco	MAR
Mozambique	Mozam	MOZ
Namibia	Namibia	NAM
Nigeria	Nigeria	NGA
Rest of North Africa	RoAMU	TUN, XNF
Rest of the Economic Community of Central African States	RoECCAS	XCF
Rest of Economic Community of West African States	RoECOWAS	BFA, GIN, TGO, XWF
Rest of the Tripartite Free Trade Area	RoTFTA	XAC, MDG, MWI, SDN, ZMB, XEC, BWA, XSC
Rest of the world, absolute	ROW_abs	AUS, NZL, JPN, CAN, ARG, BRA, ECU, CRI, GTM, CHE, NOR, BLR, UKR, XEE, KAZ, TJK, AZE, ISR
Rest of the world, business as usual scenario, absolute	ROW_bau	KOR, MNG, IDN, THA, VNM, BGD, LKA, MEX, COL, PRY, PER, JAM, ALB, KGZ, GEO, IRN, JOR
Rest of the world, intensity	ROW_int	MYS, SGP, CHL
Rest of the world, others	ROW_oth	XOC, HKG, TWN, XEA, BRN, KHM, LAO, PHL, XSE, IND, NPL, PAK, XSA, XNA, BOL, URY, VEN, XSM, HND, NIC, PAN, SLV, XCA, DOM, PRI, TTO, XCB, SRB, XEF, RUS, XER, XSU, ARM, BHR, IRQ, KWT, LBN, OMN, PSE, QAT, SAU, TUR, SYR, ARE, XWS, XTW
Rwanda	Rwanda	RWA
Senegal	Senegal	SEN
South Africa	Sthafrica	ZAF
Tanzania	Tanzania	TZA
Uganda	Uganda	UGA
United States	USA	USA
Zimbabwe	Zimbabwe	ZWE

Figure A2. Structure of the production function for the manufacturing and services sectors in the MIRAGE-Power model



Note: *Y* is production, σ^{TOP} is the top-level elasticity of substitution, *FGAS* is fluorinated gases, *NFGAS* is non-fluorinated gases, σ^{NFGAS} is the elasticity of substitution of non-fluorinated gases, CH_4 is methane, N_2O is nitrous oxide, σ^{IC} is the elasticity of substitution of intermediate consumption, σ^{VA} is the elasticity of substitution of value added, *VAQL* is the value added from the capital-energy-labour bundle, $\sigma VAQL$ is the elasticity of substitution between unskilled labour and the capital-energy–skilled labour bundle, *Q bundle* is the capital-energy–skilled labour bundle, σ^{Q} is the elasticity of substitution between skilled labour and the capital-energy bundle, *KE* is the capital-energy bundle, σ^{KE} is the elasticity of substitution between capital and energy, σ^{E} is the elasticity of substitution between the electricity generation bundle and the fossil fuels bundle, *POWER* is electric power, σ^{FFuel} is the elasticity of substitution of fossil fuel, $\sigma^{NCFFuel}$ is the elasticity of substitution of non-coal fossil fuels, *ELTND* is electricity transmission and distribution, *ELGEN* is electricity generation, σ^{ELGEN} is the elasticity of substitution of electricity generation activities, *ELRenewable* is renewable electricity, *ELNuclear* is electricity from nuclear sources, *ELFossil* is electricity from fossil fuels, $\sigma^{ELFFossil}$ is the elasticity of substitution of electricity from fossil fuels, *ELGas* is electricity from gas, *ELOil* is electricity from oil and *ELCoal* is electricity from coal.

Source: Author's construction